NORD STREAM 2
ANNUAL MONITORING REPORT 2020

Nord Stream 2 Natural Gas Pipeline construction and operation in the Finnish EEZ
Environmental and Technical Monitoring

Date: 25.05.2021
Project: PO 17-5149
Client: Nord Stream 2 AG
Document ID: W-PE-EMO-PFI-REP-812-AR2020EN-04

SITOWISE

LUODE Consulting

Nord Stream 2

Natural Gas Pipeline construction and operation in the Finnish EEZ

Environmental and Technical Monitoring

Annual Monitoring Report 2020

The Annual Monitoring Report 2020 builds upon the Annual Monitoring Reports 2018 and 2019. If there is conflicting information in the Annual Monitoring Reports, it is due to data available at the time of reporting and the Annual Monitoring Report 2020 prevails.

The original report is written in Finnish and has been, together with appendices, translated into Swedish and English. If there is conflicting information in the different language versions, the Finnish version prevails.

The draft report was developed by Sitowise Oy in 2020. Luode Consulting Oy has been the responsible consultant for reporting since February 2021.

Cover photo:
© Antti Below

SITOWISE

LUODE Consulting

ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
ADD	Acoustic deterrent device
ASCOBAN	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
AUT	Automatic Ultrasonic Testing
AVI	Aluehallintovirasto (Regional State Administrative Agency)
BQR	Biological quality ratio
DCC	Distance cross course
DP	Dynamic positioning
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
ELY	Elinkeino-, liikenne- ja ympäristökeskus (Centre for Economic Development, Transport and the Environment)
FKP	Finnish kilometre point
FNU	Formazin nephelometric unit (turbidity)
GES	Good environmental status (Marine strategy framework directive)
GKP	Global kilometre point
GOFREP	Gulf of Finland reporting system
ha	Hectare (10,000 m^2)
HELCOM	The Baltic Marine Environment Protection Commission – Helsinki Commission
IUCN	International Union for Conservation of Nature
JNCC	Great Britain's Joint Nature Conservation Committee
MBES	Multi-beam echo sounder
MMO	Marine mammal observer
NDAA	National Defense Authorization Act
NEQ	Net explosive quantity
NSP	Nord Stream Project
NSP2	Nord Stream 2 Project
NTU	Nephelometric turbidity unit
PAM	Passive acoustic monitoring device
PSU	Practical salinity unit
PTS	Permanent threshold shift
Q	Quarter of the year
ROV	Remotely operated vehicle
SAC	Special area of conservation
SAMBAH	Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise
SCI	Sites of community importance
SEL	Sound exposure level
SPL	Sound pressure level
SPA	Special protection area

t	Tonne
TTS	Temporary threshold shift
TSS	Traffic separation scheme
UXO	Unexploded ordnance
WP	Water Permit

CONTENTS

Annexes

SUMMARY

Scope of this report

The Annual Monitoring Report 2020 presents the results of environmental and technical monitoring in 2020. It includes a summary of the monitoring results in 2018-2019 and the assessment of observed impacts of the Nord Stream 2 Project pipeline construction in the Finnish EEZ in the period 2018-2020. It describes the scope and methodology used in the assessment and discusses the results.

Nord Stream 2 Project

Nord Stream 2 AG is constructing a new offshore twin natural gas pipeline system from Russia to Germany through the Baltic Sea. The length of the pipeline is approximately 1,230 km. Pipelines pass through the territorial waters and/or Exclusive Economic Zones (EEZ) of Russia, Finland, Sweden, Denmark and Germany. In the Finnish EEZ, the length of the route is approximately 374 km and it parallels the existing Nord Stream pipeline route. Pipeline construction in the Finnish EEZ started in April 2018 and it was completed in May 2020.

Monitoring targets

The monitoring targets according to the Environmental monitoring programme (approved within the Water Permit decision 53/2018/2) include underwater noise, water quality and currents, commercial fishery and cultural heritage. Additional monitoring activities have been implemented through specialist studies, to strengthen the assessment of impacts from the Nord Stream 2 implementation, and to enhance scientific knowledge of the Baltic Sea environment. These activities cover sediment contaminants, marine mammals, ship traffic and transboundary impacts.

Construction activities in the Finnish EEZ in 2018–2020

The Nord Stream 2 construction activities in 2018 included munitions clearance, rock placement, mattress installation and pipelay. Munitions clearance and mattress installation were completed in 2018. Construction activities in 2019 included pipelay and rock placement. Pipelay was completed in 2019. Rock placement was completed in 2020. Completion of construction was notified in accordance to the EEZ Consent to The Ministry of Economic Affairs and Employment in June 2020 and in accordance to Water Permit to AVI in July 2020.

Maintenance activities in the Finnish EEZ in 2020

One maintenance related task in year 2020 was conducted in November, when the rock placement vessel Rockpiper conducted maintenance rock placement at a single berm in the western part of the Finnish route section.

Environmental monitoring results 2018-2020

The Nord Stream 2 monitoring during 2018–2020 was performed in line with the environmental monitoring programme. The results of monitoring were compared to modelled impacts and assessments presented in the Water Permit application, as well as to the monitoring results from the Nord Stream pipeline project. All impacts were in line or smaller than assessed in the permitting phase.

Environmental monitoring results in 2020

Based on monitoring results in the Sandkallan area the nearby rock placement activities did not have an effect on water quality.

Underwater noise

The modelling done for the Water Permit application overestimated the noise generated during the munitions clearance work. The measured peak levels were lower and the calculated PTS (Permanent threshold shift) areas were much smaller than modelled. Main reason for difference was that the viable munition charge was often smaller than predicted, and it is also possible that the bubble curtain mitigated noise more effectively than expected. Underwater noise monitoring was carried between April 2018 and July 2018.

Underwater noise, related to munitions clearance, did not cause any behavioral impacts on grey seals at the Kallbådan seal reserve based on the Metsähallitus remote video camera monitoring conducted in 2018 and 2020. Metsähallitus is a Finnish state-owned enterprise that produces environmental services and uses, manages and protects state-owned land and water areas.

The impacts of underwater noise on biodiversity (via marine mammals) were minor and negligible in protected areas, as it was predicted in the modelling for the Water Permit application.

Water quality and currents

The impacts of the relocation of sediments on water quality during construction activities (munitions clearance and rock placement) were predicted to be minor. Construction was predicted not to deteriorate the conditions for the biota at the Sandkallan Natura 2000 site.

Turbidity impacts were generally lower than predicted and briefer in duration. At the long-term monitoring stations, including Sandkallan, only natural variation in turbidity could be detected from April 2018 to May 2020.

The impacts of construction work on water quality were minor, as predicted, and the integrity of the Natura 2000 network was not threatened by any impacts from the Nord Stream 2 Project construction in the Finnish EEZ during 2018–2020.

Commercial fishery

The impacts on commercial fishery in the Finnish EEZ, via possible changes in trawling patters, will be assessed later when the operational phase of the pipeline will start.

Cultural heritage

All cultural heritage sites within 250 m of the pipeline route were evaluated by a marine archaeologist, and two targets were identified to require precaution during construction work.

With regard to the World War II submarine barrage, the construction activities in the proximity had to be carried out in the way that minimised the damage to the target. As the anti-submarine net spreads across a long distance in the Gulf of Finland, it could not be completely avoided. To limit the damage to the target, pipeline was laid across the barrage mostly with a free-span. Some section of the pipeline is, however, in contact with the net, and therefore the impact is assessed to have been minor.

A safety zone with a radius of 50 m was required around the cannon barge from the 18th or 19th century. No construction activities were carried out within the safety zone. Line A was laid at a distance of 130 m in 2018 and Line B was laid at a distance of about 63 m from the target in 2019. No further construction activities were conducted or are planned in the surroundings. It is assessed that the impact on the target has been negligible. No monitoring was performed in 2020.

A thorough post-lay survey of both targets will be carried out later to confirm that no damage to the monitoring targets has occurred during the implementation of the project by any construction activity.

Sediment contaminants

Although the overall impact of contaminant relocation was assessed as negligible in the EIA, spreading of heavy metals and explosive residuals around the munitions clearance sites was studied in 2018. The results of the analyses of 17 sediment samples confirm that detonations did not increase the concentrations of harmful substances in the surface sediments. No explosive residuals were detected in the samples, and the heavy metal concentrations, like those found in earlier studies in the Gulf of Finland sediments, varied randomly on the seafloor. There was no correlation between the distance to the detonation site and concentration.

Marine mammals

A series of mitigation measures were successfully implemented to reduce the environmental impacts of underwater noise due to munitions clearance in 2018. Acoustic deterrent devices were used to drive marine mammals out of the clearance area. Trained marine mammal observers confirmed the absence of animals in the vicinity of the detonations. The noise released by the clearances was minimized by surrounding the munitions with the bubble curtain during detonations.

Both the permanent and temporary threshold shift zones were much smaller than predicted, limiting the possibility that any marine mammals would have experienced damage from the noise of construction work. Neither permanent nor temporary threshold shift zones (PTS and TTS) extended to any Natura 2000 areas with marine mammals as conservation objects. Noise did not cause any behavioural impacts on grey seals at the Kallbådan seal reserve based on the Metsähallitus remote video camera monitoring.

The monitored impacts of underwater noise on marine mammals were in line with predicted impacts, minor, for both grey seals and for Baltic ringed seals at both individual and population level.

Ship traffic

As the construction vessels had restricted manoeuvring ability during certain operations, temporary safety zones were established around the construction vessels. Based on records, no incidents related to ship traffic were reported in 2018–2020 and thus the Nord Stream 2 Project´s impact on ship traffic was temporary and negligible.

Crossings

The pipeline currently crosses 31 cables in the Finnish EEZ, 10 of which are out of use. The pipeline has also crossings with the Nord Stream and Balticconnector gas pipelines.

Transboundary impacts

The only potential transboundary environmental impacts of the Nord Stream 2 Project were assessed to be the potential impacts on marine mammals due to underwater noise during munitions clearance. The underwater noise monitoring at the two stations in the Estonian waters confirmed that the noise levels related to the Nord Stream 2 Project construction activities in Estonia neither exceeded the TTS limits nor the PTS limits. It is assessed that the impact significance was minor, as predicted.

Summary of the evaluation of results in 2018-2020

Project impacts on seabed sediments have been assessed to be similar to or smaller than initially predicted in the EIA and in the permit application. Similarly, impacts on water quality were minor and smaller than predicted.

Only minor or negligible impacts on marine biota, biodiversity and protected areas have been observed, in line with the predictions.

Minor impacts have been observed on the World War II anti-submarine net in few locations, where the pipelay could not be conducted with a free-span and pipelines cross the net. No impacts have been observed on the nearby cannon barge. The current status of these archaeological objects will be re-evaluated when a post-construction survey has been completed.

Only temporary and negligible impacts on ship traffic were observed.

The project has not impeded the achievement of the targets of the European Union Marine Strategy and Water Framework Directives (as implemented in the national legislation).

1 INTRODUCTION

The Annual Monitoring Report 2020 presents the results of the environmental and technical monitoring for the construction activities of the Nord Stream 2 gas pipelines in the Finnish Exclusive Economic Zone in 2020. Monitoring was based on the environmental monitoring programme, which was approved within the Water Permit decision. Furthermore, information and findings of relevant studies and follow-up to complement the mandatory monitoring are described. The Annual Monitoring Report 2020 also summarizes the results from the 2018 and 2019 monitoring, which are presented in detail in the Annual Monitoring Reports 2018 and 2019.

1.1 Project

Nord Stream 2 AG is constructing a new offshore twin natural gas pipeline system from Russia to Germany through the Baltic Sea. The length of the pipeline is approximately 1,230 km. The parallel pipelines pass through the territorial waters and/or Exclusive Economic Zones (EEZ) of Russia, Finland, Sweden, Denmark and Germany (Figure 1).

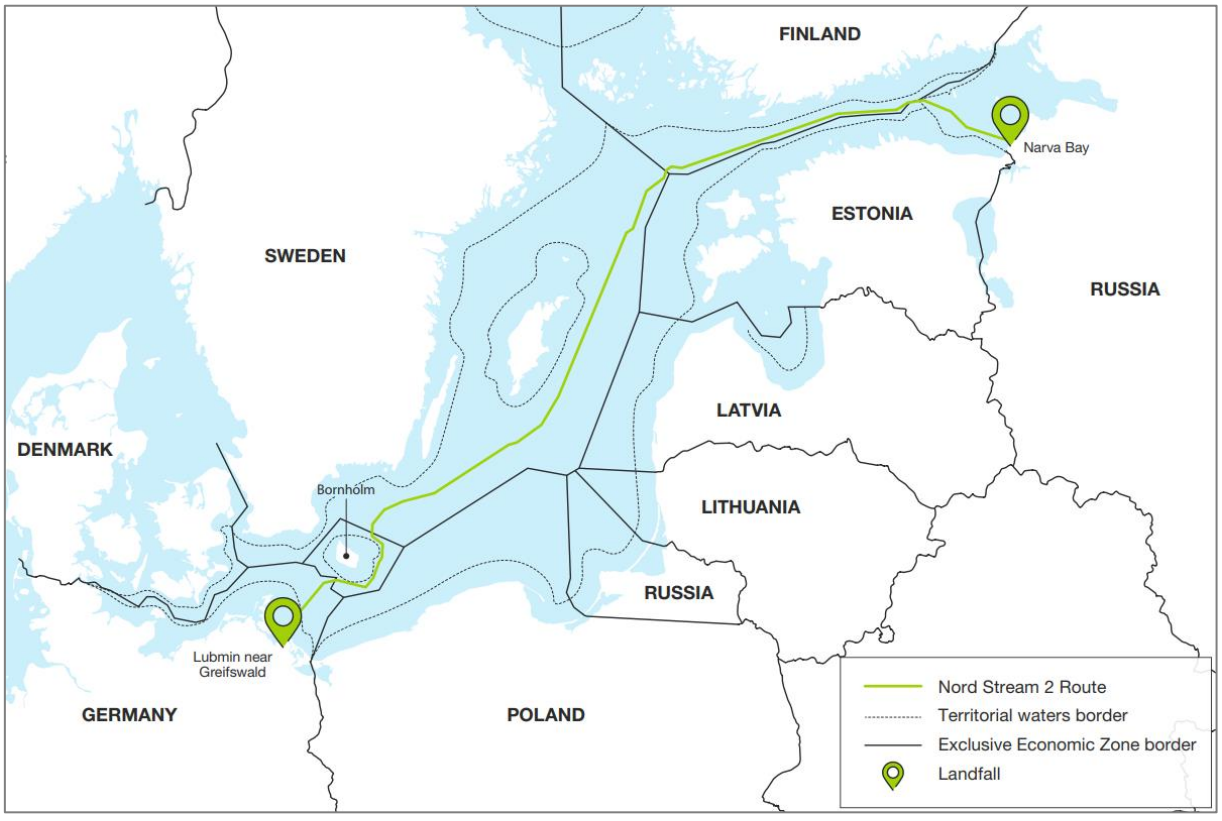


Figure 1. Nord Stream 2 pipeline route. Source: Nord Stream 2 AG.

In the Finnish EEZ, the length of the route is approximately 374 km and it parallels the existing Nord Stream AG pipeline route (Figure 2). The pipelay of Line A in the Finnish EEZ started on September 5, 2018 and it was completed on April 30, 2019, and the pipelay of Line B started on May 18, 2019 and it was completed on August 21, 2019. Rock placement was completed on May 30, 2020. Pipelay of Nord Stream 2 was suspended in the Danish Exclusive Economic Zone by contractor Allseas on December 20, 2019, in anticipation of the enactment of the US National Defense Authorization Act (NDAA).

Due to the US sanctions, pipelay was interrupted for more than one year until it was resumed again in the Danish EEZ on February 20, 2021. As of March 31, a total of 2,339 kilometres (out of 2,460 kilometres) or 95% of the Nord Stream 2 Pipeline have been laid. Approximately 121 kilometres (or 5%) remain. There are approximately 93 kilometres in Danish waters and approximately 28 kilometres in German waters to be laid.

The pipeline was completed in the Russian (2x114 km), Finnish (2x374 km) and Swedish (2x511 km) waters already in 2019. The pipelines will be taken into operation when the construction activities are completed in all countries.

The Nord Stream 2 Pipeline system is planned to deliver natural gas from Russia directly to the European Union gas market. The pipeline system will have an annual capacity to supply about 55 billion cubic metres of gas. The Nord Stream 2 Project implementation is based on the collected experience of the construction and operation of the existing Nord Stream Pipeline.

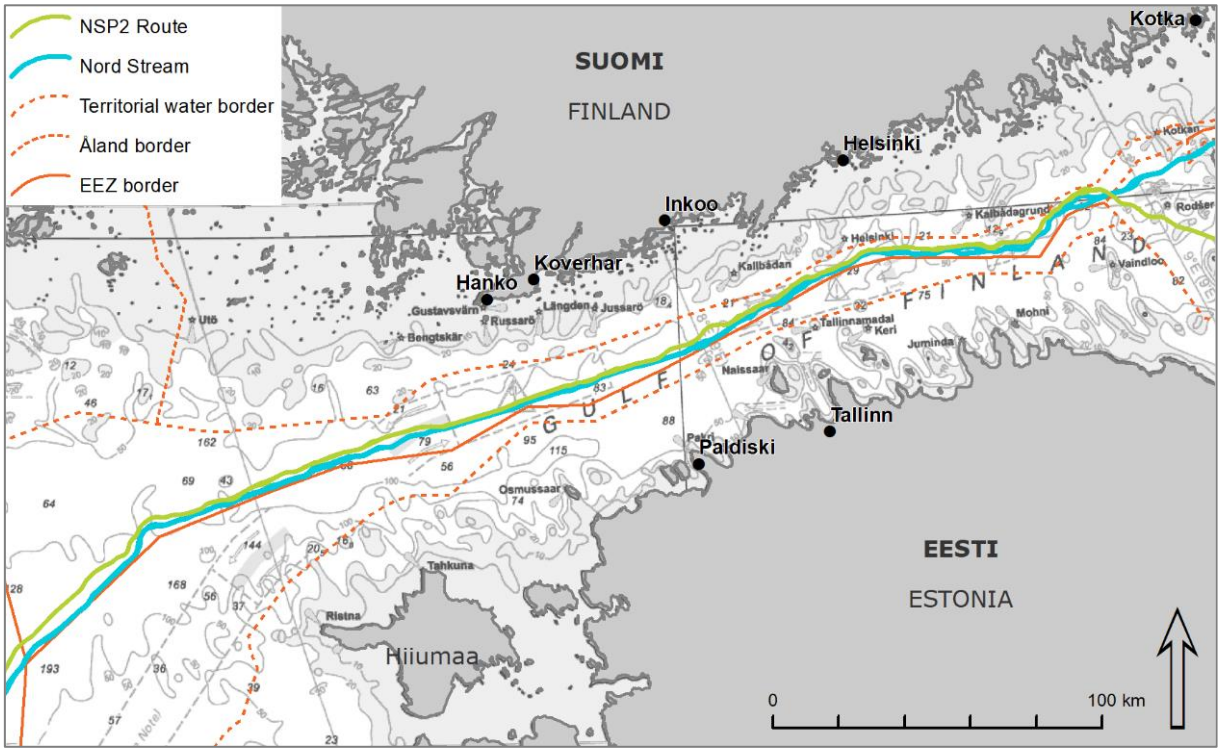


Figure 2.The Nord Stream 2 pipeline route passes through the Finnish EEZ. It is situated north of the existing Nord Stream pipelines with an exception of a short section in the eastern section near the Russian waters.

The Nord Stream Pipelines were taken into operation in 2011 and 2012. Nord Stream monitored the construction in the Finnish waters from 2009 to 2012. Monitoring during the operation phase is still ongoing.

1.2 Permits

The construction and operation of the Nord Steam 2 pipelines required two permits in Finland: a Water Permit from the Regional State Administrative Agency for construction and operation of the pipelines and a Government Consent to use the Finnish EEZ (Table 1). Prior to granting the permits, an Environmental Impact Assessment procedure was applied to the project. The EIA procedure ended on July 26, 2017 when the EIA Authority provided its statement on the EIA report. The EIA Authority notes in its statement, that the EIA report fulfils the content criteria set out in the Decree on Environmental Impact Assessment Procedure in Finland. The EIA statement was considered in the permit applications.

With its decision (TEM/1810/08.08.01/2017) issued on April 5, 2018, the Finnish Government granted Nord Stream 2 AG a consent to use the Finnish EEZ for the construction of a natural gas pipeline system as part of a natural gas pipeline project from Russia through the Gulf of Finland and the Baltic Sea to Germany. The permit became legally binding on July 12, 2018.

With its decision (53/2018/2) issued on April 12, 2018, the Regional State Administrative Agency of Southern Finland granted Nord Stream 2 AG a Water Permit to construct and operate two natural gas pipelines within the Finnish EEZ with the authorization for preparation. The permit became legally binding on August 19, 2019.

Table 1. The main permits regarding the construction and operation of the Nord Stream 2 pipeline.

Permit	Consent to use the Finnish Exclusive Economic Zone	Water Permit
Issued	April 5, 2018	April 12, 2018
Document number	TEM/1810/08.08.01/2017	N:o 53/2018/2, Dnro ESAVI/9101/2017
Authority	Council of State of Finland	The Regional State Administrative Agency of Southern Finland

A permit for research and monitoring in the seal sanctuaries of Kallbådan and Sandkallan-Stora Kölhällen (325/2018/06.06.02) was issued by Metsähallitus on March 12, 2018. The permit covered the environmental monitoring during the construction of the Nord Stream 2 natural gas pipelines at underwater noise and water quality monitoring stations. In seal sanctuaries the permit was valid from April 15, 2018 to December 31, 2018 and in all other areas from March 12, 2018 to December 31, 2018.

A permit extension for research and monitoring in the seal sanctuaries of Kallbådan and Sandkallan-Stora Kölhällen (5395/2018/06.06.02) was issued on December 7, 2018. The permit was valid from January 1, 2019 to June 30, 2020.

2 SCOPE OF ENVIRONMENTAL MONITORING AND IMPACT ASSESSMENTS

This chapter describes the scope of the Annual Monitoring Reports, including the definition of how the monitoring targets have been defined and which environmental receptors have been assessed and why. The scope of the mandatory monitoring is presented in the Environmental monitoring programme, which was approved within the Water Permit decision on April 12, 2018.

2.1 Scope of the Annual Monitoring Report 2020

The main purpose of the Annual Monitoring Report 2020 is to report the monitoring results and the assessment of observed impacts of the Nord Stream 2 Project in the Finnish EEZ in the year 2020. The report covers monitoring during the construction period in 2020 and summarizes the results of monitoring in 2018–2020. Additionally, the observed and assessed impacts will be compared with the predictions made in the EIA phase and the Water Permit application and with the monitoring results from the Nord Stream Project. The most vital parts of the Annual Monitoring Report are the in-depth data analysis of the monitoring results, and thorough discussion on the observed and assessed impacts and their significance (Figure 3).

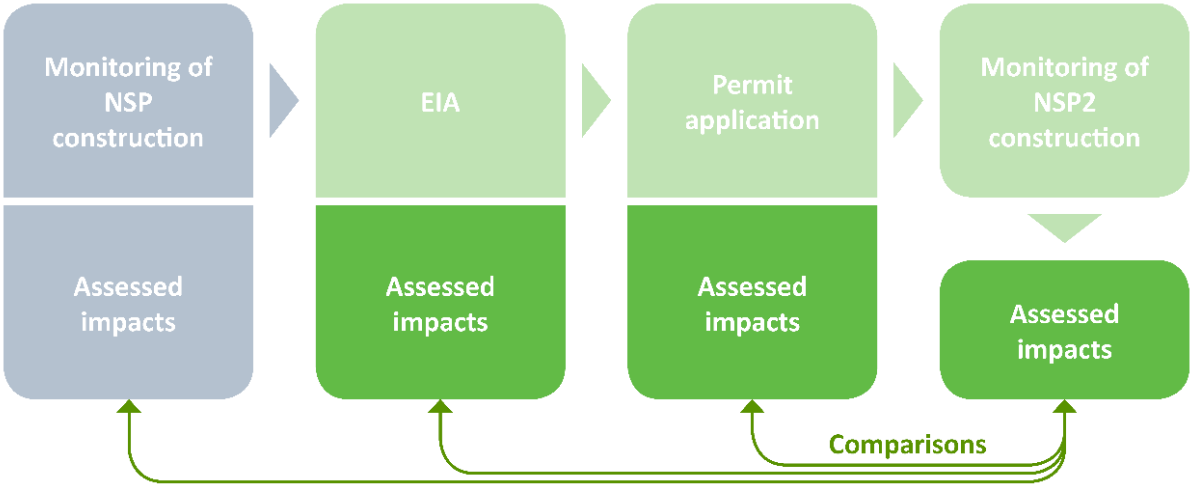


Figure 3. Phases of the analysis of the monitoring results and assessment of their impacts in the Nord Stream 2 Project. The monitoring results of the Nord Stream Project were used to predict impacts for the EIA phase and for the permit application. The monitoring results of the Nord Stream 2 Project (measured impacts) are compared to the predicted impacts and also to the impacts measured during the Nord Stream Project.

2.2 Environmental monitoring targets

2.2.1 Monitoring targets defined by the Nord Stream 2 Project monitoring programme

The scope of monitoring is presented in the Environmental monitoring programme /2/. The programme was approved within the Water Permit decision on April 12, 2018 (53/2018/2). Monitoring is most intensive during the construction phase (Table 2).

Table 2. General schedule for the monitoring activities during 2018–2023 in the Finnish EEZ (based on /2/, modified).

Phase	Construction			Operation		
Monitoring target	2018	2019	2020	2021	2022	2023
Underwater noise (local and transboundary impacts)	X					
Water quality and currents	X	X	X*			
Commercial fishery					X	
Cultural heritage	X			**		

* Monitoring of water quality and currents continued in 2020 until four weeks after the completion of the construction work in the vicinity of the monitoring site.

** Monitoring will be done later; actual timing is not yet confirmed

Underwater Noise (Monitored in 2018)

The construction phase of the Nord Stream 2 pipeline system, especially munitions clearance, may generate underwater noise that may be harmful to biota. Underwater noise travels long distances and may reach the protected areas designated to seals, even in the Estonian waters.

The monitoring of underwater noise was carried out during munitions clearance, as this activity has a potential impact on the marine life. The stationary monitoring areas were selected based on their location with respect to the highest density of munitions, water depth, location of the Natura 2000 sites and known seal populations and the distance to the pipeline route. In addition, three vessel-based monitoring campaigns were performed during the clearances of three targets of different size and type.

The main objectives for the underwater noise monitoring programme were to evaluate:

1. How far does the noise originating from munitions clearance operations penetrate the sensitive areas in the archipelago?
2. How high are the maximum noise levels?
3. How well do the impacts modelled during the EIA phase and the permitting phase correspond to the measured values?
4. How does the use of a bubble curtain as a mitigation measure affect the underwater noise levels?

Monitoring also addressed the following uncertainties:

1. The levels of background noise during munitions clearance in the Gulf of Finland
2. The impact of munitions clearance related activities (i.e. vessels) to the background noise level

Monitoring of underwater noise was carried out in 2018 and no new data on underwater noise is provided in this report.

The Nord Stream 2 Project monitoring programme included two underwater noise monitoring stations (Uhtju and Malusi) in the Estonian waters to monitor transboundary impacts. The monitoring of underwater noise in the Estonian waters was completed in 2018.

Water quality and currents/Sediment spreading (Monitored in 2018–2020)

The construction phase of the Nord Stream 2 pipeline system generates sediment spreading that can have an environmental impact on marine life.

The monitoring of water quality and currents started prior to the construction phase and was carried out during the whole construction period from April 2018 to May 2020 in the Finnish route section.

The main objectives for the turbidity and current monitoring program were to evaluate:

1. How far do the sediments originating from construction operations travel?
2. How high does the sediment spill rise from the seabed?
3. What is the maximum turbidity generated by the construction operations?
4. How much does the construction-related sediment spreading elevate the background levels in monitoring locations?
5. How well do the impacts modelled during the EIA phase match with the measured values?

Commercial fishery

The Nord Stream 2 Project pipeline may change trawling and other fishing patterns in the proximity of the pipeline.

In addition to a fishery questionnaire, data will be gathered by tracking fishing vessels. The vessels' avoidance of the pipeline area and possible changes in fishing patterns in the Finnish EEZ will be evaluated after the construction of the pipeline system is completed. The tracking data obtained prior to the construction will be compared with the tracking data collected during and after the construction of the pipeline system.

Cultural heritage (Monitored in 2018)

The construction phase of the Nord Stream 2 pipeline system may disturb cultural heritage objects along the pipeline route.

Two marine archaeological objects were identified within the impact area of the Nord Stream 2 pipeline route during the surveys in the planning phase. The cultural heritage monitoring covers these objects, a late 18th — early 19th century wooden gun barge wreck and a World War II anti-submarine net. A minimum safety zone has been set for the barge, which is regarded as an important archaeological site, and detrimental interventions must be minimized with the World War II anti-submarine net. To verify that these safety provisions were respected in construction, the results of the post-lay surveys of both pipelines were analysed. In addition, a more detailed survey of the targets by an independent contractor will be performed, when all construction activities are completed.

2.2.2 Additional monitoring targets

Additional monitoring activities that are outside the scope of the national monitoring programme have been implemented through specialist studies to strengthen the assessment of impacts from the Nord Stream 2 Project implementation and to enhance scientific knowledge of the Baltic Sea environment. The general schedule for the additional monitoring activities is presented in Table 3.

Table 3. General schedule for the additional monitoring activities during 2018–2023 in the Finnish EEZ.

	Construction		Operation			
Monitoring target	2018	2019	2020	2021	2022	2023
Sediment contaminants	X					
Marine mammals	X		X			
Ship traffic	X	X	X			

Sediment contaminants (Monitored in 2018)

Explosive residuals may accumulate in the sediments due to underwater detonations in munitions clearance work.

In 2018, altogether 17 sediment samples from areas close to detonation of two targets were collected in order to study explosive residuals and heavy metal spreading in the surroundings of the clearance site.

Marine mammals (Monitored in 2018 and 2020)

Marine mammals are sensitive receptors of underwater noise and changes in water quality.

During the munitions clearance period, trained marine mammal observers onboard the clearance vessels visually monitored the perimeter of the vessels before and after each detonation for a minimum of one-hour period before the scheduled initiation of the charge. Passive acoustic monitoring was also performed to ensure that no marine mammals were present in the monitored area.

In 2018, Metsähallitus monitored grey seals in the Kallbådan seal sanctuary, using remote video camera equipment from June to August. In 2019, monitoring took place from May to July, but due to series of technical issues it was not possible to collect a full range of data. In 2020 monitoring was carried out from May to August. Based on Metsähallitus report in 2021, neither direct injuries from blasts nor abnormal behavior of seals during the detonations were observed. According to studies conducted in 2018 during the munition clearance operations and in 2020, the number of seals was quite similar in the area in May and in the beginning of June.

Ship traffic (Monitored in 2018–2020)

Surveys and construction of a large-scale project close to shipping lanes may cause risks to sea traffic.

Safety zones were established around all vessels and activities of the vessels were notified to the authorities. In addition, during the pipelay, near a shallow area close to Kalbådagrund, a tug was stationed nearby in order to respond to potential ship emergencies, such as danger of grounding.

2.3 Definition of the receptors of impact assessment

Monitoring of the impacts during the construction of the Nord Stream gas pipeline in 2010–2012 indicated that most of the impacts were minor or moderate. Therefore, the Nord Stream 2 Monitoring Programme, approved within the Water Permit decision (Nro 53/2018/2, Dnro ESAVI/9101/2017), focused monitoring on a limited number of receptors most likely to experience impacts (minor or moderate). Nord Stream 2 also decided to add some additional monitoring targets (specialist studies) to complement the assessment of actual impacts. The coverage of the Nord Stream 2 Project monitoring targets and impact receptors (compared to the assessments in the EIA phase) is shown in Table 4.

In this monitoring report, an impact assessment has been carried out for the receptors that have been identified as potentially experiencing impacts from the construction activities of the Nord Stream 2 Pipeline project. The assessment is based on the monitored impacts. For example, for assessing the impacts on marine mammals, the results of monitoring of underwater noise, water quality and currents as well as actual monitoring of marine mammals were used (Table 4). For assessing the impacts on seabed morphology, not only monitoring data, but also reports from the construction contractors were analysed, and for the Compliance analysis (whether the project meets the requirements stated in the Marine Strategy and Water Framework Directive, as implemented in the Finnish national legislation) monitoring data of water quality and currents, contaminant release and marine mammals (as part of biodiversity) and several different types of contractor reports were analysed. As underwater noise does not yet have quantitative indicators (“target conditions”), the results of underwater noise were evaluated as factors affecting the living conditions of biota.

Table 4. The Nord Stream 2 Project monitoring targets and impact assessment coverage in the EIA phase. The receptors, for which the assessment was conducted, are shown in bold. The Compliance assessment of the receptor "Underwater noise", marked in parenthesis below, was performed through the evaluation of impacts on the living conditions of biota, as it does not yet have quantitative indicators.

		MONITORING TARGET							
		IN MONITORING PROGRAMME				ADDITIONAL			
	IMPACT RECEPTOR	UNDERWATER NOISE	WATER QUALITY AND CURRENTS	COMMERCIAL FISHERY	CULTURAL HERITAGE	CONTAMINANTS	MARINE MAMMALS	SHIP TRAFFIC	UNDERWATER NOISE IN ESTONIA
INCLUDED IN THE EIA 2017	CLIMATE AND AIR QUALITY								
	SEABED MORPHOLOGY AND SEDIMENTS		**X**			X			
	HYDROGRAPHY AND WATER QUALITY		X						
	UNDERWATER AND AIRBORNE NOISE	X							
	BENTHIC FLORA AND FAUNA								
	FISH								
	MARINE MAMMALS	X	**X**				X		
	BIRDS								
	PROTECTED AREAS	**X**	**X**				X		
	NON-INDIGENOUS SPECIES								
	BIODIVERSITY	X	**X**				X		
	SHIP TRAFFIC							X	
	COMMERCIAL FISHERY			X					
	MILITARY AREAS								
	INFRASTRUCTURES								
	FUTURE USE OF THE EEZ								
	SCIENTIFIC HERITAGE								
	CULTURAL HERITAGE				X				
	SOCIAL IMPACTS								
	COMPLIANCE ASSESSMENT	(X)	X			X	X		
TRANSBOUNDARY: UNDERWATER NOISE, MARINE MAMMALS, BIODIVERSITY AND PROTECTED AREAS									X

2.4 Methodology used for the impact assessment

A multi-criteria analysis methodology (IMPERIA) /3/ was applied in evaluating the significance of impacts in all assessments in the EIA phase, in the Water Permit application and monitoring. The approach takes into account both the sensitivity of the impact receptor and the magnitude (intensity and direction) of change resulting in the impact significance (Table 5). Using the same approach in all assessments prior to implementation, and in the assessment of impact significance of monitored impacts, enables reliable comparison of the predicted and monitored impacts (see Chapter 7.3).

Table 5. Categories of impact significance in the approach developed in the IMPERIA project (Adapted from /4/).

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

3 CONSTRUCTION ACTIVITIES

Construction activities started in April 2018. Munitions clearance was completed in June 2018 and the installation of support mattresses at infrastructure crossings was completed in October 2018. Pipelay and rock placement started in 2018 and continued in 2019. Pipelay of both Line A and Line B was completed in the Finnish EEZ in 2019, and post-lay rock placement was completed in May 2020.

3.1 Timing of activities

The construction activities during 2018 included munitions clearance, mattress installation, rock placement and the pipelay of Line A (Table 6). Munitions clearance and mattress installation were completed in 2018. Pipelay of Line A continued in 2019 and the pipelay of Line B commenced in 2019. The pipelay of both lines was completed in 2019. Rock placement continued in 2019 (Table 7) and it was completed in May 2020 (Table 8). A single maintenance rock placement operation was conducted in November 2020.

Table 6. Timing of construction activities in 2018.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Munitions clearance					■							
Mattress installation							■	■	■			
Rock placement				■	■			■	■	■	■	
Pipelay of Line A									■	■	■	■

Table 7. Timing of construction activities in 2019.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rock placement	■	■	■	■	■	■		■	■	■	■	■
Pipelay of Line A	■	■		■								
Pipelay of Line B					■	■	■	■	■	■	■	■

Table 8. Timing of construction activities in 2020.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rock placement	■	■	■	■	■	■	■	■	■	■	■	■

The offshore operations in the Finnish EEZ during 2018–2020 involved several survey vessels, two munitions clearance fleets (each with two vessels; one clearance vessel and one bubble curtain vessel), several dynamic positioned (DP) rock placement vessels, DP mattresses installation off-shore construction vessels, two DP pipelay vessels and supply vessels for these activities (Figure 4, Figure 5, Figure 6).

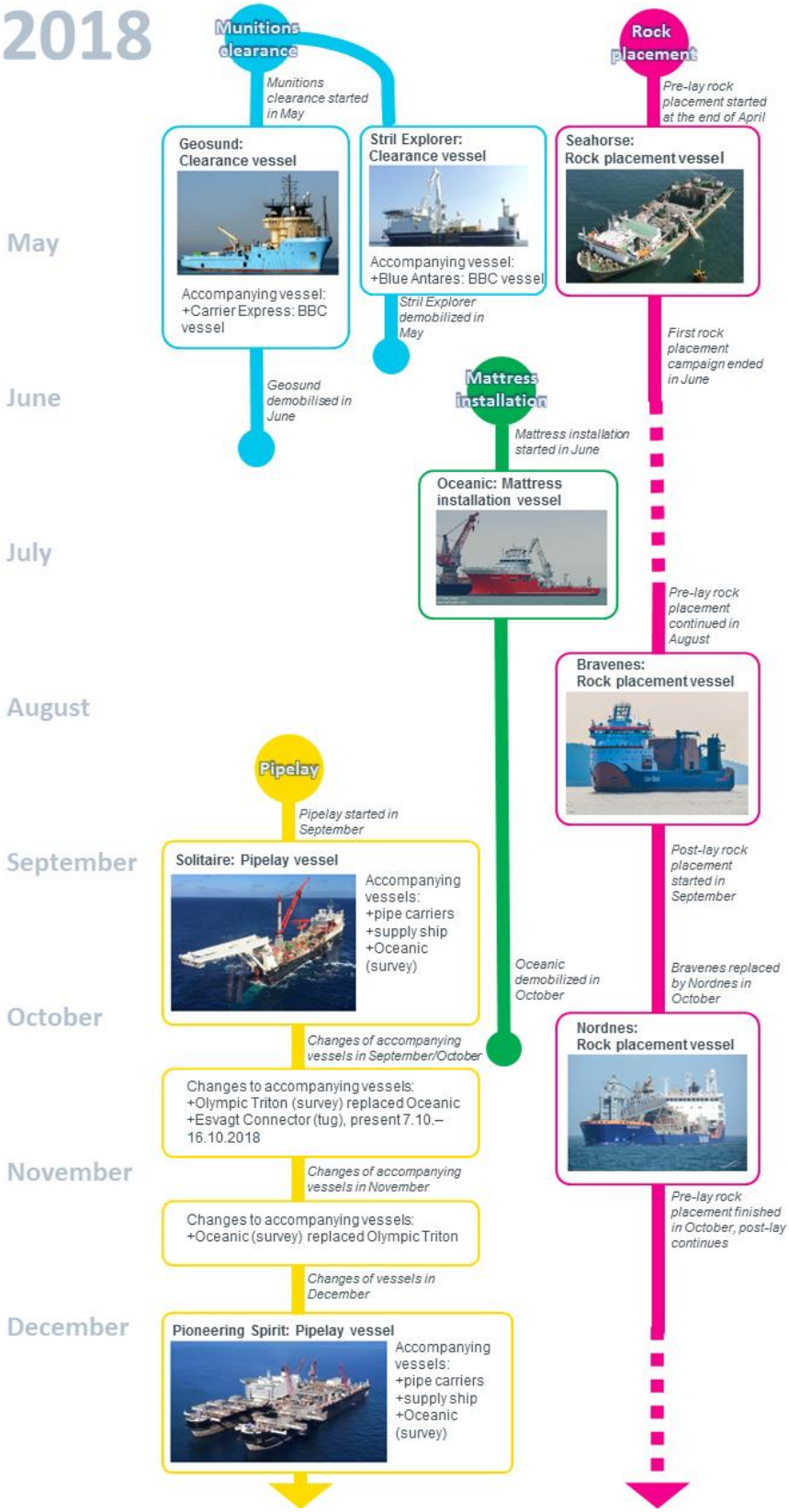


Figure 4.Vessels performing construction for the Nord Stream 2 Project in the Finnish EEZ during 2018.

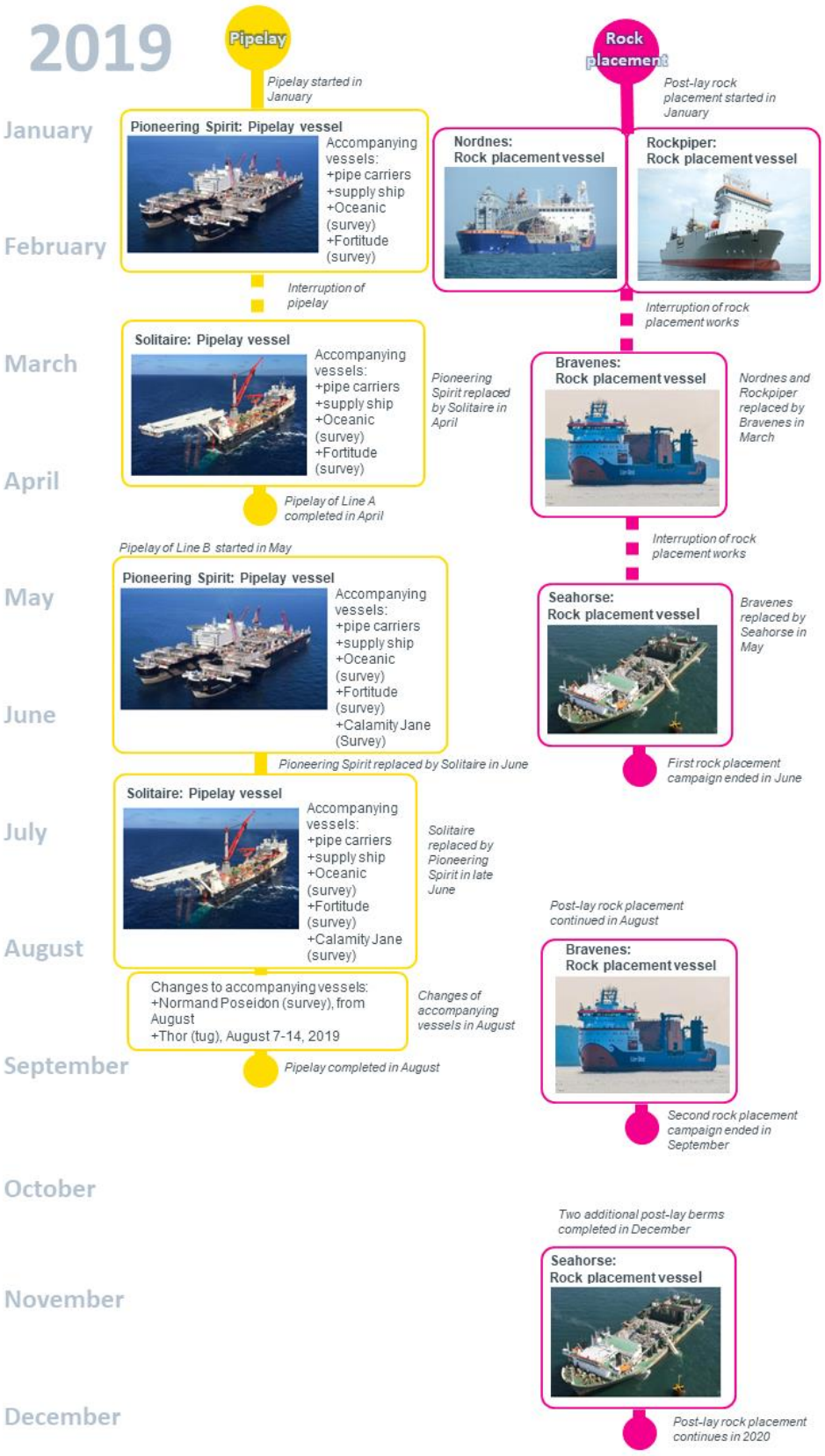


Figure 5.Vessels performing construction for the Nord Stream 2 Project in the Finnish EEZ during 2019.

Figure 6.Vessels performing construction for the Nord Stream 2 Project in the Finnish EEZ during 2020.

3.2 Munitions clearance (completed in 2018)

In total, 74 munitions were cleared from the pipelay corridor during the one-month campaign in 2018. A detailed survey during the clearance work confirmed that 14 targets of the planned 87 clearance targets were not munitions. One target was not found, but the survey uncovered two additional munitions on the route. Most of the munitions were cleared on site utilizing a donor charge, and only three munitions were relocated prior to detonation to enable an efficient use of the bubble curtain and to ensure safe distance to cables. The bubble curtain, as a mitigation measure to reduce noise from the detonation, was used for 58 detonations. These included all detonations with a total net explosive quantity (munition charge plus donor charge) of 22 kg or more; all detonations taking place in sensitive area east of kilometre point GKP 174; and those detonations, in which the owner of a cable within a 500 m security corridor had requested so.

The munitions clearance contractors were committed to the ISO 14001 based Environmental Management Plans and were responsible for the implementation of mitigation measures in line with the Great Britain's Joint Nature Conservation Committee (JNCC) guidelines /5/.

Nord Stream 2 AG provided a procedure for the deployment of mitigation measures for marine mammals, fish and birds for the munitions clearance operators /6/. The procedure follows the JNCC Guidelines for minimizing the risk of injury to marine mammals from using explosives /5/. According to the clearance reports, both contractors followed the given procedure in majority of cases /7, 8/ (Table 9). The exceptions were: Due to equipment failure, nine detonations were performed with three acoustic deterrent devices (ADDs), and in four cases the range of observation for marine mammals was reduced to a radius of 500 m due to weather conditions. In five detonations in the beginning of the campaign the pressure wave was not recorded.

During the operations, no marine mammals were observed. Some bird activity was observed during the pre-watch, however no birds were detected before detonation in the vicinity of the detonation area. Similarly, no schools of fish were detected in the detonation area prior to detonation /7, 8/.

Concerning ship traffic, a safety zone having a radius of 1.5–2.5 km was established around the munitions clearance sites, depending on the size of the munition. Munitions clearance was completed in 2018.

Table 9. The Nord Stream 2 Project requirements and the implementation of mitigation measures for the munitions clearance work by the munitions clearance contractors /7, 8/.

Action	N-Sea/Bodac 44 detonations	MMT Sweden Ab/Ramora 30 detonations
4 ADD[1]s	**Applied in all detonations.**	9 detonations with 3 ADDs (equipment failure) **Applied in 21/30 detonations.**
MMO[2], > 1 km radius	**Applied in all detonations.**	Radius of 500 m in 4 cases (weather conditions) **Applied in 26/30 detonations.**
PAM[3]	**Applied in all detonations.**	**Applied in all detonations.**
Fish finder (Sonar sweep)	**Applied in all detonations.**	**Applied in all detonations.**
Bubble curtain	**Applied in required detonations** (40 cases)	**Applied in required detonations** (18 cases)
Pressure wave sensor (Hydrophone)	**Applied in 39/44 detonations.**	**Applied in all detonations.**

[1] Acoustic deterrent device; [2] Marine mammal observer; [3] Passive acoustic monitoring device

3.3 Rock placement

3.3.1 Origin, transport and placement of rock material

The term 'rock placement' refers to the use of rock to locally reshape the seabed before or after pipelay, thereby providing support to the pipelines to ensure their long-term stability and integrity. Rock placement was required for free-span correction and for the crossings with other gas pipelines (Nord Stream Project and Balticconnector). In the Finnish EEZ, the total permitted volume of rock material for the Nord Stream 2 Project is 1,7 million m^3 (Water Permit, 53/2018/2, ESAVI/9101/2017). Granite used for berm construction was mainly acquired from three quarries of Rudus Oy's in Southern Finland, the Rajavuori quarry in Kotka, the quarry at Inkoo port and the Skogsmora quarry in Karjaa.

The average size of the rock material was 50–70 mm (total range from 16 to 125 mm) /9/. The used material did not contain any contaminants, such as heavy metals, that could be released to the marine environment. In addition, the used material was clean, i.e. did not contain any clay, silt, lime, vegetation or other scattering constituents or any additional waste materials. Material was tested in quarries for grain size and purity /10/.

In Kotka after blasting and crushing phases, rock material was transported by trucks from the quarry to the temporary rock storage site in Mussalo port /11/. In Inkoo, the rock material transport from the quarry to the vessel-loading is done entirely within the port area. In addition, rock material was transported to the Inkoo port area from the Skogsmora quarry in Karjaa /12/.

The rock material was transported from the port to the offshore rock placement site by dynamically positioned (DP) vessels. The rock material was placed onto the bottom through the fall-pipe, which extends through the water column. The lower end of the fall-pipe is equipped with nozzles to allow precise shaping of each rock berm (Figure 7). Upon completion of rock placement at individual berm sites, a ROV survey was conducted to measure used rock volume and to ensure that the shape and size of the rock berm was as designed /13/.

In order to minimize risks involving third party ship traffic, a 500 m wide safety zone was established around the rock placement vessels /14, 15/ when working at the rock placement site.

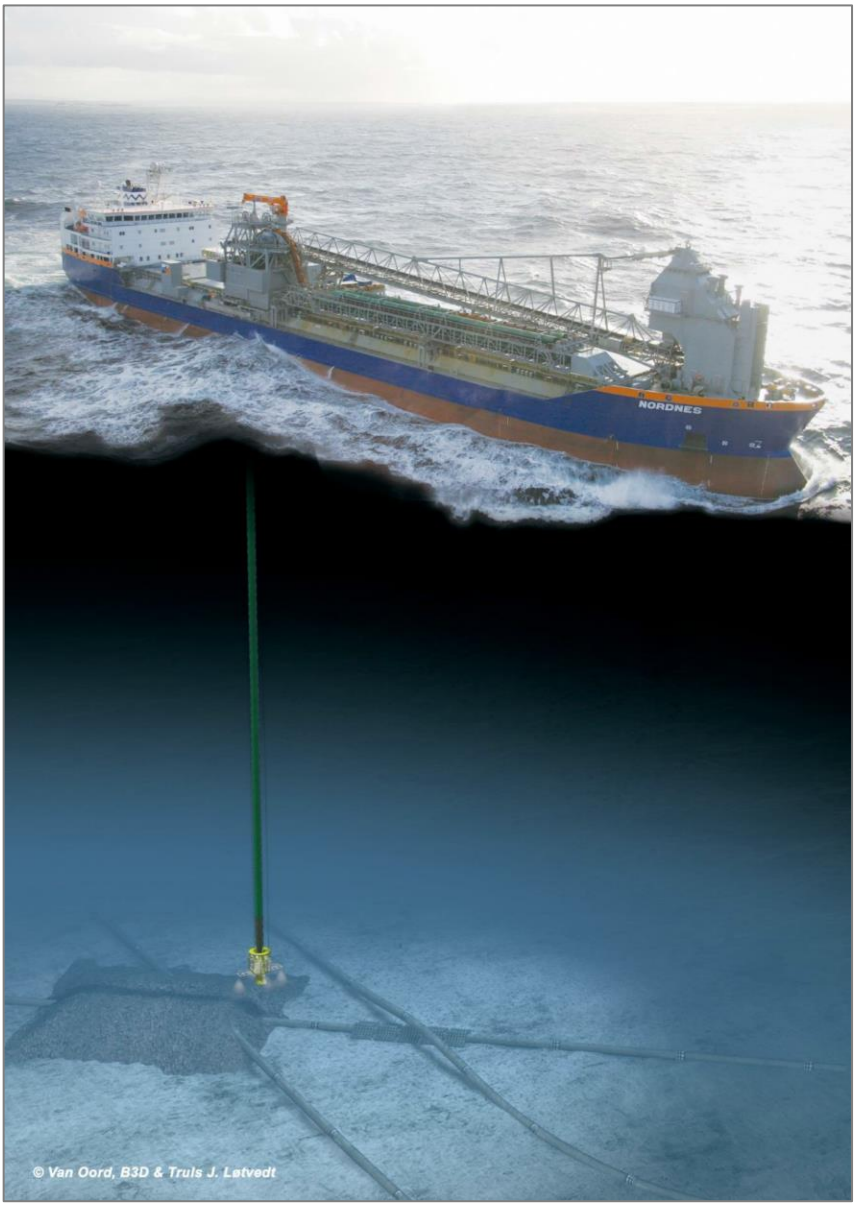


Figure 7. Post-lay rock placement using a fall-pipe. Figure: © Van Oord 2019.

Four long-term scientific monitoring stations (LL5, LL6A, LL7S and LL11) are located near the pipeline route. To mitigate potential impact on scientific heritage, the Nord Stream 2 Project agreed with the Finnish Environmental Institute (SYKE) that neither munitions clearance nor rock placement activities were to be conducted during or just before the annual benthos monitoring campaigns, which took place in June 2018, in May-June 2019 and in June 2020. A minimum distance of 2 km was kept from the above-mentioned works to the monitoring sites prior to and during the SYKE sampling campaign.

3.3.2 Rock placement in 2018

Most rock placement works during 2018 took place to the east of Inkoo, Finland (GKP 255). The first pre-lay rock placement campaign by rock placement vessel Seahorse took place from April to June. The second campaign started in August and continued to the end of the year by vessels Bravenes (August to October) and Nordnes (from October onward). Post-lay placement was initiated in September. The responsible contractors were Boskalis Offshore Contracting B.V. and Van Oord Offshore B.V. (BoVO).

The volume of placed rock material was 479,000 m^3 during 2018 and only Finnish rock material was used. Altogether 144 berms were constructed, but as one berm can comprise either pre-lay or post-lay, or both, the work in 2018 included 69 pre-lay and 87 post-lay berms. Furthermore, five top-ups were added to berms constructed earlier. The need for top-ups is determined when berms are re-surveyed after settling. Additional rock (top-up) is placed, if berms have naturally deformed, due to conditions on the seafloor, to a shape which does not satisfy the minimum design requirements. Top-ups are performed until the design condition is reached again. The volumes of installed individual berms varied between 186 m^3 and 16,000 m^3. The rock placement activities in 2018 are described in detail in the Annual Monitoring Report 2018 /16/.

Since the publishing of the Annual Monitoring Report 2018 /16/, there was a small specification in the as-built register for berms /17/: the total volume of post-lay stress/free-span correction increased by 200 m^3, which can be seen as a difference when comparing the total installed volume reported in the Annual Monitoring Report 2018 to the volume reported in the Annual Monitoring Report 2019.

3.3.3 Rock placement in 2019

Rock placement during 2019 took place between kilometre points GKP 114 and GKP 429. Rock placement works were most active during the first half of the year, slowing down in the autumn when the focus was on the completion of the rock placement in Russia. Dynamically positioned (DP) fall-pipe vessels Seahorse, Bravenes, Nordnes and Rockpiper were used for the rock placement in 2019. Rockpiper was the only vessel that did not conduct works already in 2018.

Rock placement was conducted by Nordnes in the first half of January and continued by Rockpiper from January to February and subsequently by Bravenes from March to April. In May and June, the work was continued by Seahorse. Bravenes resumed rock placement after a summer pause in August and continued until September. Seahorse returned to rock placement work in September and continued until October, after which Bravenes conducted rock placement in November and December.

By the end of 2019, the total amount of placed rock material was 909,300 m^3 (Table 10). Of this, 18,300 m^3 was of Norwegian origin and the rest was Finnish rock material. In addition to post-lay rock placement works performed throughout the year, there were also pre-lay rock placement works in January and during the summer. The pre-lay rock placement was to provide additional support in predicted free-span areas for Line B, and to build crossings for Line B with the Balticconnector pipeline and the Nord Stream gas pipelines. The volume of pre-lay rock placement was 39,300 m^3. During 2019, 68 % of the total rock placement volume was installed for Line A and 32 % for Line B. The rock placement activities in 2019 are described in detail in the Annual Monitoring Report 2019.

3.3.4 Rock placement in 2020

Rock placement in 2020 took place between kilometre points GKP 120 and GKP 483 (Figure 8). Only post-lay rock placement was performed, as pipelay was completed in 2019. Rock placement was intensive and it was completed in the Finnish EEZ on May 30, 2020 /18, 19/.

When 2019 turned into 2020, Bravenes was performing rock placement work in the Finnish EEZ. Two berms were initiated during 2019 and were reported to be finished in 2020. After this, Bravenes completed one more berm on January 2, 2020 and then the vessel left the Finnish EEZ /18 /. On April 14, 2020, Bravenes returned shortly to Finland to complete two berms /19/.

Between January 22 and May 30, Rockpiper worked several times in the Finnish EEZ: on January 22, from February 14 to February 25, from March 29 to April 12, from April 20 to April 26, on April 28, and from May 1 to May 30 /18, 19/.

In addition, on February 4, and from February 12 to February 21, 2020, Nordnes, and from February 6 to February 24, Stornes conducted rock placement in the Finnish EEZ /18/.

When rock placement was completed, the volume of rock material placed was 604,600 m^3 in 2020, and the total cumulative volume of rock was 1,513,900 m^3/21/. Only Finnish rock material was used during 2020 /21/.

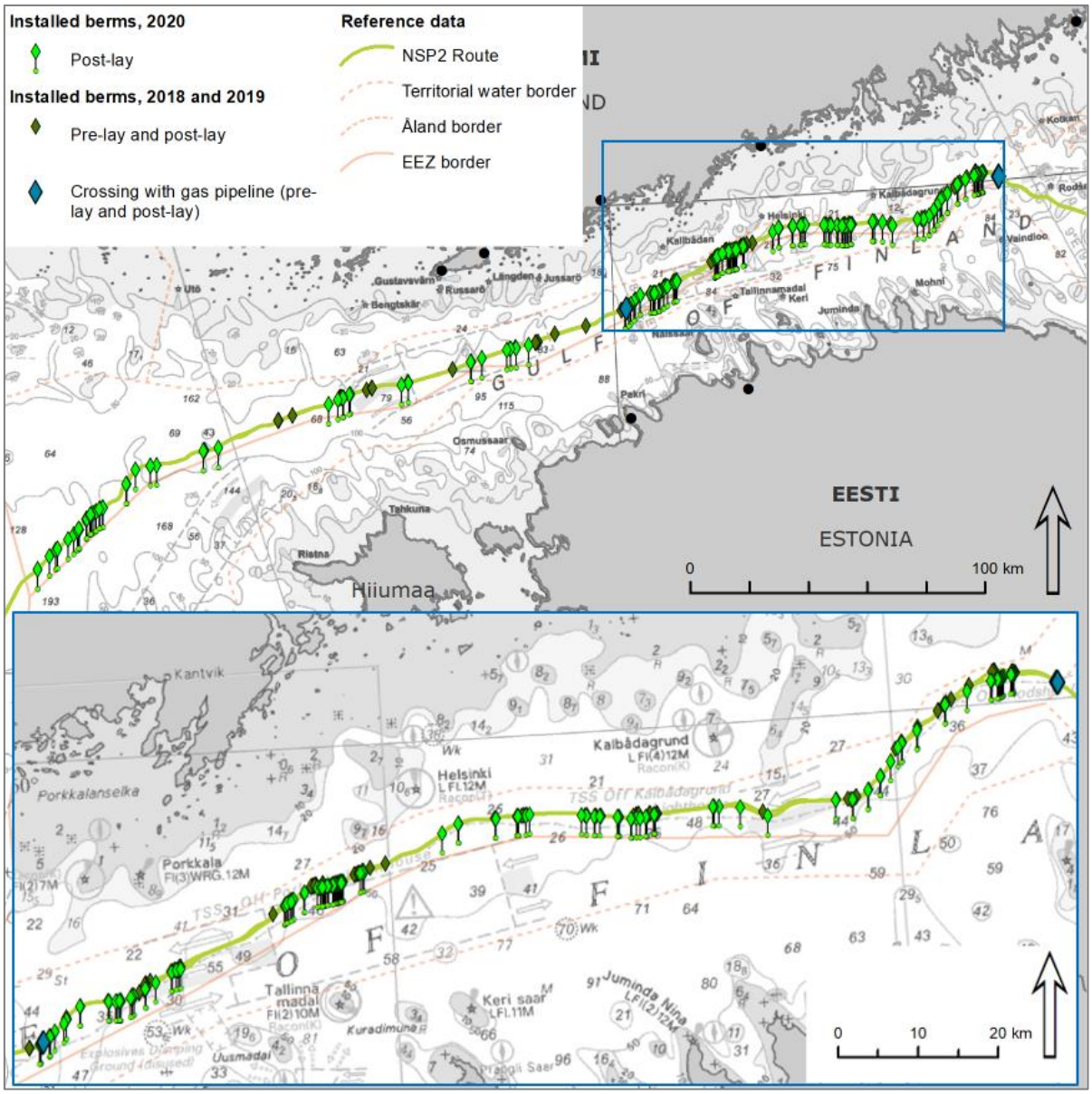


Figure 8.Rock placement in the Finnish EEZ during 2018–2020. The lower map shows the selected area (blue frame) in more detail.

Comparing the permitted and installed volumes (Table 10), the largest differences are seen in categories pipeline crossings and unexploded ordnances (UXO). The amount of rock material at pipeline crossings is higher than estimated in the Water Permit application. This is mainly due to the redesign of the crossing with the Nord Stream gas pipeline, based on a detailed survey prior to pipelay. In the update, the number of pre-lay berms increased. In addition, post-lay rock placement and counterfill berms as well as winglet berms surrounding the pre-lay berms were added. The Balticconnector gas pipeline was built after the pipelay of Line A. The design for the crossing with the Balticconnector pipeline was finalized after the Nord Stream 2 Project had submitted the Water Permit application and therefore the rock volume for the crossing was not known, and hence not included in the Water Permit application

/23/. In addition, three berms were constructed to avoid unexploded ordnances (UXO) /17/ detected during the detailed pre-lay survey for Line B.

Table 10. Rock placement status in the end of 2020 /21, 22/.

Berm type	Installed volume, m^3*				Estimate in the Water Permit application, m^3 without allowances, losses and installation tolerances
	2018	2019	2020	Total	
Pipeline crossings	40,200	67,200	---	107,400	37,300
Pre-lay	40,200	22,600	---	62,800	
Post-lay	---	44,600	---	44,600	
Stress/free-span correction	377,700	288,400	462,700	1,128,800	901,100
Pre-lay	256,400	16,700	---	273,100	
Post-lay	121,300	271,700	462,700	855,700	
In-service buckling mitigation *(post-lay)*	57,000	64,900	124,600	246,500	352,600
Spot gravel placement for on-bottom stability *(post-lay)*	4,100	---	1,800	5,900	39,600
Unexploded ordnance *(post-lay)*	---	9,800	15,500	25,300	---
Total	**479,000**	**430,300**	**604,600**	**1,513,900**	**1,330,600**
Permitted volume				***1,700,000***	

** Installed volume is notified to the Nord Stream 2 Project by contractors as tonnes (t), which is converted to cubic meters using a factor 1.5625 t/m^3.*

The preliminary documentation of the volume installed in 2019 was confirmed in 2020, resulting in an increase of 6,100 m^3 of the total installed volume in 2019. This is seen as a difference between the volume reported in the Annual Monitoring Report 2019 /20/ and in this report.

3.4 Infrastructure crossings (completed in 2019)

3.4.1 Crossing agreements and methods

The pipeline currently crosses 31 cables in the Finnish EEZ, 10 of which are out of use. The pipeline crosses with the Nord Stream and Balticconnector gas pipelines (Figure 9).

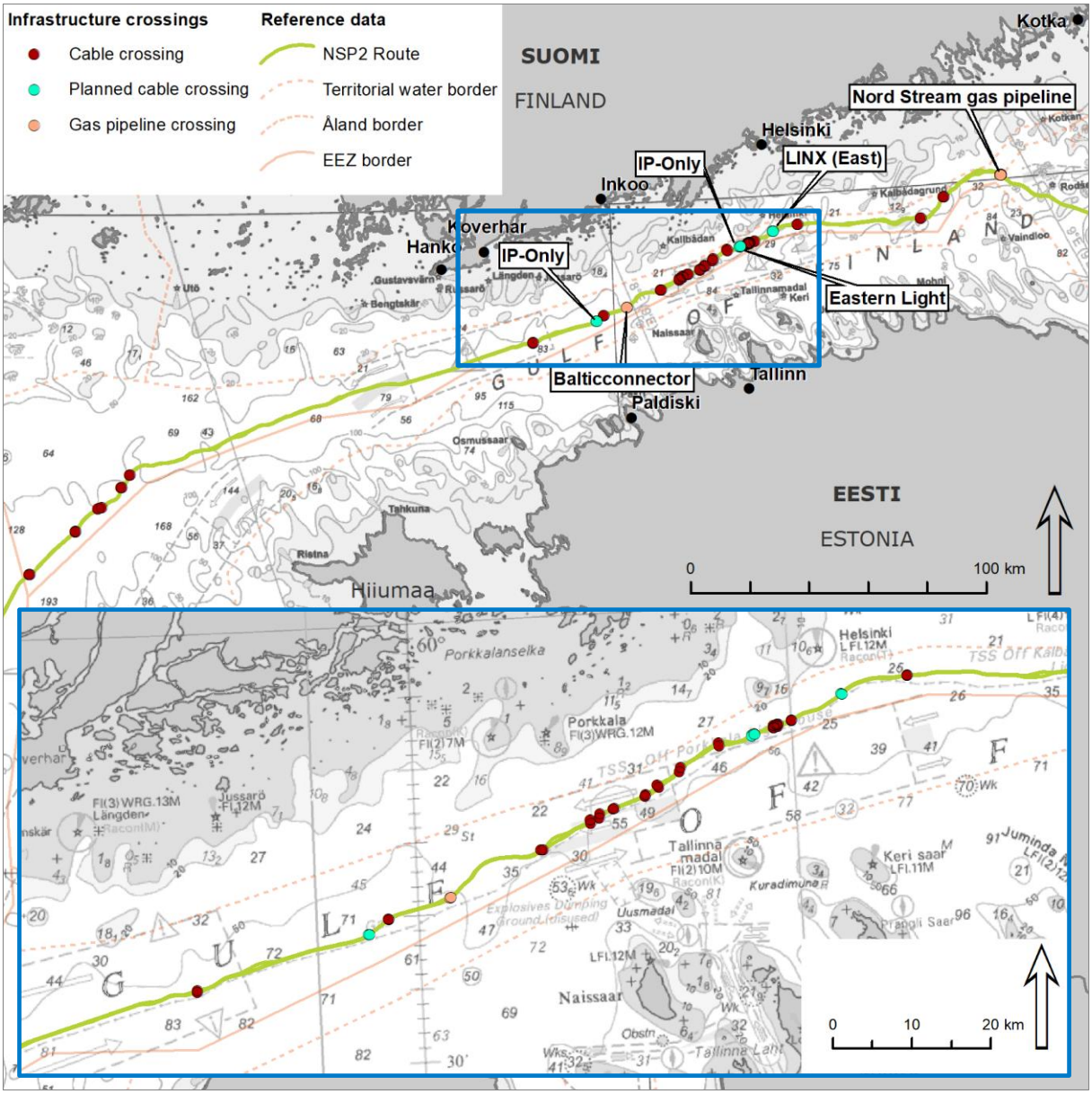


Figure 9. Crossings between the Nord Stream 2 Pipelines, cables and other gas pipelines.

For the cables with known owners, crossings were constructed according to the cable crossing agreement between Nord Stream 2 AG and the owner of the cable. Detailed information on the crossings was provided to the applicable cable owner and written agreements have been signed for all known owners of active cables. For the pipeline crossings, similar agreements have been made.

For cables with unknown owners, surveys were conducted in order to locate the cables and to determine whether they are in use /24/. All cables, that were not confirmed to be out of use, were protected with concrete mattresses to shield them from any damage.

Prior to mattress installation, a pre-installation survey of the installation locations was performed by an ROV -device to verify the status of the existing infrastructure. Two types of mattresses were used: flexible multi-block concrete mattresses with tapered edges and rigid concrete beam mattresses. Flexible mattresses were placed between the cable and the pipeline, and rigid mattresses were placed to support the pipeline from below on both sides of the crossing. The installation work was monitored by the ROV -device. After the installation of mattresses, the ROV -device carried out the as-built survey using a multi-beam echo sounder (MBES) and visual (video) inspection in order to document that the mattress was installed correctly /25/.

In addition to concrete mattresses, rock berms were used in the crossing with the Nord Stream gas pipeline. In the crossing with the Balticconnector gas pipeline, support with rock berms was sufficient. /17, 26/.

In order to minimize risks involving third party ship traffic, a safety zone having a radius of 500 m was established around the mattress installation vessels during the installation works /14/ on site.

Within a period from June to October 2018, altogether 492 mattresses were constructed to protect the crossings with cables /27/. For Line A, 178 flexible and 60 rigid mattresses were constructed to cross 18 cables, four of these twice. For Line B, 200 flexible and 54 rigid mattresses were constructed to cross 18 cables, three of these twice. The total number of flexible mattresses was lower than what was notified to the authorities in 2018, 378 mattresses instead of 393, due to changes in the design of one crossing during detailed survey prior to mattress installation. The total number of rigid mattresses was as notified in 2018.

The mattress installation for cable crossings was completed in 2018 and it was reported in the Annual monitoring report 2018 /16/.

3.4.2 Cable crossings

In 2018, the pipelay of Line A crossed with 15 cables.

In 2019, the pipelay of the remaining part of Line A crossed with 4 cables and the pipelay of the complete Line B crossed with 19 cables.

In November 24–25, 2019, Elisa Oyj's E-Finest telecommunication cable between Espoo and Tallinn was laid on top of Lines A and B /28, 29/. In September 2020, the Baltika Submarine Data Cable, which runs across the Baltic Sea from the Leningrad Region to the Kaliningrad Region, was laid on top of Lines A and B of the Nord Stream 2 pipeline. Therefore, in the beginning of 2021, the Nord Stream 2 pipeline route has crossings with 23 active cables /30/.

3.4.3 Pipeline crossings

The Nord Stream 2 pipelines cross the Nord Stream twin pipeline and the Balticconnector gas pipeline, that runs from Inkoo, Finland, to Paldiski, Estonia.

The crossing area of the Nord Stream gas pipeline and Nord Stream 2 pipeline includes four crossing points, since both of them are twin pipelines. Support structures for the crossing area contain a total of 12 concrete support mattresses (Figure 10) and several large rock berms.

The Balticconnector pipeline was built after the completion of the Nord Stream 2 Line A in the Finnish EEZ, and before the Nord Stream 2 Line B. The Balticconnector pipeline was laid on top of Line A on

June 5, 2019 and Line B was laid on top of the Balticconnector pipeline on July 17, 2019. There were no simultaneous operations between the vessels involved in the construction of the Nord Stream 2 pipelines and the vessels involved in the construction of the Balticconnector pipeline. The construction of the Balticconnector pipeline and the Nord Stream 2 Project pipeline at the crossing area was conducted at different times.

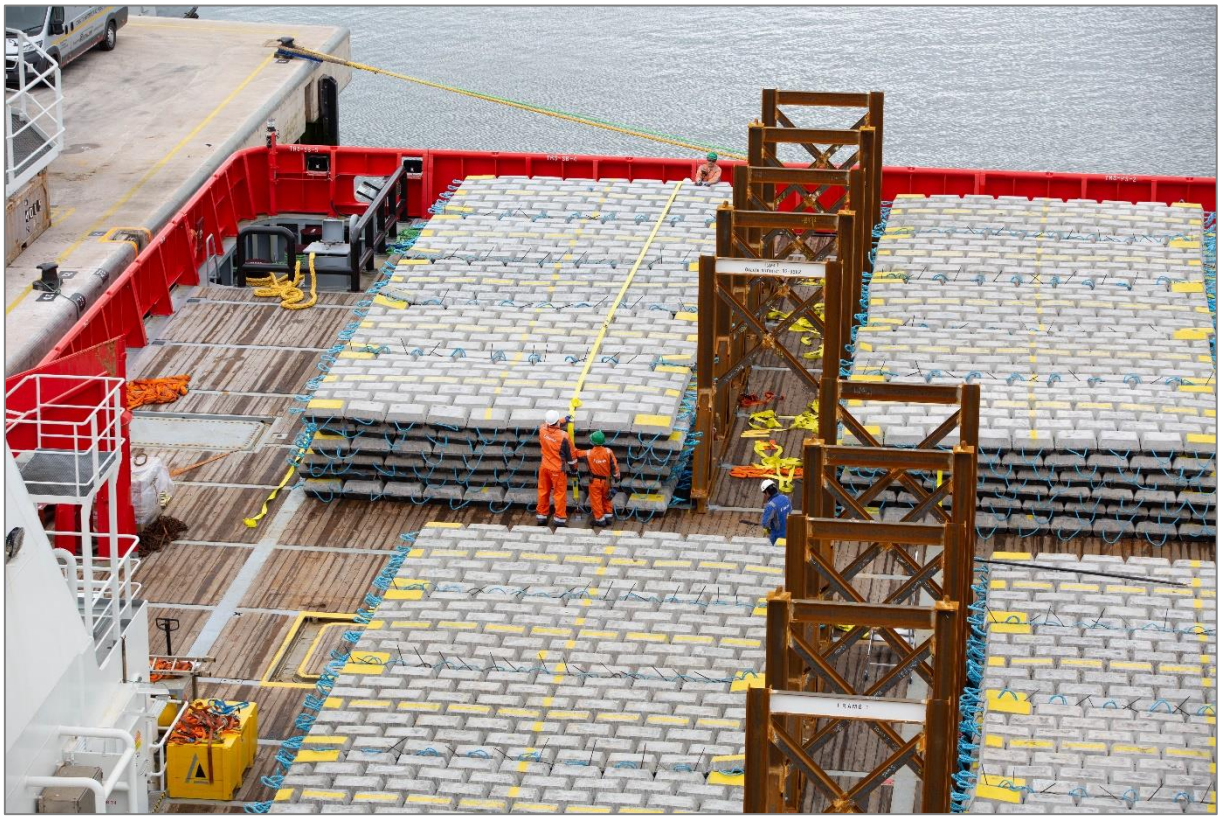


Figure 10. Concrete support mattresses used for protecting cables and pipelines in crossings with the Nord Stream 2 -pipeline. © Nord Stream 2 / Thomas Eugster.

3.5 Pipelay (completed in 2019)

3.5.1 Pipelay procedure

Prior to commencing pipelay, munitions were cleared to ensure safe installation, and the necessary supports in the rough parts of the seafloor were provided by pre-lay rock placement. Mattresses were put in place to protect the cable crossings. The pipelay of Line A in the Finnish EEZ started in September 2018 and was completed in April 2019, and the pipelay of Line B started in May 2019 and was completed in August 2019.

On board the pipelay vessel, the pipe ends were bevelled and the inside of the pipe cleaned using compressed air before it was conveyed to the double-joint welding station. There, the 12-metre pipe joints were aligned and welded together to create a 24-metre double-joint segment (Figure 11). The double-joint was moved to a non-destructive testing station to undergo automatic ultrasonic testing (AUT) to detect any flaws. Following AUT, the double-joint was moved to the central assembly line. There, the insides were checked for debris and the double-joint was aligned with the main pipe string. The double-joint was joined to the end of the pipeline using a semi-automatic welding process. The weld between the double-joint and the main pipeline underwent AUT. Any unacceptable flaws were removed

and the weld was re-scanned to ensure it meets international standards. Once the weld was confirmed acceptable, a corrosion resistant heat-shrink sleeve was applied over the circumferential girth weld and polyurethane foam poured into a form surrounding the weld area. The hardened foam provides further protection. The pipeline was lowered to the seabed using the S-lay method with the help of a stinger, which provides support to the pipeline as it was progressively lowered to its designated place on the seabed.

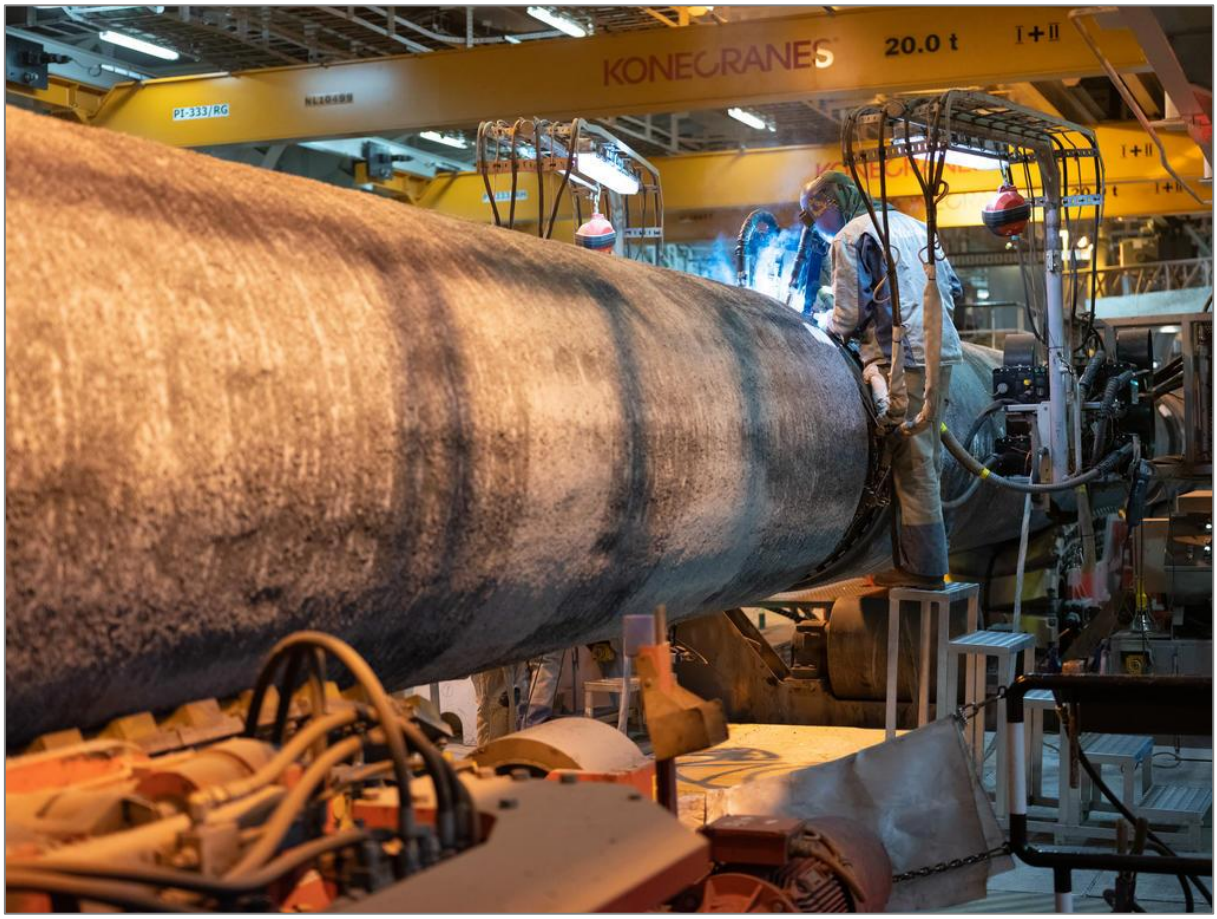


Figure 11. Pipeline welding in progress. © Nord Stream 2 / Axel Schmidt

Pipelay was done by two large, dynamically positioned (DP) pipelay vessels, Solitaire and Pioneering Spirit. Both vessels can lay pipe in most weather conditions. When it was necessary to interrupt pipelay due to unsuitable weather conditions, the pipeline was laid down in a controlled manner. A special head was welded to the pipeline, and a cable was connected to the head, after which the pipeline was laid on the seabed for later recovery. Once weather conditions had improved, the vessel could recover the pipeline back onto the vessel. The cable was then disconnected, and the head was removed before regular pipelay continued.

Pipelay work was supported by survey vessels. They used ROV video cameras to monitor pipeline touchdown and cable crossings and assisted in the pipeline abandonment and recovery procedure. They also performed as-laid surveys of the pipeline.

3.5.2 Pipelay in 2018

Most of the pipelay of Line A took place in 2018 (Figure 12). The pipelay vessel Solitaire (Figure 13) commenced the pipelay of Line A in September and continued until October. Solitaire had a four-day

service break in Muuga Port, Estonia, and then continued the pipelay of Line A until late December, when it was replaced by the pipelay vessel Pioneering Spirit. By the last day of 2018, approximately 260 km of Line A had been laid between kilometre points GKP 117 in eastern and GKP 376 in western Gulf of Finland, crossing 15 cables and the two Nord Stream gas pipelines.

In 2018, pipelay had eight short interruptions due to unsuitable weather conditions. There were 103 days of effective pipelay, making the average speed 2.5 km/day. The highest lay speed during the year was approximately 4.2 km/day by Pioneering Spirit and 3.6 km/day by Solitaire.

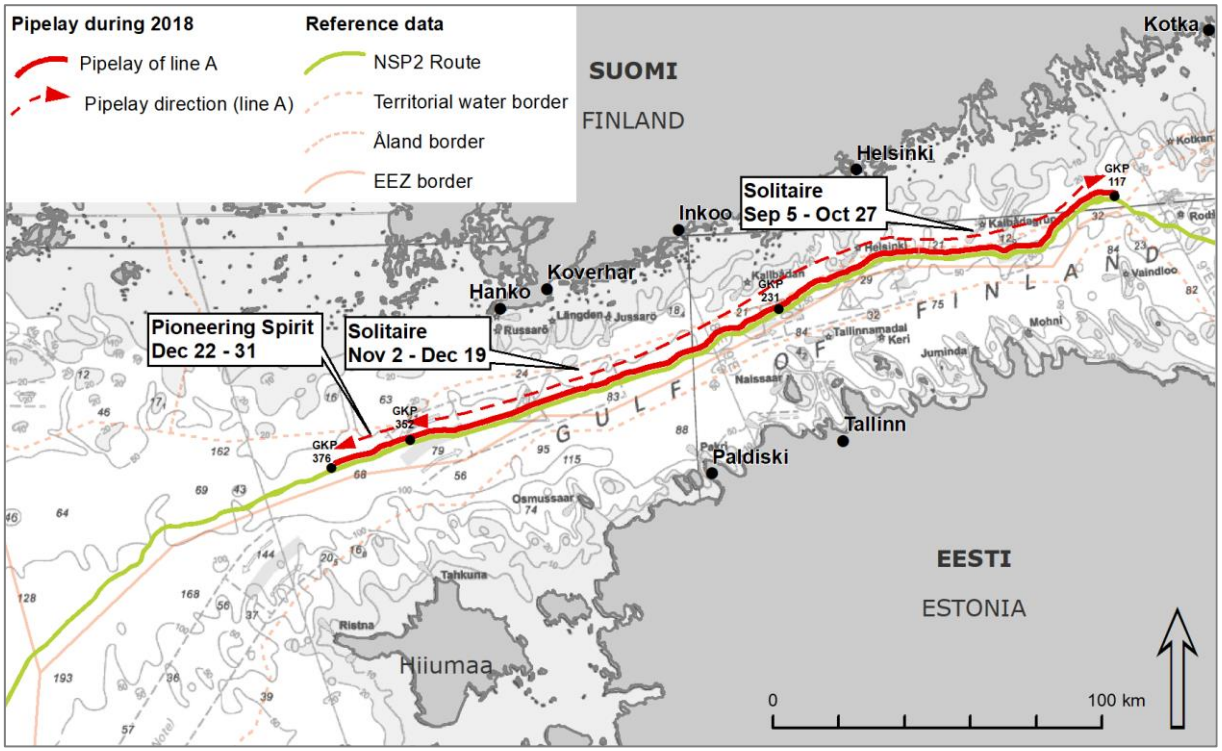


Figure 12. Pipelay in 2018 in the Finnish EEZ by the pipelay vessels Solitaire and Pioneering Spirit.

Figure 13. Pipelay vessel Solitaire. © Nord Stream 2 / Thomas Eugster.

3.5.3 Pipelay in 2019

In 2019, the remaining western part of the Line A, from kilometre point GKP 377 to kilometre point GKP 488, was laid by the pipelay vessel Pioneering Sprit (Figure 15) from January 3 to February 4, 2019 (Figure 14). In the last days of April 2019, the pipelay vessel Solitaire completed the pipelay of the final, about 3 km long section of Line A in the Finnish EEZ from kilometre point GKP 117 to kilometre point GKP 114 (Figure 14). From May 18 onwards, pipelay vessels Pioneering Spirit and Solitaire alternated in the pipelay of Line B, with Pioneering Spirit completing the pipelay in the Finnish EEZ on August 21, 2019 (Figure 14). The pipelay of the remaining part of Line A crossed with four cables, two of them twice, and the pipelay of the complete Line B crossed with 19 cables, some of them several times so that the total number of crossings was 30. In addition, the pipelay of both Line A and Line B crossed the two Nord Stream gas pipelines and Line B crossed the Balticconnector gas pipeline.

In 2019, pipelay had two short interruptions, both in January, due to unsuitable weather conditions for pipelay. There were 130 days of effective pipelay, making the average speed 3.8 km/day. The highest lay speed during the year was approximately 5.4 km/day by Pioneering Spirit and 4.2 km/day by Solitaire.

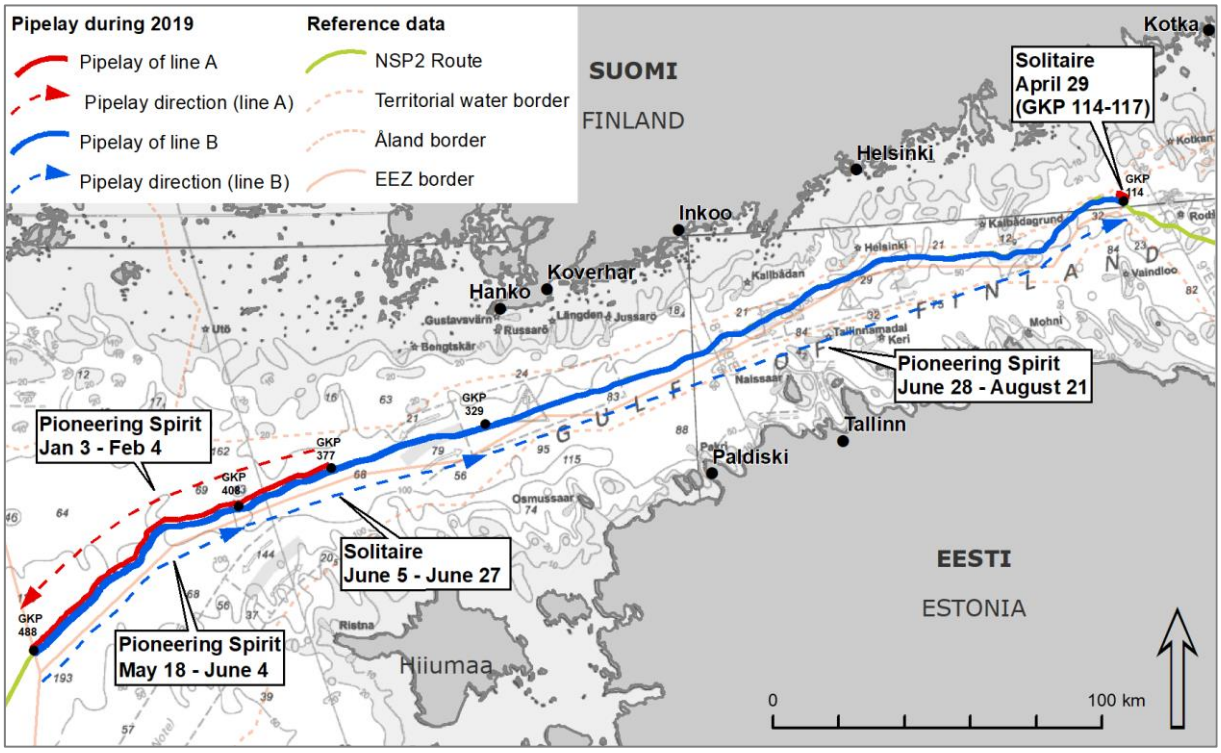


Figure 14. Pipelay in 2019 in the Finnish EEZ by the pipelay vessels Solitaire and Pioneering Spirit.

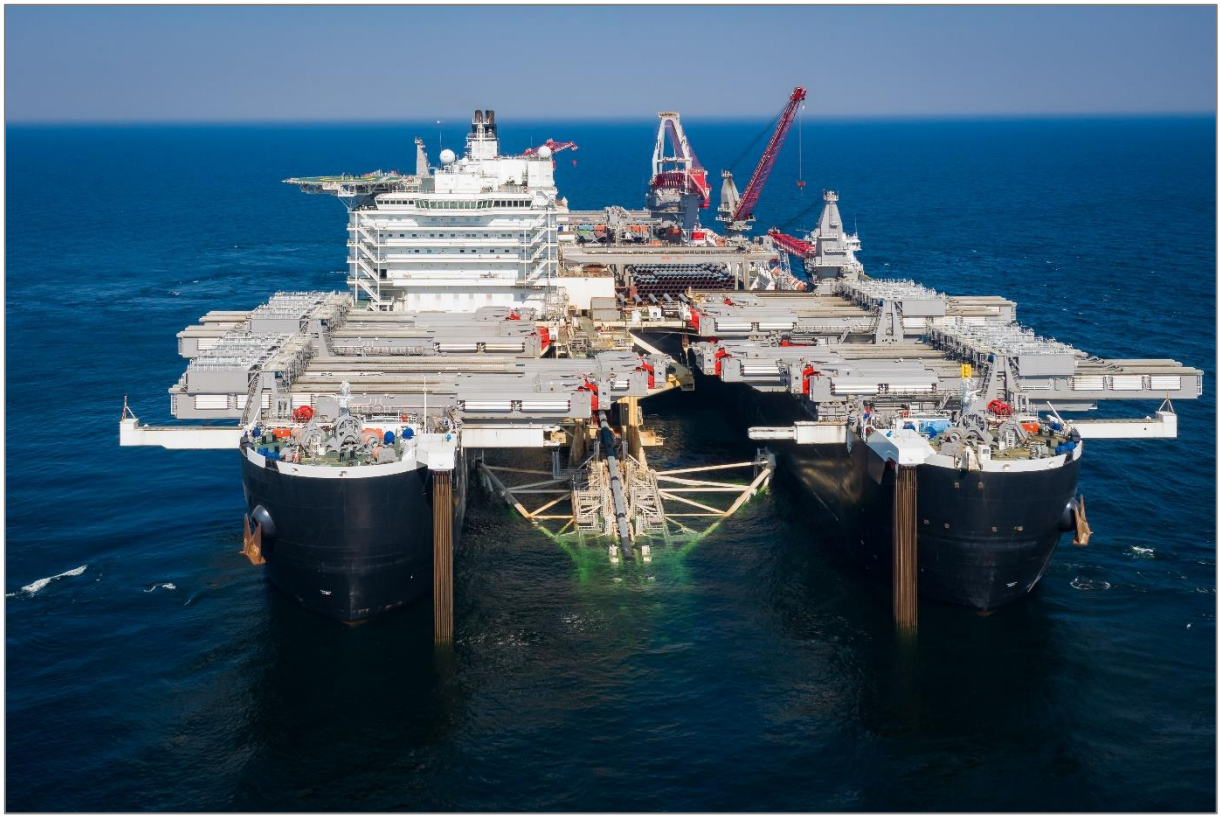


Figure 15. Pipelaying vessel Pioneering Spirit. © Nord Stream 2 / Axel Schmidt.

3.6 Notifications related to construction

The Nord Stream 2 Project has submitted general implementation plans prior to the initiation of different project construction campaigns and monthly plans to present upcoming activities in Finland. Monthly plans were submitted approximately one week before the beginning of each month. In addition, the Nord Stream 2 construction vessels have provided weekly and daily authority notifications regarding the progress and scheduling of construction activities according to the Consent to use the Finnish EEZ and according to the Water Permit provisions.

In 2018 eleven, in 2019 two and in 2020 four notifications related to the construction in the Finnish EEZ were submitted to the Finnish authorities (Table 11). Notifications related to unplanned events are presented in Chapter 3.7.

The first notification related to the construction activities in 2020 was provided to the Finnish authorities on March 27, 2020 /31/. It presented the justification for using a re-designed route on one section of the pipelay of Line A and two sections of the pipelay of Line B. At Line A, the route was optimized to accommodate the crossing with the Balticconnector gas pipeline from kilometre point GKP 252 to kilometre point GKP 261. At Line B, from kilometre point GKP 207 to kilometre point GKP 209, the re-routing was done due to a steep slope on the seabed near several cable crossings. The minor deviation took the pipelay to a more even area to guarantee mattress stability at the crossings. At Line B, from kilometre point GKP 450 to kilometre point GKP 453, the rerouting was necessary due to large boulders on the seafloor endangering mattress installation and thereby safe cable crossing with a cable of an unknown owner. In addition, the notification describes the reason for construction, planned location and construction of an additional berm falling outside the security corridor of Line B prior to construction, as requested in the Water Permit.

The second notification related to the construction activities in 2020 was submitted to the Ministry of Economic Affairs and Employment on June 25, 2020 /32/. It confirms that the construction work was completed on May 30, 2020. The provision 16 of the Consent to Exploit the Finnish Exclusive Economic Zone states that when the construction is finished in the Finnish Exclusive Economic Zone, the Nord Stream 2 Project must inform the Ministry of Economic Affairs and Employment of it, in writing within 30 days. The notification also informs the Ministry that further maintenance rock placement may take place after the post-construction survey.

The third notification related to the construction activities, to deliver the As-Laid pipeline coordinates, was submitted to the authorities on July 3, 2020 /33/. The provision 17 of the Consent to Exploit the Finnish Exclusive Economic Zone states that the Nord Stream 2 Project must submit the final position coordinates of the installed pipelines without delay following the installation to the Ministry of Economic Affairs and Employment, the Ministry of the Environment, the Ministry of Defence, the Finnish Border Guard and the Finnish Transport and Communications Agency Traficom. The coordinates were delivered to these authorities as a list and in geographical WGS-84 format.

The fourth notification related to the construction activities, to inform the authorities of completing the construction works in the Finnish EEZ, was submitted to the authorities on July 7, 2020 /34/. The provision 45 of the Water Permit states that a written notification of the completion of the project must be submitted within 60 days of completion to the Regional State Administrative Agency; the ELY Centres of Southeast Finland, Uusimaa and Southwest Finland (responsibility area of Environment and Natural Resources); the fishery authority in the Southwest Finland ELY Centre ; the Finnish Transport and Communications Agency Traficom; and the environmental protection authorities of the relevant cities and municipalities. The notification of completion must include a map indicating the final location of the natural gas pipelines with the positioning data (as-laid coordinates) for the marine area. The positioning data must be submitted in a numeric format. The notification informs the authorities of the completion of the construction works in the Finnish EEZ and shows the final location of the pipeline, infrastructure

crossings and main constructed rock berms in a map format. The notification also includes the pipeline coordinates as a list and in geographical WGS-84 format. /35/

Table 11. Notifications related to construction in the Finnish EEZ during 2018–2020 and submitted to the Finnish authorities according to permit provisions.

Date	Content
26.3.2018	Provisional notification of the General Implementation Plan on rock placement, munitions clearance and mattress installation in the Finnish EEZ
21.4.2018	Amendment to the General Implementation Plan submitted on March 26, 2018, on rock placement, munitions clearance and mattress installation in the Finnish EEZ
21.4.2018	Delivery of pipeline position data (coordinates) for the overall project
2.7.2018	General Implementation Plan on the start of pipelay of Line A in the Finnish EEZ
13.8.2018	Amendment to the General Implementation Plan, submitted on July 2, 2018, for the Nord Stream 2 pipelay activities for Line A in the Finnish EEZ
24.8.2018	Notification on the use of a tug at the Kalbådagrund TSS area
21.9.2018	Second amendment to the General Implementation Plan, submitted March 26, 2018, on rock placement, munitions clearance and mattress installation in the Finnish EEZ
19.10.2018	Notification on schedule update for the vessel Solitaire in the Finnish EEZ
9.11.2018	Notification on the change of pipelay vessel. Pioneering Spirit to replace Solitaire in December 2018
28.11.2018	Amendment to the General Implementation Plan for pipelay of Line A in the Finnish EEZ. Fortitude to replace Pioneering Spirit as a survey vessel
18.12.2018	Notification on an additional vessel and change in the scope of work for the vessel Fortitude
25.6.2019	Notification on two new pipe supply vessels to start supporting pipelay in the Finnish EEZ
25.7.2019	Notification on the use of a tug at Kalbådagrund TSS area
27.3.2020	Justification for three re-routes and one additional berm
25.6.2020	Notification on the completion of the construction work on May 30, 2020 in accordance with the Consent to exploit the EEZ
3.7.2020	Delivery of the As-Laid pipeline coordinates
7.7.2020	Notification on completing the construction works in the Finnish EEZ in accordance with the Water Permit, with the final location of the pipeline, infrastructure crossings and main constructed rock berms in a map format and the pipeline coordinates as a list and in geographical WGS-84 format

3.7 Unplanned events

No unplanned events took place during 2020. Four minor oil leaks occurred during the construction activities in 2018 and two oil leaks in 2019. All of these unplanned events were notified to the relevant authorities (Table 12). A comprehensive investigation was performed after the largest (150 L) incident that took place in October 2018 /36/. No measurable environmental impacts occurred due to any of the unplanned events, and the authorities did not request any actions to be taken due to the incidents.

Table 12. Notifications related to incidents submitted to the Finnish authorities in 2018–2020.

Date	Content
12.7.2018	Incident Report - minor oil leak. A small oil leak (release of 4 L of biodegradable oil) occurred with the ROV -device of the vessel Oceanic.
16.9.2018	Notification on small oil leak. A small amount of biodegradable oil (< 2 L) was leaked into the water from the ROV -device of the vessel Olympic Triton.
22.10.2018	Notification on oil leak. An oil-leak occurred during vessel Solitaire pipelay. The vessel's thruster leaked approximately 150 L of gearbox lubrication oil. It is estimated that the slow release of the oil started at kilometre point GKP 132.0 and was subsequently detected and stopped at kilometre point GKP 130.4. The leaked oil is expected to be biodegradable, not to bio-accumulate through food chains and not classified as hazardous to the environment.
1.11.2018	Notification on small oil leak. A small amount of biodegradable oil (approx. 4 L) was leaked into the water from the ROV -device of the vessel Oceanic.
26.7.2019	Notification on small oil leak. A crane used onboard survey support vessel Fortitude leaked about 20 L of biodegradable, non-bioaccumulable hydraulic fluid on deck. Of the total spill, about 10 L could be bunded on the deck.
12.8.2019	Notification on oil leak. The rock placement vessel Bravenes lost 40 L of oil from one of its azimuth thrusters to the sea. The major constituents of the oil are inherently biodegradable, although it contains components that may persist in the environment. According to the Product Safety Sheet, the oil is practically non-toxic to marine life.

4 MAINTENANCE ACTIVITIES

The construction of the Nord Stream 2 pipeline in the Finnish EEZ started in April 2018 and it was completed in May 2020. Technical monitoring of the pipeline continues and post-construction surveys and maintenance activities are performed based on the results of the technical monitoring.

4.1 Post-construction surveys

Post-construction surveys are performed after the construction is completed. They aim at assessing the condition of the pipeline and associated rock berms against the design requirements to confirm the overall integrity of the pipeline system.

The first post-construction survey took place on September 15, 2020. It was performed by a survey vessel Geosurveyor X and it focused on a large berm in the vicinity of kilometre point GKP 473. The results revealed that some maintenance rock placement was necessary at this site (see following chapter).

4.2 Maintenance rock placement

If deemed necessary in the post-construction surveys, additional rock placement (top-ups) is performed until the design condition is reached again.

Based on the post construction survey in the vicinity of GKP 473 in the western Finnish EEZ, it was assessed that remedial works were required for one berm (FI-B1332) to assure the pipeline integrity in operation. Altogether 2,918 m^3 of rock material was placed at the site on November 7-8, 2020 by the rock placement vessel Rockpiper.

4.3 Notifications related to maintenance

In 2020, two notifications related to maintenance activities in the Finnish EEZ were submitted to the Finnish authorities (Table 13). In addition, the Nord Stream 2 survey and maintenance vessels have provided daily authority notifications regarding the progress and scheduling of maintenance activities according to the Consent to use the Finnish EEZ and according to the Water Permit provisions.

The first notification related to maintenance activities, a General Implementation plan for Post-Construction Survey in the Finnish EEZ, was submitted to the authorities on July 20, 2020 /37/. It informs the authorities about a one day, at a section less than 20 km, post-construction survey to be carried out in August 2020.

The second notification related to maintenance activities was submitted to the authorities on October 20, 2020 /94/. It is a general implementation plan for maintenance rock placement in the Finnish EEZ and provides information on the maintenance rock placement at one berm.

Table 13. Notifications related to maintenance activities in the Finnish EEZ in 2020 and submitted to the Finnish authorities according to the permit provisions.

Date	Content
20.7.2020	General Implementation plan for Post-Construction Survey in the Finnish EEZ
20.10.2020	Maintenance rock placement at one berm in the Finnish EEZ

5 ENVIRONMENTAL BASELINE

This chapter describes the weather conditions during 2020 and presents the prevailing environmental conditions in the project area. The chapter portrays the state of the Baltic Sea as assessed in the Marine Strategy of Finland and describes physical, chemical, biological and anthropogenic baseline conditions in the project area. Only those environmental conditions that the Nord Stream 2 Project may have impact on, as assessed in the EIA phase, are described. Therefore, data on fish and birds is not included. Baseline data is collected from the observations of the Nord Stream 2 Project monitoring contractors and from various public sources, and has to a large extent been presented in the Annual Monitoring Reports 2018 and 2019. Updated data, compared to the results presented in the Annual Monitoring Reports 2018 and 2019, has been added to chapters 5.1 Weather conditions in 2020 and 5.3.2 Marine mammals.

5.1 Weather conditions in 2020

The statistics of the Finnish Meteorological Institute show that the year 2020 was the warmest on record since measurement recording in Finland. The record-warm year can be explained by the very mild winter period which raised the average annual temperature. The mean annual temperature was 2.5 °C above the long-term (1981–2010) average in Finland. In Helsinki Kaisaniemi observation station, the average temperature was 2.8 °C above the long-term average (1981–2010) (Figure 16) /38/.

In coastal areas of the Gulf of Finland, precipitation was exceptionally high in many locations, at levels that are reached, on average, once in every 30 years /38/. For example, in Helsinki Kaisaniemi observation station, the annual precipitation was 92 mm higher than the long-term average (1981–2010) (Figure 16) /39/.

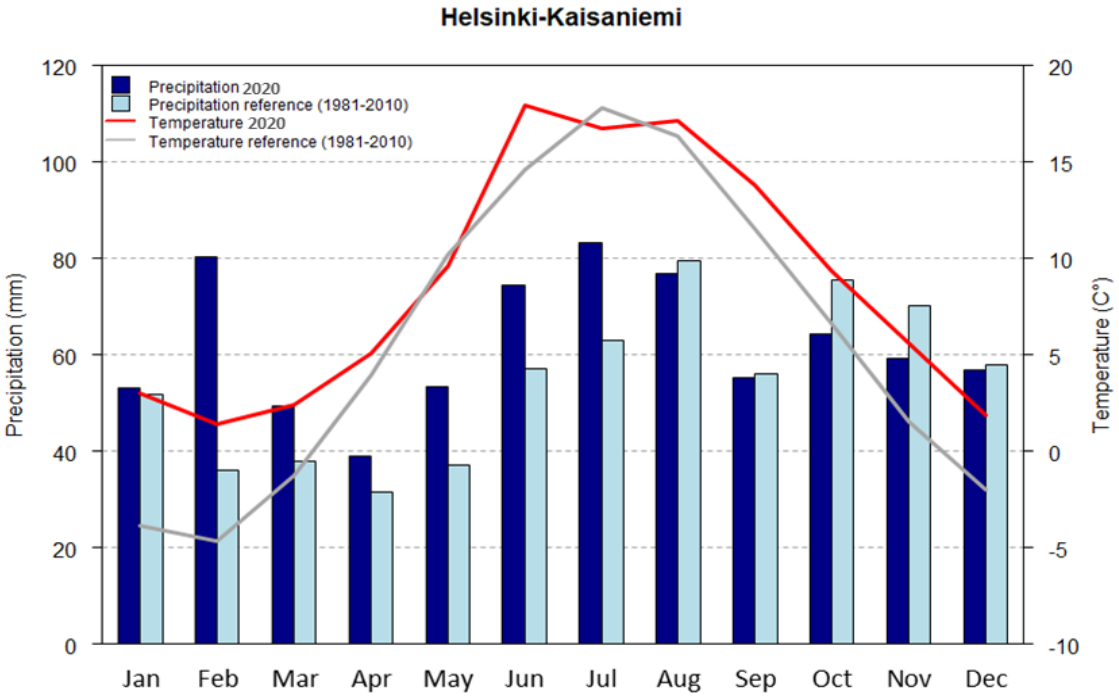


Figure 16. Monthly average temperature (°C) and monthly total precipitation (mm) in Helsinki Kaisaniemi observation station in 2020 and during the reference period (1981–2010). Data from the Finnish Meteorological Institute /40/.

Data for wind speed and direction was collected from the Finnish Meteorological Institute weather observation stations Jussarö, Eestiluoto and Orrengrund, representing western, central and eastern Gulf of Finland coastal conditions, respectively (Figure 17). Southwest was the dominant wind direction. Occasional wind speeds reaching 15 m/s were measured at all stations, and up to 20 m/s in both western and eastern Gulf of Finland, more often in Jussarö, which is closer to the open Baltic Proper (Figure 17).

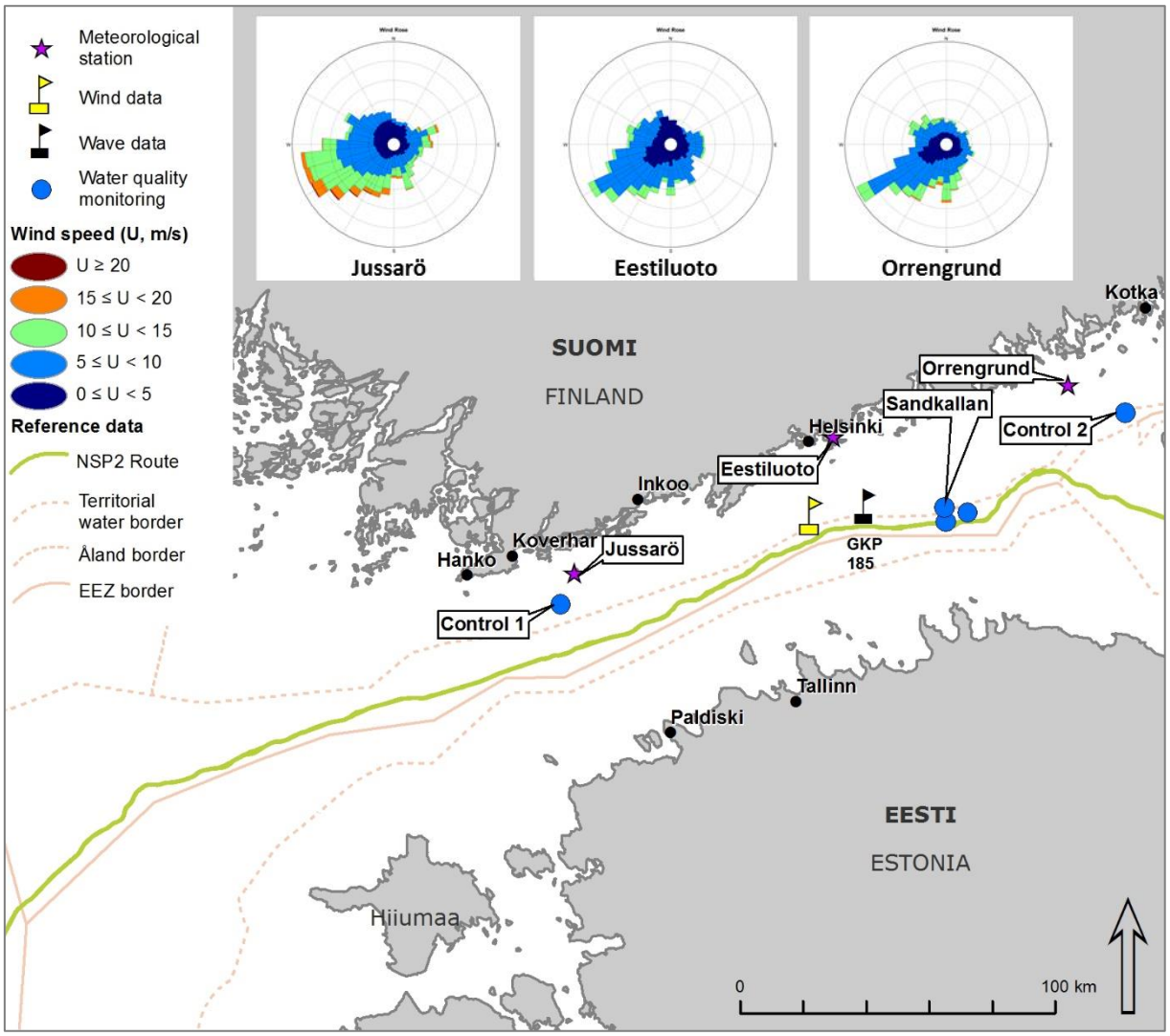


Figure 17. The observation stations of the Finnish Meteorological Institute and the Nord Stream 2 monitoring stations in the Gulf of Finland. Wind data /40/.

The significant wave height observation data was collected from an open sea wave buoy located in the Gulf of Finland approximately six kilometres north of kilometre point GKP 185. Wave height varied from 0.1 to 4.1 m, with higher waves measured during the winter (Q1) than during the summer (Q2 and Q3). The average wave height was 0.96 m /40/.

Ice season 2019–2020 was the mildest in the history of measurement recording in Finland. The Gulf of Finland remained free of ice throughout the entire winter 2019–2020 (Figure 18). Only occasional thin ice formation was found after cold nights in sheltered and shallow inland archipelago in the Finnish

territory. At eastern end of the Gulf of Finland in the Russian territory, ice was only covering Vyborg Bay and the coastal sea area outside of St. Petersburg. These coastal ice formations melted and the Gulf of Finland was completely free of ice at the end of March 2020. /41/

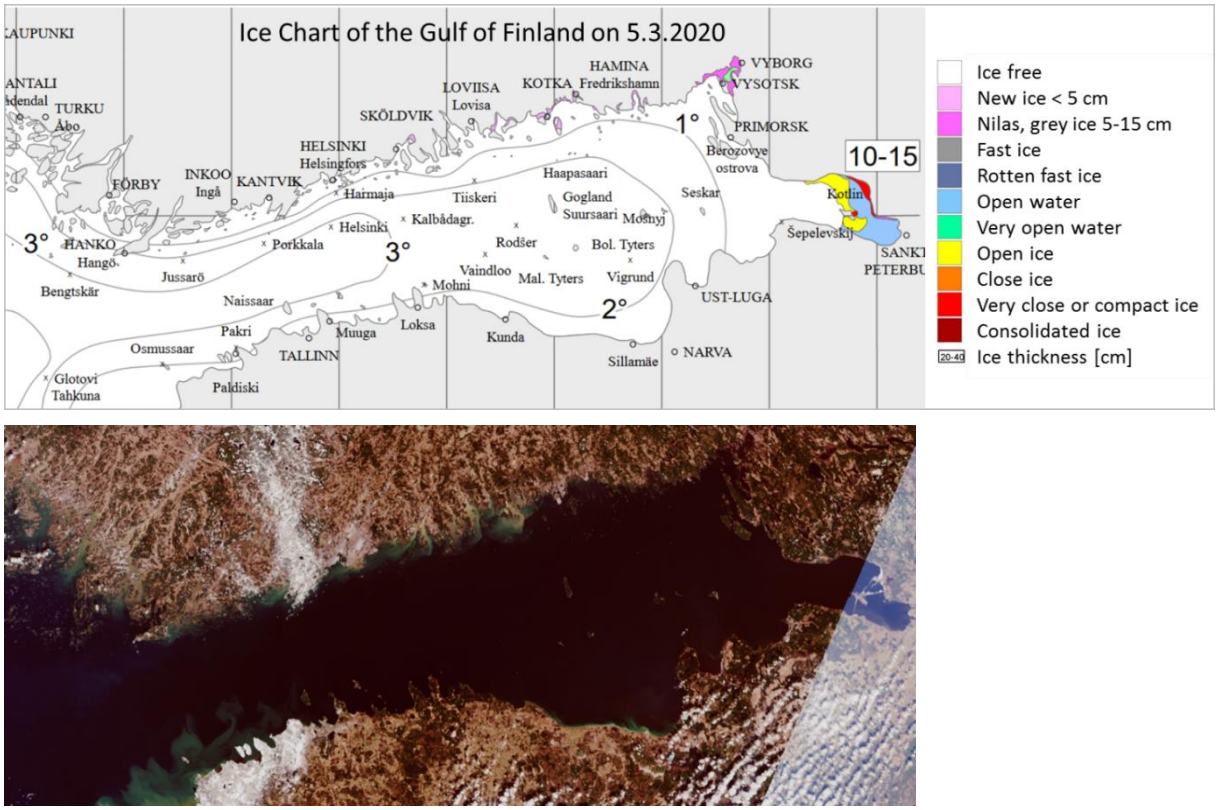


Figure 18. Sea ice chart of the Gulf of Finland by the Finnish Ice Service (FIS) and the Swedish Meteorological and Hydrological Institute (SMHI) on 5 March 2020 when the Baltic Sea had the largest ice extent during the ice season of 2019–2020. Adapted from /42/, ESA Copernicus Sentinel Data.

5.2 Physical and chemical environment

5.2.1 Seabed morphology and sediments

The seabed of the pipelay corridor consists of sedimentation areas, erosion areas and transport areas, where material alternatingly accumulates and shifts away. In the eastern part of the Finnish EEZ, the pipelay corridor is mainly located on hard seabed consisting of hard clay, while the middle and western parts of the Finnish EEZ the corridor mainly consist of soft clay/mud sediments. Soft seabed areas form about 60 % of the total project area. Oxygen conditions near the seafloor fluctuate between good and poor due to natural processes (mixing, saline inflows, organic matter decomposing) /43/.

The presence of contaminants in the surface sediments along the survey area was analysed from seven areal stations and the results were presented in detail in the EIA Report /4/. The normalized concentrations of metals were mainly at concentration level 1 (concentrations close to natural background levels) according to the Ministry of the Environment guidelines on sediment dredging and dumping /44/. The normalized concentrations of some metals in single samples were within levels 1A–1C (increasing impact, but affecting less than 5 % of biota). The concentrations were within the higher level 2 only in five samples, in four cases with respect to nickel (60.4; 60.8; 93.7; and 130.6 mg/kg with level 2 limit >60 mg/kg; all in surface sediment) and once for copper (95.5 mg/kg with level 2 limit >90 mg/kg, at the sediment layer 10–15 cm) /43/.

5.2.2 Hydrography and water quality

The average water depth in the Gulf of Finland is 37 m and the maximum depth is 123 m at the Paldiski Deep. The water depth gradually increases from the Gulf of Finland towards the deeper Baltic Proper basin, where the water depth exceeds 185 m within the Finnish EEZ. The depth of the pipeline route corridor within the Finnish EEZ varies from 34 m to 183 m. More than 90 % of the pipeline route is located at depth of more than 60 m, and 34 % at depth of more than 80 m (Figure 19).

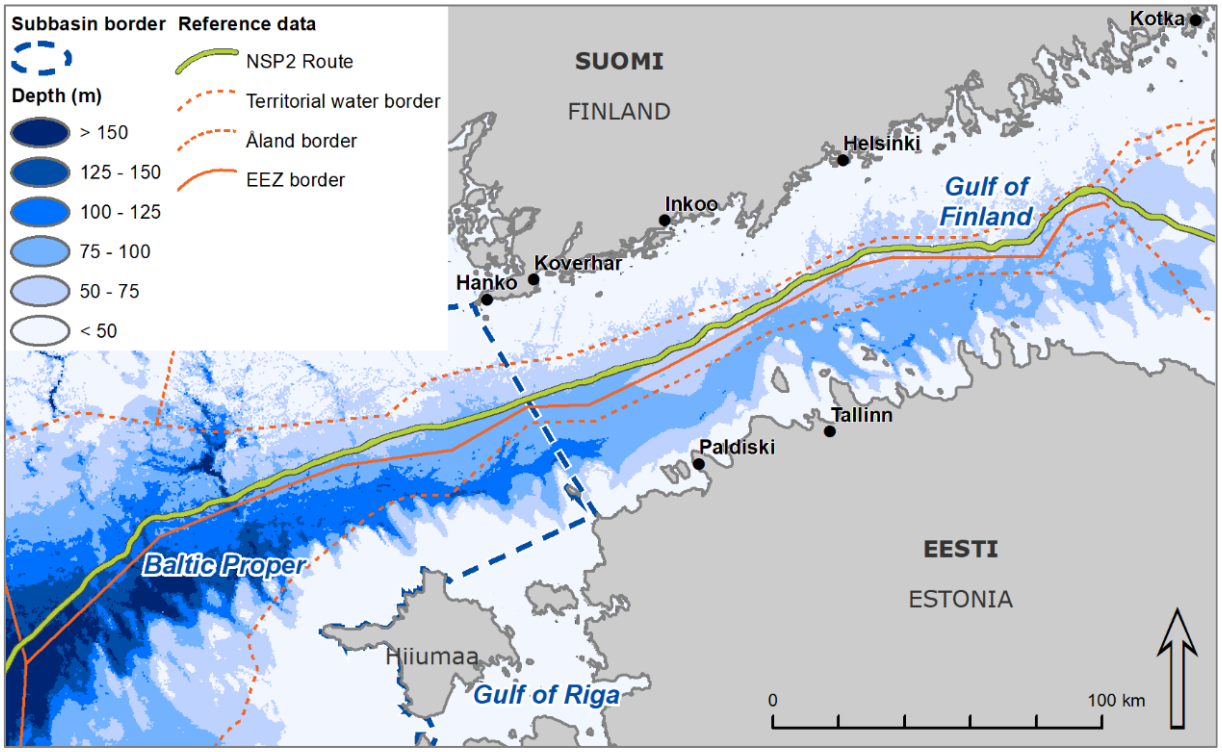


Figure 19. Baltic Sea sub-basins and water depth conditions along the pipeline route.

Currents in the Gulf of Finland (Figure 20) are mainly induced by wind, but also by variations in salinity and temperature. Mean surface circulation is cyclonic. Current speed was monitored during the construction activities of the Nord Stream pipelines in 2010–2011 in the open, deep sea waters of the Gulf of Finland. At the depth range of 60–80 m, the average current speed was 0.05 m/s. The highest single recorded value was 0.21 m/s /4/.

A dominant feature of the Gulf of Finland is the stratification structure shaped by differences in temperature and salinity across the water body. The large input of freshwater from the rivers in the drainage basin creates a surface salinity gradient from east (salinity almost zero) to west (salinity up to 10 PSU (practical salinity unit)). In the deepest layers, salinity is higher due to an incoming deep current from the Baltic Proper and it ranges from 0–5 PSU in the east to over 10 PSU in the west.

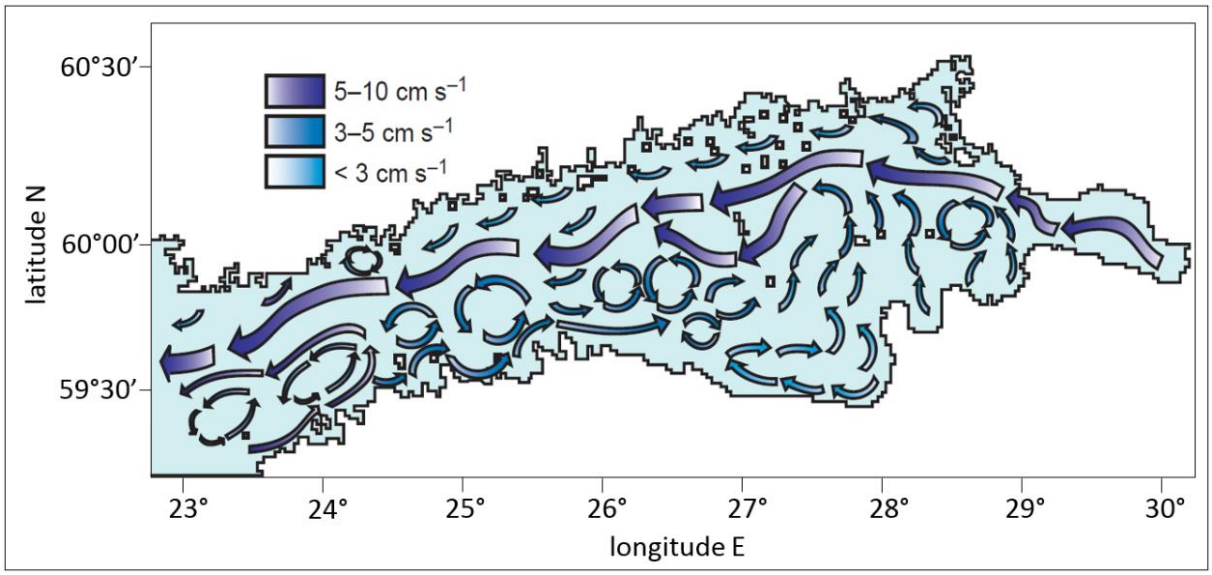


Figure 20. Schematic illustration of the mean circulation in the Gulf of Finland /4/.

In the surface waters of low salinity, the temperatures vary seasonally from ice cover in winter to over 20 °C in late summer. The warm water layer in summer is only 10–20 m deep; below thermocline (a thin transition layer where temperature decreases rapidly), water is cold and it does not mix with the warm surface water until autumn. At the Nord Stream 2 long-term monitoring stations (see Chapter 6.2) thermal stratification prevailed from April to late July in 2018 and from March to October-November in 2019. In 2020, only the Sandkallan stations were monitored. There, the highest temperatures (+6°C) were measured in December and lowest temperatures (+3°C) in March-April (see Chapter 6.2).

In the deepest layers below the depth of about 70 m, temperatures are stable, at around 2–3°C year-round, due to the nearly permanent halocline (a thin transition layer where salinity increases rapidly). Density differences between the layers above and below the halocline limit the mixing of the deep, high saline waters with the less saline layers above, leading to persistent anoxia at the sediment floor. This is also evident at the deepest Nord Stream 2 long-term monitoring station Sandkallan 3 (67 m), where high salinity at the deepest layers limited the mixing for most of the monitoring period from April 2018 to December 2019. Consequently, oxygen concentrations were low on the seafloor /45/. Poor oxygen conditions inhibit colonization by benthic fauna on most of the sediments below the depth of 70 m in the Gulf of Finland. In 2020, practically no halocline was observed in winter or in spring. Weak or missing halocline allowed the mixing of surface and bottom waters, increasing oxygen concentration at the bottom. Salinity near the sea floor at the deepest station Sandkallan 3 increased to 10 PSU in May 2020, indicating the re-establishment of the halocline /45/.

Water stratification structure plays an important role in vertical dispersal of sediments released from the bottom during construction, as well as in natural resuspension process during storm events. Strong salinity and temperature stratification reduce the mixing of bottom water and upper water column, thus limiting the spreading of released sediment spill to below halocline and thermocline. Strong temperature stratification also reduces natural resuspension at areas shallower than the permanent halocline, until the stratification break-up takes place, typically in autumn.

The current status of the marine environment in the Gulf of Finland is classified as “poor” for the physico-chemical indicators “eutrophication” and “contaminants and the impacts of contaminants”, and “good” for the indicator “changes in hydrography” /46/.

5.2.3 Underwater noise

Water carries sounds over long distances, and the underwater world is never silent. Natural sources of sound are, for example, wind, waves and animals, whereas anthropogenic sources include activities, such as ship traffic and echo sounding. Sounds are either continuous or impulsive. In excess, both types disturb underwater fauna. A good environmental status with respect to underwater noise requires that the level and distribution of both continuous and impulsive sounds should not cause negative impacts on marine life /47/. So far, such levels have not been defined for sound sensitive species in the Baltic Sea /48/.

The sound levels vary widely across the Baltic Sea. Continuous sound in the Baltic Sea has been monitored in a comprehensive study using automated hydrophone loggers in 2014 /49/. The results indicate that both impulsive and continuous sound are present in the Baltic Sea and can be perceived by, for example, fish, seals and harbour porpoise at a wide range of frequencies /44/. High sound levels were found along major shipping routes especially in the southernmost areas (Figure 21). The Nord Stream 2 pipeline route largely follows the major shipping routes. Impulsive sounds are not monitored, but since 2015 it has been possible to log activities associated with loud impulsive sounds into a regional registry hosted by ICES /50/. By 2016, Denmark, Estonia, Finland, Germany, Lithuania, Poland had registered such activities, with Latvia and Russia yet to join the registry. In the future, the registry can be used to evaluate the magnitude and distribution of activities that generate impulsive sound.

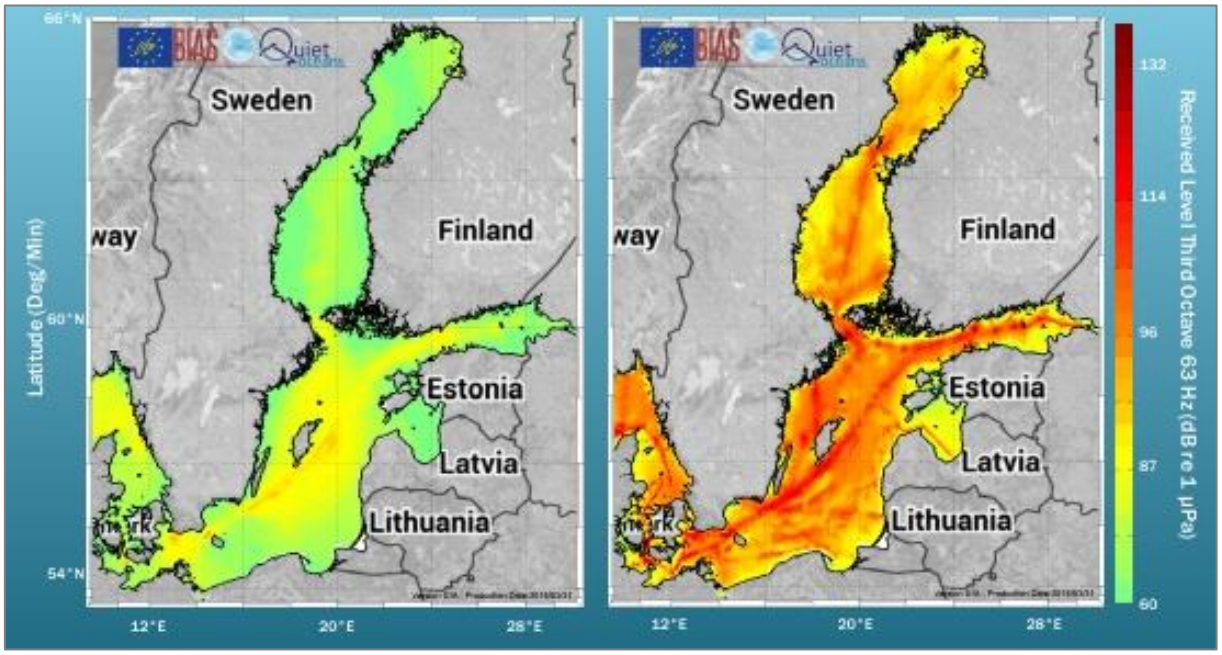


Figure 21. Soundscape maps modelled in the BIAS project for June 2014 showing the sound pressure levels for the 63 Hz band that are exceeded 95 % (left) and 5 % (right) of the time considered /51/.

5.3 Biotic environment

5.3.1 Biodiversity

The Baltic Sea is low in salinity and its brackish waters host a low number of species, some of which are endemic. Despite this, the salinity gradient and the variety of habitat types create a basis for a diverse flora and fauna. Species in the Baltic Sea, both with marine and freshwater origin, are stressed by the brackish water, making them even more sensitive to anthropogenic impacts. To conserve habitats and species, the Marine Protected Areas (MPAs) and other conservation efforts are of great importance /48/.

Benthic habitats are sensitive to eutrophication, physical disturbance, habitat loss /48/ and fishing (trawling) /52/. An integrated biodiversity status assessment with focus on soft bottom habitats shows an integrated biological quality ratio (BQR) of 0.4–0.6 along the southern coast of Finland, and a value of 0.2–0.4 in the central Gulf of Finland. The coast of Estonia has a value of 0.6–0.8. A good status for a benthic habitat would have a value of 0.6 or higher. The benthic quality in the area is classified as "not good" by the core indicators /48/.

Pelagic habitats are sensitive to anthropogenic impacts, such as hazardous substances and eutrophication as well as climate change and strong pressure of fishing. The health of pelagic habitats is commonly monitored by studying zooplankton diversity and primary producers, such as phytoplankton. The BQR of pelagic habitats in the Gulf of Finland is 0.2–0.4 along the pipeline area, and 0.4–0.6 closer to the coasts of Finland and Estonia. The status of phytoplankton and zooplankton, which are used as core indicators, is classified as "not good" /48/.

5.3.2 Marine mammals

Three marine mammal species occur in the Finnish waters of the Baltic Sea: the harbour porpoise (*Phocoena phocoena*), the grey seal (*Halichoerus grypus grypus*) and the Baltic ringed seal (*Pusa hispida botnica*). Both the grey seal and the ringed seal are isolated subspecies endemic to the Baltic Sea. The protection statuses of marine mammals are listed in Table 14.

Table 14. Marine mammals and their protection statuses in the Baltic Sea. Roman number refers to the Annexes of a directive, a convention or an agreement.

Species	Harbour porpoise	Baltic ringed seal	Grey seal
Habitats Directive	II, IV	II, V	II, V
HELCOM	CR, Critically endangered	VU, Vulnerable	LC, Least concerned
IUCN	CR, Critically endangered	LC, Least concerned	LC, Least concerned
Bern Convention	III	III	III
Bonn Convention	II	-	-
Washington Convention	II	-	-
ASCOBAN Agreement	Included	-	-

The harbour porpoise was widely distributed in the Baltic Sea until the first half of the 20th century. However, a dramatic decline was observed during the past 50–100 years /53/. The severe decline of the harbour porpoise population in the Baltic Proper makes it the smallest population of harbour porpoises in the world /54/. The latest population estimate was done during the SAMBAH project 2016. The remaining number of porpoises in the Baltic Proper was estimated to be approximately 500 individuals, although the estimate was rough, with a 95 % confidence interval covering a range of 80–1,100 /55/.

Based on observations and acoustic detection /55/, porpoises are likely to be found in low densities in most parts of the Gulf of Finland and the Archipelago Sea /53/.

The ringed seal population has passed a major decline over the last 100 years and is now recovering from very low numbers. The population was estimated to be around 200,000 individuals in the beginning of the 20th century, around 3,000–5,000 individuals in the 1970s, and 11,500–17,400 individuals by 2014 /53/. The situation of the subpopulations in the Gulf of Finland, in the Archipelago Sea and in the Gulf of Riga is unclear due to poor data from recent years.

The subpopulation in the Archipelago Sea was estimated to be 140-300 individuals during 2002–2005 /56/. An estimate of 100 individuals for the Gulf of Finland population was made in 2011, which compared to an estimate of 300 individuals in the 1990s indicates a rapid decline, if correct /53/. The main part of this subpopulation inhabits the Russian waters, but to some extent reaches across the border to the Finnish areas as well as to the Estonian areas. With the support of Nord Stream 2 AG and in cooperation with experts and state and private stakeholders, marine mammal scientists have been carrying out telemetry studies of the Baltic ringed seals in the Gulf of Finland since 2017. By 2018, 11 and by the end of 2019, 18 individual ringed seals were tagged, and their movements were monitored in the Russian waters in separate spring and autumn campaigns. The results agree with the earlier data of the population distribution in the Gulf of Finland, confirming that ringed seals inhabit remote and relatively untouched marine areas. The results add to the growing knowledge base of movements within and between subpopulations /57, 58/.

The grey seal population of the Baltic Sea has been increasing in recent years. It was estimated to have comprised of 80-100,000 individuals approximately 100 years ago, but it decreased to a critical number of 4,000 individuals during the 1970s due to hunting and pollution. Since then, the number of individuals has increased again, and the total population during 2014 was estimated to be more than 40,000 individuals /53, 59/. Seal counts during 2016 (30,116 individuals), 2017 (30,348 individuals), 2019 (38,000 individuals) and 2020 (40,075 individuals); data from LUKE - Natural resources institute Finland) suggest that the population is still increasing. Part of the sudden, large increase from 2018 to 2019 is, however, explained by the exceptionally good weather conditions during the seal counts in 2019. Part of the annual increase in population is due to the migration from other areas to the southern Baltic Sea. The grey seal moves across great distances in the Baltic Sea and gathers in coastal areas, preferably on drift ice during winter and in undisturbed islands during summer /53/.

Table 15. Protection criteria of the Natura 2000 sites designated to the protection of seals and distance of the site from the pipeline (source: /62/).

Site and distance from the pipeline	Site code	Grey seal	Ringed seal
Archipelago Sea, 14.5 km	FI0200090	x	x
Tammisaari and Hanko MPA, 17.8 km	FI0100005	x	-
Pernaja Bay and Pernaja Archipelago, 13.1 km	FI0100078	x	x
Eastern Gulf of Finland Archipelago, 23.5 km	FI0408001	x	x
Kallbådan Islets and Waters, 9.8 km	FI0100089	x	-
Archipelago of Söderskär and Långören, 12.5 km	FI0100077	x	-

Grey seal hunting is allowed in Finland from April 16 to December 31. The Gulf of Finland quota was 140 individuals for the 2018/2019 hunting period and 300 individuals for the 2019/2020 and 2020/2021 hunting periods /60, 61/.

There are no Natura 2000 sites along the pipeline in the Finnish waters designated to the protection of harbour porpoise, and it is unlikely that a harbour porpoise would appear along the Nord Stream 2 pipeline route /53/.

Three Natura 2000 sites designated to the protection of both **ringed seal** and **grey seal** are located within 100 km of the Nord Stream 2 pipeline route: Archipelago Sea, Pernaja Bay and Pernaja Archipelago, and Eastern Gulf of Finland Archipelago (see Table 4.7.1. in /49/) (Table 15). Altogether 15 Natura 2000 sites designated to the protection of **grey seal** are located within 100 km of the Nord Stream 2 pipeline route. The closest sites are Kallbådan Islets and Waters at a distance of 9.8 km and Archipelago of Söderskär and Långören at a distance of 12.5 km from Line A (see Table 5.7.2. in /53/).

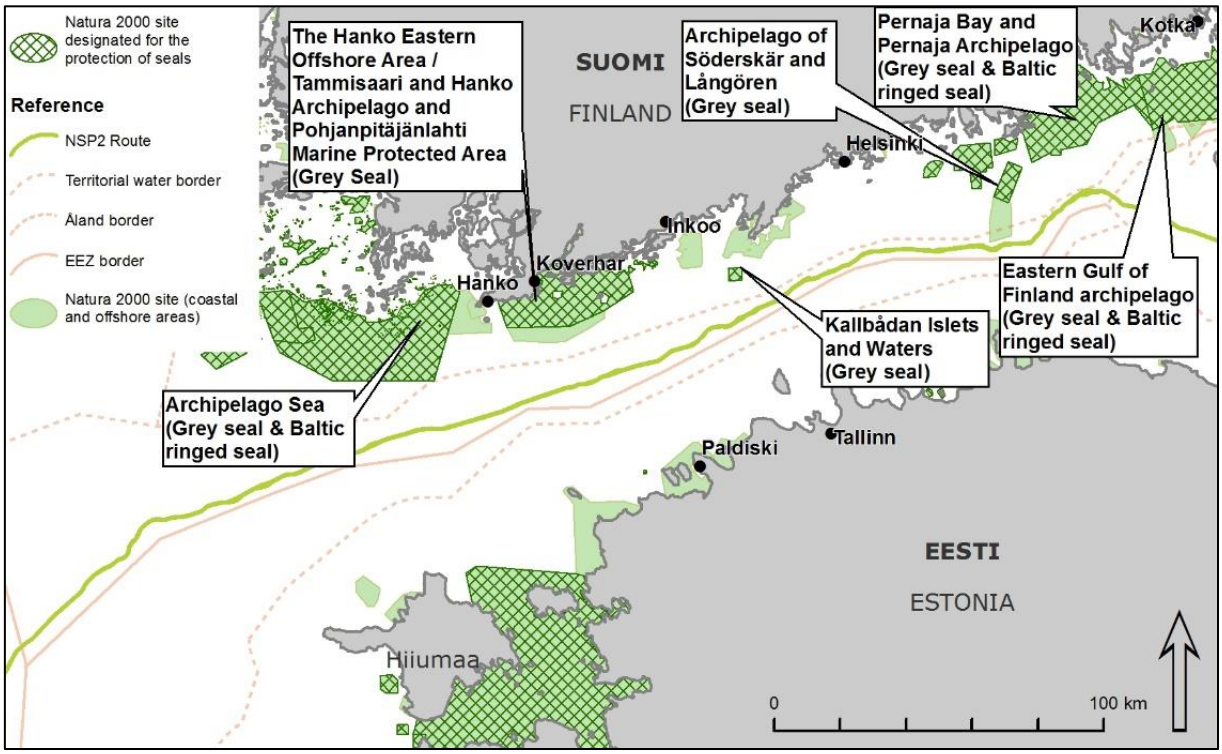


Figure 22. Natura 2000 sites designated to the protection of seals.

5.3.3 Protected areas

The Natura 2000 site **Sea Area South of Sandkallan** (SAC FI0100106) has a total area of 7,468 ha. Of this area, 220 ha consists of the habitat type "Reefs" (code 1170), which is an Annex I habitat type protected as a special area for conservation under the Habitats Directive. No Annex II species under the Habitats Directive or Annex I species under the Birds Directive exist in the area. This area is the closest reef to the pipeline with a distance of 1.9 km from the Line A. The seafloor is diverse with hard and soft substrates. Rock formations at depths between 15–20 m provide habitats for blue mussels (*Mytilus edulis*), with a maximum cover of 80 %, and barnacles (*Amphibalanus improvisus*) as well as red algae and clawed fork weed (*Furcellaria lumbricalis*). The species abundance decreases with depth, and blue mussels occur to a depth of approximately 30 m. Hydrozoans occur in sparse colonies on hard bottoms at depths between 40–50 m. At the depth of 50 m, the substrate consists of smooth clay bottoms. Other important species in the Sea Area South of Sandkallan are the Baltic macoma (*Limecola balthica*),

isopods (*Saduria entomon*), amphipods (*Gammarus* sp.), ragworm (*Hediste/Nereis diversicolor*), and the European eelpout (*Zoarces viviparus*). The area is important for species distribution and survival, as it is located in a sea area off the coast.

The Natura 2000 site **Kallbådan Islets and Waters** (SAC FI0100089) was primarily established for the protection of grey seals, and it includes a seal sanctuary by the same name. It is protected as an area for conservation under the Habitats Directive. The area of the site is approximately 1,520 ha, and it is located in an offshore area southwest of the Porkkala Peninsula. In 2018, the habitat type "Reefs" (code 1170) and the habitat type "Boreal Baltic islets and islands in outer archipelago and open sea zones" (code 1620) were added covering approximately 511 ha within the protected area (Figure 23) /63/. The Annex II species under the Habitats Directive present in the area is the grey seal. The distance from this area to the Line A is 9.8 km.

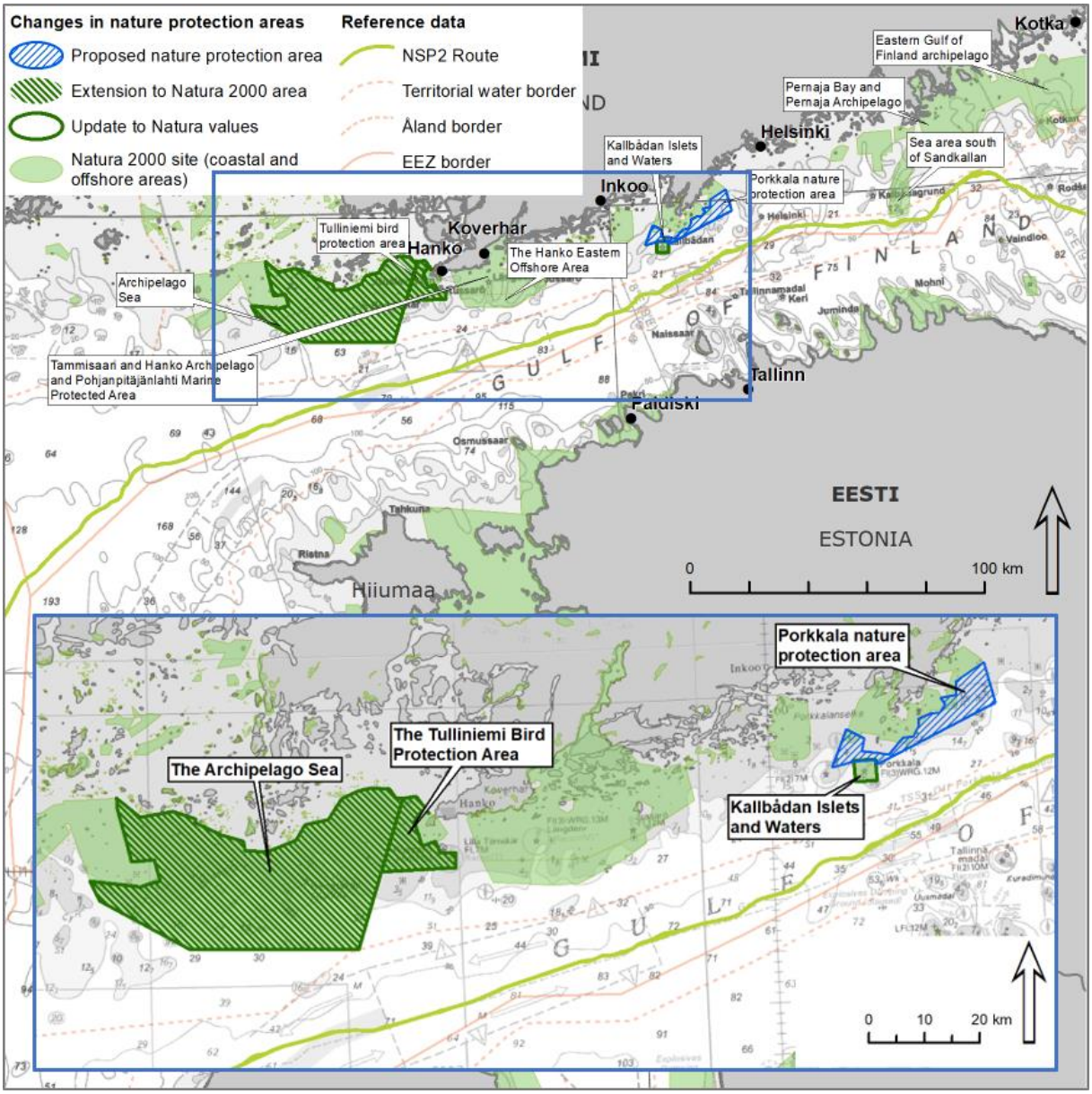


Figure 23. Changes to the Natura 2000 areas and nature protection areas in 2018 (lower map). The coastal and offshore Natura areas are shown in the upper map, and the names of the closest protected areas to the Nord Stream 2 Project pipeline route are indicated. Information on updates to protection areas from /46, 63,64/.

The Natura 2000 site **Hanko Eastern Offshore Area** (SAC FI0100107), at a distance of 13.7 km to Line A, has an area of 1,200 ha and is defined and protected as a habitat type "Reefs" (code 1170). The average water depth is 35 m and hard substrates constitute 40 % of the bottom. This area is exposed to noise and vibration from the Finnish Defence Forces, as it is adjacent to a military training area.

The Hanko Eastern Offshore Area is connected to another Natura 2000 site, the **Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti Marine Protected Area** (SPA/SAC FI0100005) at a distance of 17.8 km to the Line A. Together they create a nature type succession from poor species diversity at sea, to a bladder wrack (*Fucus vesiculosus*) belt in the outer archipelago and ultimately highly diverse inner archipelagic areas. Soft seabed in the area is dominated by Baltic macoma, blue mussels, isopods and polychaetes. The Annex II species under the Habitats Directive present in the area is the grey seal.

The Natura 2000 site **Archipelago Sea** (SPA FI0200164 and SAC/SCI FI0200090), at a distance of 14.5 km from the Line A, includes different delineations of SPA, SAC and SCI areas. The surface area of FI0200164 approximately tripled to 162,205 ha in 2018 with an extension decision of the Finnish Government (Figure 23) /63/. The extension was also established as a SCI area (Sites of Community Interest), which means that the EU member states proposed the area as a SAC area. When approved, this will triple the SAC surface area (FI0200090) to 152,223 ha. The area is a significant breeding and migration area of birds. Many Annex I species under the Birds Directive and nationally threatened species have been observed in the area. It is also used by the Finnish Defence Forces. The Annex II species under the Habitats Directive present in the area are the grey seal and the Baltic ringed seal.

The Natura 2000 site **Tulliniemi Bird Protection Area** (SPA FI0100006), more than 23 km north of the Line A, was extended to the west in 2018 to include the sea area around the previously protected islands /63/. The surface area today, 11,155 ha (96,6 % of marine area), is now approximately five times larger than in 2017. The Natura site is protected as both a special area for conservation under the Habitats Directive and a special protection area under the Birds Directive. The archipelago area is significant for sea birds. Water covered sandbanks and reefs are unique and relatively well preserved in spite of anthropogenic pressures. The largest habitat types are "Sandbanks" (code 1110), covering 866 ha, which are slightly covered by sea water all the time, "Reefs" (code 1170), covering 715 ha, "Boreal Baltic islets and islands in outer archipelago and open sea zones" (code 1620), covering 581 ha and "Vegetated sea cliffs of the Atlantic and Baltic coasts" (code 1230), covering 120 ha. Additionally, 12 habitats with an area smaller than 100 ha exist in the area. The area is connected to the Archipelago Sea Natura area (FI0200164/FI0200090) in the west.

The Pernaja Bay and Pernaja Archipelago Natura 2000 site (FI0100078) has a total area of 65,760 ha. It includes Special Areas of Conservation (SAC) and Special Protection Areas (SPA). It forms an internationally valuable ecological entity representing biota variation caused by differing salinity and other environmental conditions. There are a wide variety of habitat types: "Boreal Baltic narrow inlets" (code 1650), covering 10,900 ha, "Reefs" (code 1170), covering 8,400 ha, "Coastal lagoons" (code 1150), covering 2,400 ha, "Sandbanks which are slightly covered by sea water all the time" (code 1110), covering 533 ha, "Estuaries" (code 1130), covering 200 ha, "Transition mires and quaking bogs" (code 7140), covering 150 ha and "Large shallow inlets and bays" (code 1160), covering 120 ha. In addition, there exist 16 other habitat types with area less than 100 ha. The Annex II species under the Habitats Directive present in the area are the grey seal and the Baltic ringed seal (proposed, not confirmed).

The Natura 2000 site of **Eastern Gulf of Finland archipelago** (FI0408001) has an area of 95,628 ha, of which 99 % is marine. It is confirmed as Sites of Community Importance (SCI) and designated as Special Protection Areas (SPA) and as Special Areas of Conservation (SAC). The largest habitat types are "Reefs" (code 1170) covering 7,847 ha, "Sandbanks which are slightly covered by sea water all the time" (code 1110) covering 2,746 ha, "Boreal Baltic islets and small islands" (code 1620) covering 1,439 ha, "Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation" (code 1610)

covering 534 ha and "Vegetated sea cliffs of Atlantic and Baltic Coasts" (code 1230) covering 188 ha. In addition, there are 18 other habitat types smaller than 100 ha represented. The Annex II species under the Habitats Directive present in the area are the grey seal and the Baltic ringed seal.

In 2019–2020, no changes to the Natura areas or other nature protection areas were proposed.

The Finnish Government is working towards establishing the Porkkala Nature Protection Area (Figure 23), which has an area of 12,777 ha under the Nature Protection Act (1096/1996) with a Government Decree. The area is located north of the Kallbådan Islets and Waters Natura 2000 Area (Figure 23), indicated with blue raster). The aim of establishment is the protection and conservation of western archipelagic nature representative to the region of Uusimaa, valuable shallows, biodiversity, landscape and related cultural heritage; the area is also established for public recreation and camping, nature activities, education and research. Limited hunting of seals, some sea birds and invasive species is allowed from September 10 to December 31. The Ministry of Environment requested comments on the draft on regulations concerning state nature reserves by February 2019 /64/.

5.4 Socio-economic environment

5.4.1 Cultural heritage

Historically and archaeologically significant underwater cultural heritage sites have been taken into consideration when planning the route of the pipelines in the Finnish EEZ. Detailed surveys were carried out to identify cultural historical sites (wrecks and other underwater objects of historical value) on the seabed along the planned route. All potential underwater cultural heritage sites in the proximity (within 250 m) of the pipeline route have been evaluated by a marine archaeologist. Additional pre-lay surveys were carried out for the two targets (S-R05-7978 and S-R09-09806) subject to monitoring according to the environmental monitoring programme /2/.

The target S-R05-7978 is a wreck that consists of the remains of a cannon barge. The wreck is of cultural historical interest, as the cannon barge can provide new insight and information about warfare, technical solutions and everyday life during the second half of the 18th century in the Baltic Sea area.

The target S-R09-09806 is a World War II anti-submarine net that has been laid along a prominent rock outcrop on the seabed. Only the associated floats/ buoys and the cable are visible /65/.

5.4.2 Ship traffic

The Gulf of Finland commercial freight traffic runs both in east-west and north-south directions. Commercial cruise ships and private recreational vessels operate in the archipelago area and between Finland and Estonia, especially in summer.

The commercial ship traffic in the Gulf of Finland is organised via the use of the mandatory ship reporting system (GOFREP), vessel traffic services (VTS) and the traffic separation scheme (TSS). For the most extent, the Nord Stream 2 pipeline route is located in the GOFREP area, which is an intensive traffic area that is also covered by the local VTS services.

5.4.3 Commercial fishery

There were 1,506 commercial fishing vessels operating in the Finnish waters on the southern coast of Finland in 2015. Nearly the whole fleet consisted of small coastal fishing boats under 10 m in length. In 2017 there were 40 licensed offshore fishing vessels longer than 12 m. By 2019, the number had decreased to 34 vessels /66/. Professional fishery consists of both coastal and offshore fishing. In the coastal areas, mostly nets and trap nets are used. Offshore fishing comprises mid-water trawling (no bottom trawling is performed in the Finnish waters) and long-line fishing /62, 67/.

European sprat and Baltic herring comprise about 95 % (by weight) of the total commercial catch in the Finnish EEZ in the Gulf of Finland, the Archipelago Sea and the Northern Baltic Proper /4/.

5.5 Marine Strategy and Water Framework Directives

The Marine Strategy Framework Directive aims at attaining a good environmental status (GES) of the European Union's marine waters. The Water Framework Directive aims at achieving a good ecological status and preventing the deterioration of the ecological status of all aquatic environments within the Union. The directives have been implemented in Finland by the Act on the Organisation of River Basin Management and the Marine Strategy (1299/2004, amendment 272/2011), by the Government Decree on the Organisation of the Development and Implementation of the Marine Strategy (980/2011), by the Government Decree on Water Resources Management (1040/2006) and by the Government Decree on Water Resources Management Regions (1303/2004).

The first part of the Finnish Marine Strategy (Merenhoitosuunnitelma, Marine Management Plan) was completed in 2012 and approved by the Government. The first part included a preliminary assessment of the current state of the sea, the determination of good environmental status of the marine environment, and the setting of environmental objectives and related indicators. The second part, the Marine Management Monitoring Program, was completed in 2014. The Government approved the third part, the Marine Management Operational Program for 2016–2021, in 2015. The "State of the Marine Environment in Finland 2018" report /46/ is an update to the first part of the Finnish Marine Management Plan. The status report also includes an assessment of the pressures on the marine environment, identifies good environmental status and presents environmental status objectives and related indicators to monitor the achievement of the objectives. The state of the marine environment is assessed through eleven qualitative indicators of good status based on the EU Marine Strategy Directive.

The descriptors for the good environmental status are biodiversity, food webs, non-indigenous species, commercial fish, eutrophication, seabed integrity, hydrographical conditions, contaminants, contaminants in fish and seafood, marine litter and introduction of energy (into the sea) and underwater noise. Of these descriptors, those potentially affected by the Nord Stream 2 Project are biodiversity, eutrophication, seabed integrity, contaminants and underwater noise. In addition to affecting the descriptors of good environmental status, the project may also affect commercial fishery, cultural heritage and ship traffic.

The status of the Finnish marine environment is determined either as good or deteriorated.

The study of the Finnish Environment Institute /46/ summarizes the state of the Finnish marine environment as follows:

> *"The greatest pressure deteriorating the status of coastal and offshore environment is the excessive nutrient loading and related eutrophication. Due to the eutrophication as well as other human-made pressures, a significant share of broad sea floor habitats are in deteriorated state. The status is the worst in the offshore areas of the Northern Baltic Proper and the Gulf of Finland which suffer from oxygen deficiency. The state of the sea floor in the Gulf of Bothnia is predominantly good. The assessment of harmful and hazardous substances still shows the deteriorated status of the marine area. With regard to marine litter, the state could not be assessed, even though the amounts of litter were much higher close to human activities and in areas accumulating litter. The status of indigenous species can be estimated as good. The two seal species have a different status in the Finnish marine area: the grey seal population has grown in recent years and the status of grey seal is good. The ringed seal indicates good status only in the Gulf of Bothnia and deteriorated status in the Archipelago Sea and in the Gulf of Finland, where*

the ringed seal population is very scarce and does not grow. Populations of several breeding sea birds are declining, and their state is predominantly not good. The status of commercially exploited fish stock, on the other hand, is mainly good, but especially the status of eel, sea trout and pike-perch stock is alarming."

In the Water Framework Directive, the ecological status is defined mainly through the living conditions for the biota, compared to pristine conditions. The factors affecting the conditions include chemical, physical and biological factors. In the coastal areas of the Gulf of Finland, which are included in the impact area the Water Framework Directive, the main pressures to the marine environment are related to eutrophication, and the potential impacts caused by the Nord Stream 2 Project are related to the release and spreading of nutrients and contaminants from the sediment disturbed during construction /4/.

The ecological status of the water body is classified on a scale of excellent, good, satisfactory, passable or poor. The status of the Finnish coastal waters in the Gulf of Finland ranges from poor to satisfactory, with most of the area classified as passable in the preliminary assessment in 2019 /68/.

6 ENVIRONMENTAL MONITORING

The environmental monitoring of the Nord Stream 2 Project is based on the Nord Stream 2 Environmental Monitoring Programme, Finland. The monitoring programme was approved on April 12, 2018 within the Water Permit decision (Nro 53/2018/2, Dnro ESAVI/9101/2017). In addition, the Nord Stream 2 Project performed additional monitoring activities to strengthen the assessment of impacts from the Nord Stream 2 implementation. This chapter presents the monitoring methods, activities and results of the Nord Stream 2 Project in 2020, and summarizes the results in 2018–2019, which are presented in detail in the Annual Monitoring Reports 2018 and 2019, to give a comprehensive description on the observed impacts of construction. Environmental monitoring has been intensive in the Finnish EEZ during the construction phase from spring 2018 to the end of May 2020. The majority of monitoring activities took place in 2018.

6.1 Notifications related to monitoring

According to the permit provisions of the Water Permit (53/2018/2), Nord Stream 2 AG submits notifications to the Finnish authorities in relation to environmental and technical monitoring. During 2018 Nord Stream 2 AG submitted 9 notifications and 2 proposals and during 2019 one notification and one proposal (Table 16). There were no notifications related to monitoring in 2020.

Table 16. Notifications related to monitoring during construction activities and submitted to the Finnish authorities.

Date	Content
18.4.2018	Notification on commencement of works
23.4.2018	Proposal of change related to the monitoring programme regarding underwater noise monitoring. Accepted 27.4.2018.
11.5.2018	Updated information on munitions not requiring bubble curtains during clearance in the Finnish EEZ
14.5.2018	Preliminary results of underwater noise measurements (as per monitoring programme)
15.5.2018	Summary table and map of munitions (interim version)
24.5.2018	Interim technical underwater noise report (as per monitoring programme)
25.5.2018	Notification regarding chance finds
31.5.2018	Non-conformity notification regarding use of bubble curtains
29.6.2018	Summary table and map of munitions (final version)
3.7.2018	Proposal regarding changes in mattress amount and size. Accepted 6.8.2018
9.7.2018	Notification on munitions not requiring clearance
15.2.2019	Clarification on the Annual Monitoring Report submission date.
9.10.2019	Proposal of Amendment of the monitoring scope in 2020. Accepted 8.11.2018

6.2 Water quality and currents

6.2.1 Monitoring methods

The construction of the Nord Stream 2 pipeline system generates sediment spreading that can potentially impact marine life. Sediment spreading is monitored by turbidity measurements with water quality probes. In addition, current fields are measured with ADCP -devices (Acoustic Doppler Current Profiler). The main objective for turbidity and current monitoring is to evaluate how far the construction-related sediment spills travel, how high sediment spills rise in the water column and what is the maximum turbidity generated by the construction. Main sources for increased sediment spreading are munitions clearance and rock placement operations.

Impacts of pipelay and pipe supply on sediment resuspension were also monitored in the Nord Stream Project, in which both anchored and dynamically positioned (DP) pipelay vessels were in use. For the DP vessels, the monitoring results gathered at 1.5–2.0 m above the seabed or through the water column along the transects indicated no disturbance of bottom sediments from the pipelay /69/. In the Nord Stream 2 Project, only DP pipelay vessels were used. As the effects of pipelay and pipe supply were assessed to be none or negligible, they were not monitored in the Nord Stream 2 Project.

Water quality and current monitoring was carried out with self-logging oceanographic sensors. Sensors were moored to the seabed and brought to the surface only for regular service with an acoustic releaser system (Figure 24). This allowed monitoring without visible surface buoys and disturbance to third party shipping activities.

Short-term monitoring of water quality took place at four locations and long-term monitoring took place at three locations. A set of three monitoring arrays was used in a triangular shape around each selected short-term monitoring station (i.e. rock placement and munitions clearance site), as well as at the Sandkallan long-term monitoring station. At each site the three monitoring arrays represented three sectors to measure the potential impact from the origin. Only one array was used at the other long-term monitoring stations. All arrays consisted of three sensors, located 2, 5 and 15 metres above the seabed (Figure 24). In addition, one array per station was equipped with a 3D-current sensor (Figure 24), which measured the current speed and direction at all depths.

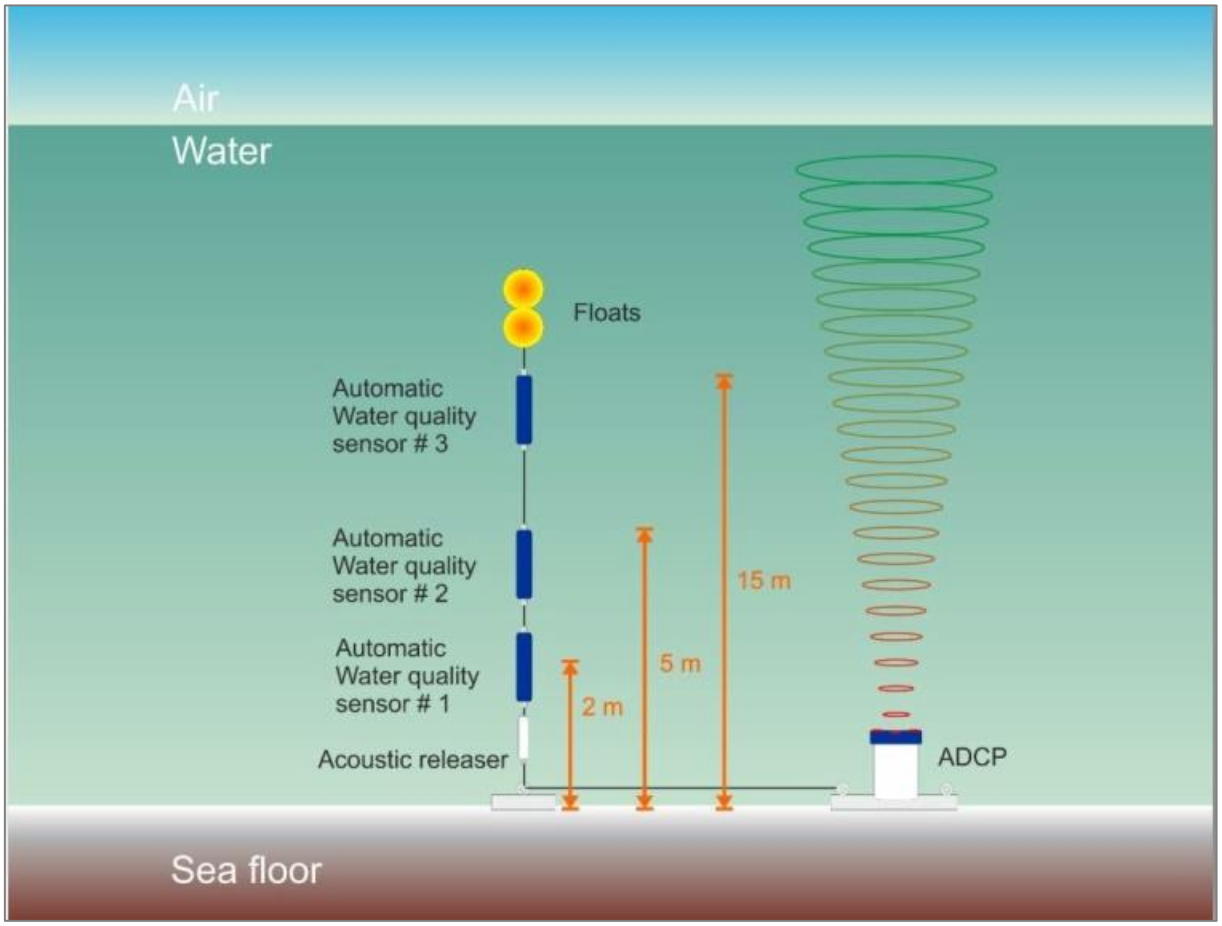


Figure 24. Measurement setup for the water quality and current monitoring stations /70/.

Water quality monitoring was performed with probes, which record salinity, temperature, oxygen concentration and turbidity at 15-minute intervals at each of the monitoring sites. Turbidity and oxygen concentration were measured with optical sensors equipped with automatic cleaning system in order to prevent the false readings caused by biofouling. Sensors were calibrated at 6-month intervals.

Current monitoring was performed with ADCP -device (Acoustic Doppler Current Profiler). Current speed and direction were measured from the sea floor to the surface at 15 minutes intervals with two-meter vertical resolution. Sensors were also equipped to measure pressure, pitch, roll and temperature. Any errors caused by tilting due to potentially uneven seabed were automatically corrected.

Short-term monitoring at the rock placement and munitions clearance sites

The short-term monitoring at the rock placement sites and at the munitions clearance sites was completed in 2018. Detailed information regarding the monitoring methodology is presented in the Annual Monitoring Report 2018.

Long-term monitoring

Three monitoring locations, Control 1, Control 2 and Sandkallan were selected to provide long-term monitoring data for water quality during the construction phase. Control 1 and Control 2 stations were placed in the same locations that were used during the Nord Stream Project, far from any project-related construction activities (Figure 25). In addition to Control 1 and 2 stations, three stations were deployed at the Sandkallan area (Figure 25). The Sandkallan area was selected as a long-term monitoring

location due to its vicinity to several rock berms as well as to munitions clearance operations. In addition, the Sandkallan area is part of the Natura 2000 network.

Monitoring started at Control 1 site on April 17, 2018 and at Control 2 and Sandkallan sites on April 18, 2018. Long-term monitoring at stations Control 1 and Control 2 was completed in December 2019. Monitoring at Sandkallan site continued until May 14, 2020, more than four weeks after the completion of the construction work in the nearby area.

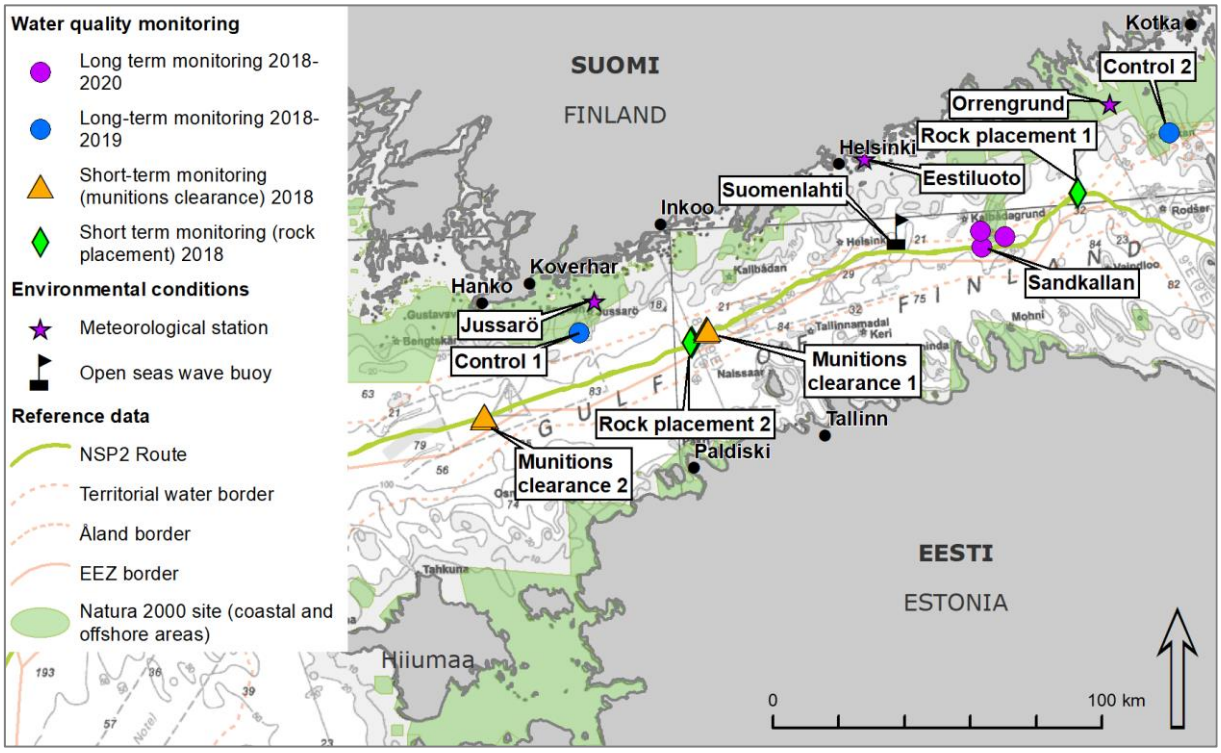


Figure 25. Long-term monitoring sites Control 1, Control 2 and Sandkallan and short-term monitoring sites Munitions Clearance 1 and 2 as well as Rock Placement 1 and 2, together with the nearest weather and wave monitoring station operated by the Finnish Meteorological Institute.

6.2.2 Water quality and currents in 2018

Monitoring at rock placement sites

Altogether 25,000 t (16,000 m^3) of rock material was placed close to the monitoring site Rock placement 1. The constructed rock berm (FI-A1001) is one of the largest berms in the Finnish EEZ. Only the berm needed for the crossing of the Nord Stream pipeline is larger. Another reason for the selection of this berm for monitoring is its location on soft sediment. The impact of rock placement on turbidity was clearly detected by the network of turbidity sensors, but the impacts were in general smaller than predicted in the modelling for the EIA report /4/ (see Table 19).

The rock berm (FI-B1031) at the Rock Placement 2 site was significantly smaller compared to the Rock Placement 1 berm. The site was selected for monitoring due to a very soft clay seabed /2/. Altogether 9,000 t (5,760 m^3) rock material was placed close to the monitoring site Rock Placement 2 within two days of operation. The impact of rock placement on turbidity was detected by the network of turbidity sensors, but none of the modelled turbidity estimates /4/ were exceeded.

Monitoring at munitions clearance sites

The measured impact of munitions clearance on water quality was small and short-term (Table 19). No impacts on water quality were detected from the actual detonations, but impacts of preparation and follow-up works could be seen. The maximum measured turbidity peak was 9.2 turbidity units (FNU). Turbidity impact was limited to the layer near the bottom, at 2 m and 5 m above the sea floor. Turbidity in the upper layer, measured at 15 m above the sea floor, remained below the background levels (1–2 FNU).

When comparing the monitoring locations to the estimated route of the released sediment plume at both munitions clearance monitoring sites, it is possible that the released sediment plume did not travel directly towards the monitoring locations and thus impacts were not fully recorded with the water quality sensors.

Long-term monitoring

Results from the long-term monitoring stations show natural variation in water quality. All recorded turbidity peaks during the monitoring period were linked to storm events. The significant wave height peaks matched with the turbidity peaks. The maximum recorded turbidity value was 20 FNU at the Control 1 site, 24 FNU at the Control 2 site and 12 FNU at the Sandkallan site. The average background turbidity at all sites remained below 1 FNU.

6.2.3 Water quality and currents in 2019

Water quality and currents were monitored in 2019 at the long-term monitoring sites Control 1, Control 2 and Sandkallan. No impacts from construction activities were detected on water quality /45/. Stormy periods with strong currents and high wave action induced elevated levels of water turbidity, with peak values up to 26 turbidity units (FNU), due to the resuspension of sediment on the shallow bottoms. The effects of stormy periods were hardly detectable at the deeper Sandkallan monitoring stations, where slightly increased turbidity, up to 10 FNU, was observed in late summer. This was connected to anoxic conditions, in which iron and manganese are soluble in water. When the anoxic water meets first traces of oxygen, iron and manganese start to form insoluble oxides observed as turbidity.

6.2.4 Water quality and currents in 2020

Water quality and current speed were monitored at three stations at the Sandkallan long-term monitoring site. The aim of monitoring was to record potential impacts of rock placement in the vicinity of the Sandkallan Natura 2000 area. Shortest distance from monitoring stations to rock berms varied from 1.2 km to 5.6 km. The results cover the period between December 2019 and May 2020, when the monitoring equipment was recovered, and the monitoring ended. The Sandkallan site consists of three separate water quality stations. One of them is equipped with the profiling current meter (ADCP) measuring flow speeds and directions at separate depth layers covering the whole depth range from the bottom to the surface (Figure 24). Water quality monitoring includes turbidity, oxygen concentration, salinity and temperature measurements at three depth layers near the seabed. The water depth at the stations varies between 51 and 67 metres. Monitoring at the Control I and II stations ended in December 2019, when the monitoring equipment was recovered.

The Sandkallan area represents the deep bottoms of the Gulf of Finland, where no distinct seasonal variations of temperature can be seen like in the coastal waters. The highest temperatures (+6 °C) were measured in December and the lowest temperatures (+3°C) in March-April (Figure 26).

Strong halocline could be detected in the Sandkallan stations in 2018–2019 with salinities regularly exceeding 10 PSU. In 2020, practically no halocline was observed in winter or spring. Weak or missing halocline allows the transport of oxygen from the surface water to the near bottom waters. In the end of the monitoring period, the salinity in the deepest station Sandkallan 3 reached the level of 10 PSU again indicating the re-establishment of the halocline (Figure 26).

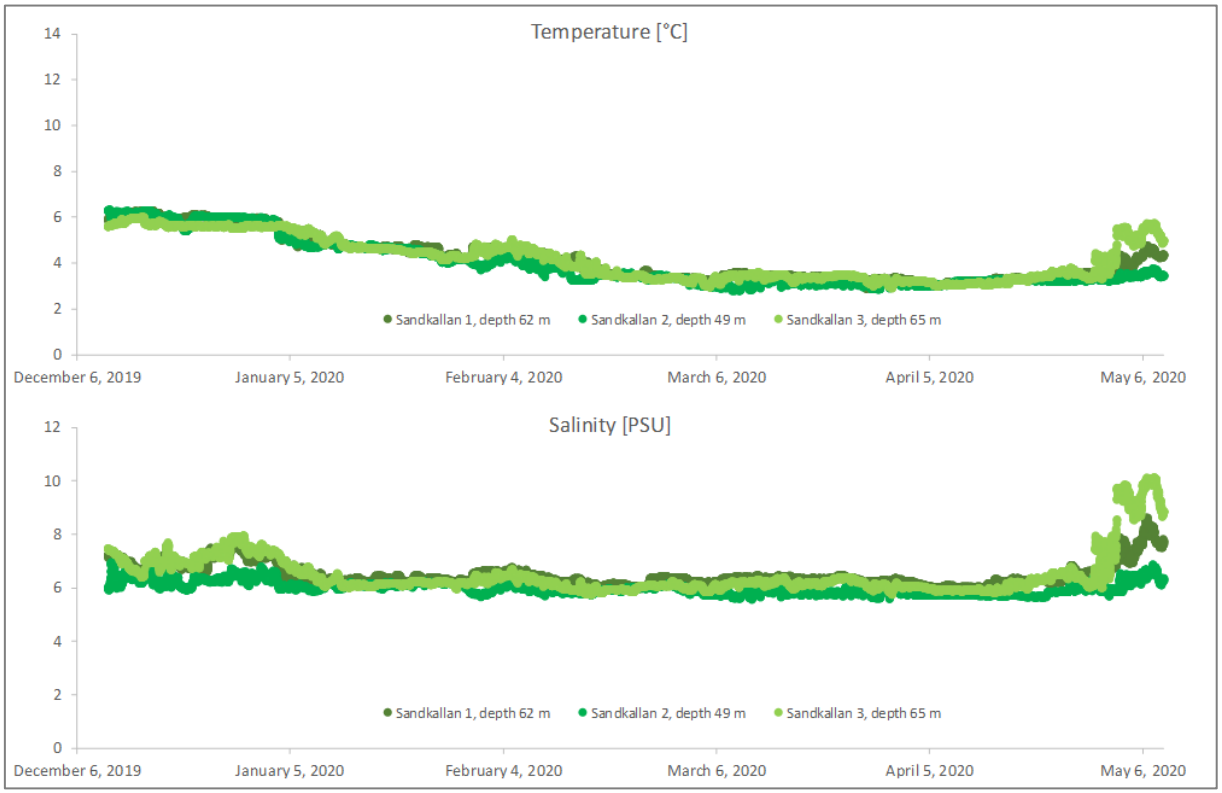


Figure 26. Temperature and salinity in 2020 measured 2 m above the seabed in the long-term monitoring stations Sandkallan 1, 2, and 3.

No impacts on water quality from construction activities were detected during the monitoring period (Figure 27). The highest measured single turbidity value was 8 FNU, which is within the natural turbidity variation in the area. The average turbidity was below 1 FNU. Anoxic periods were not measured. Weak or missing salinity stratification and stormy periods during ice-free winter improved the mixing of the water layers, leading to an increase in oxygen concentration in the deeper water layers (Figure 27).

Figure 27. Oxygen concentration, turbidity and flow speed at the monitoring stations Sandkallan 1, 2 and 3 and the significant wave height measured by the Finnish Meteorological Institute. /40/. The images are combinations of all measurements carried out at the monitoring stations. They represent the depth range of 2-15 m above the seabed. Rock berm construction within the radius of 10 km of the stations is indicated by arrows.

6.3 Sediment contaminants (completed in 2018)

In 2018, altogether 17 sediment samples from two targets were collected in order to study explosive residuals and heavy metal spreading in the surroundings of the clearance site. Heavy metal concentrations in the sediments were compared with the concentrations prior to the munitions clearance work, analysed in the baseline study in 2016.

The detailed results of the contaminant study are presented in the Annual Monitoring Report 2018. A brief summary of results is presented below.

Target R-R08-5261

Six sediment samples were taken from the seabed surrounding the target R-R08-5261 before and after its relocation and detonation. The target was a possible Russian depth charge BM- 1, which contained 25 kg of explosives and which was cleared with a 5 kg donor charge. The bubble curtain was used during the clearance to decrease the pressure and noise impact on the surrounding environment.

Collected sediment sample data showed that none of the analysed six samples contained explosive material residuals that exceeded the laboratory detection limits. The analysed metal concentrations varied randomly and no clear pattern between the location and concentration could be seen. The samples showed similar concentrations before and after the detonations.

Target R-R09-7495

Eleven sediment samples were taken approximately two months after the detonation at the location of a German EMC-1 mine, which contained 300 kg of explosives and was cleared with a 10 kg donor change. The bubble curtain was used during the detonation. The delay between clearance and sampling time has no impact on the results due to the persistent characteristics of the compounds to be analysed.

Collected sediment sample data showed that none of the analysed eleven samples contained explosive material residuals that exceeded the detection limits. Heavy metal concentrations varied randomly and no clear pattern between the location and concentration could be seen. The analysed concentrations were at comparable level to those measured during the baseline surveys in 2016 from the same area. Seabed heterogeneity is evident, as duplicate samples from the same station showed different concentrations /71/.

6.4 Underwater noise (completed in 2018)

6.4.1 Monitoring methods

Munitions clearance generates impulsive noise and high peak sound pressure levels, which can have impacts on marine life. Monitoring of underwater noise associated to munitions clearance was carried out in 2018. The details are presented in the Annual Monitoring Report 2018.

The peak- and SEL- levels were calculated for the clearance of each munition and in most cases the same clearance event was monitored at several stations. Measured peak levels were compared against the assessments of the Water Permit application /72/.

The measured sound exposure levels were used for the re-modelling of the Permanent Threshold Shift (PTS) areas. PTS describes the sound exposure level, which is the onset for the risk of a permanent damage for hearing. For marine mammals this level is 179 dB re 1 μPa^2s (Sound exposure level, SEL). PTS is usually presented as the area where the 179 dB level is exceeded. It can also be presented as the maximum distance from the sound source where the 179 dB level is still reached. The temporary

threshold shift (TTS) describes the sound exposure level, which is the onset for the risk of a short-term hearing loss after which the animal will regain its original detection abilities after a recovery period. The TTS threshold for single impulsive noise for marine mammals is 164 dB re 1 µPa²s (SEL). /73/

The calculated PTS areas, based on measured data, were compared with the modelling results. Modelling was done for the environmental impact assessment /73/, updated EIA report /62/ for the Water Permit application and the Natura assessment /74/. Munition by munition modelling /72/ was based on the maximum individual peak pressure levels measured during the Nord Stream Project.

The monitoring consisted of 8 fixed long-term monitoring stations with continuous recording and vessel-based on-site monitoring of three munitions clearance events.

Long-term monitoring stations were established near the Natura 2000 areas with marine mammals as a conservation objective. Six stations were placed along the Finnish coastline and two stations along the Estonian coastline.

In addition to long-term monitoring, three vessel-based monitoring campaigns with high resolution sample rate were performed during the clearances of three targets of different size and type. These short-term monitoring campaigns were conducted in the beginning of the clearance operations in order to provide high resolution information as early as possible.

In total, 74 targets were cleared during the munitions clearance campaign. In accordance with the permit application, the bubble curtain was used for munitions with a total net explosive quantity (NEQ, explosive charge + donor charge) of 22 kg or more and all munitions east of kilometre point GKP 174 (FKP 60). The bubble curtain was used for 58 targets. For three targets, the distances to the long-term stations were too long to record the detonations, and the detonations were not recorded by clearance contractors' vessels due to technical reasons. In total, noise generated from the detonations of 71 clearance targets were measured and analysed.

6.4.2 Underwater noise monitoring results

Peak levels and SEL

Altogether 254 peak levels were measured and compared to the values modelled for the permit application. 253 out of 254 peak levels were lower than the modelled values in the permit application. Variation in measured peak levels increased with the distance to the detonations. Distance attenuation was more effective along the Finnish coast due to low water depth and variable bathymetry when compared to the deeper Estonian coastline with less islands. The measured SEL-values at the long-term monitoring stations did not exceed PTS or TTS levels, and it is therefore assessed that no TTS area of any clearance operation extended to the Kallbådan Natura 2000 site.

PTS areas

The permanent threshold shift (PTS) distances were calculated based on the close-range measurement data received from the munitions clearance vessels and the vessel-based monitoring campaigns. Results from the long-term stations were used for validation. The measured PTS areas were in average only 24 % of the modelled, exceeding the modelled only in one case. The results indicate that the used bubble curtain effectively attenuated noise.

Time-series at the long-term monitoring stations

During the long-term monitoring most of the clearance operations were detected at Kallbådan A, which is the closest monitoring station to areas with the highest munition density.

Munitions clearance operations did not affect the noise levels at the Hanko monitoring stations. Shallow areas at Söderskär and in the Eastern Gulf of Finland effectively blocked the noise caused by clearance

operations to enter the stations and no detonations were detected. Noise propagation was stronger along the deeper coastline of Estonia.

The ambient noise level was mainly influenced by ship traffic, which exceeded the noise caused by nature. The background levels did not increase because of the Nord Stream 2 activities.

6.5 Marine mammals

During munitions clearance, a trained marine mammal observer made visual observations from the clearance contractor's vessel before and after each detonation for a minimum of one-hour period before the scheduled initiation of the charge. Passive acoustic monitoring was also performed, indicating that no marine mammals were present in the monitored area. (See Table 9 for implemented mitigation measures). No injured marine mammals were observed before, during or after munitions clearances.

Metsähallitus monitored the behaviour of seals at the Kallbådan seal sanctuary (Figure 28) from May 3, 2018 to August 23, 2018 and again in May-August 2020 as post-monitoring campaign, using remote recording camera equipment. According to the study, the detonations had no impact on the occurrence of grey seals on the islets, even when the detonations were closest to the Kallbådan seal sanctuary /75, 76/. The distance between the detonations and the seal sanctuary was so long that the seals did not react to the detonations at all.

Metsähallitus monitored seals also in 2019 from May to July. Due to a series of technical issues, it was not possible to collect all data.

Detailed results from 2018-2020 campaigns are presented in the Annual Monitoring Report of seal monitoring 2020 /75/. Based on the seal monitoring report, no impacts on seals were recorded.

Figure 28. Grey seals in the Kallbådan seal sanctuary on May 15, 2018, when munitions clearance work was proceeding near the Kallbådan area, and on June 7, 2018, a day after the last clearance. Figures from Metsähallitus remote recording camera equipment (© Antti Below, Metsähallitus).

6.6 Cultural heritage

Thorough pre-lay surveys were carried out in May 2018 for the two targets subject to monitoring, a cannon barge wreck (S-R05-7978) /77/, and an anti-submarine net (S-R09-09806) /78/. A thorough post survey of these two targets will be carried out after the construction activities have been completed as part of the post construction survey planned for 2021, to confirm that no damage to the monitoring targets have occurred during the implementation of the project. No new cultural heritage objects or indications of such were found during the construction activities.

The wreck of the cannon barge is located approximately 58 m from the nearest pipeline (Line B). The Water Permit provisions require a 50 m safety zone around the cannon barge. The post-lay survey of Line A in 2018 confirmed that the pipeline has been laid within the lay tolerance at a distance of approximately 130 m from the wreck /79/. The lay tolerance for Line B was reduced to minimize any potential construction related impacts during the pipelay of Line B. The post-lay survey of Line B in 2019 confirmed that Line B has been laid within the reduced tolerance corridor, at approximately 63 m from the wreck /80/.

No further construction activities, such as maintenance rock placement, are planned in the surroundings. The distance from the wreck to the nearest planned rock berm is more than 500 m. The distance to the nearest munitions clearance site is 6.9 km.

The anti-submarine net S-R09-09806 spans across the Gulf of Finland, making it impossible to avoid crossing the net. The Water Permit provisions require that construction work must be carried out in a way that damages to the net are minimized.

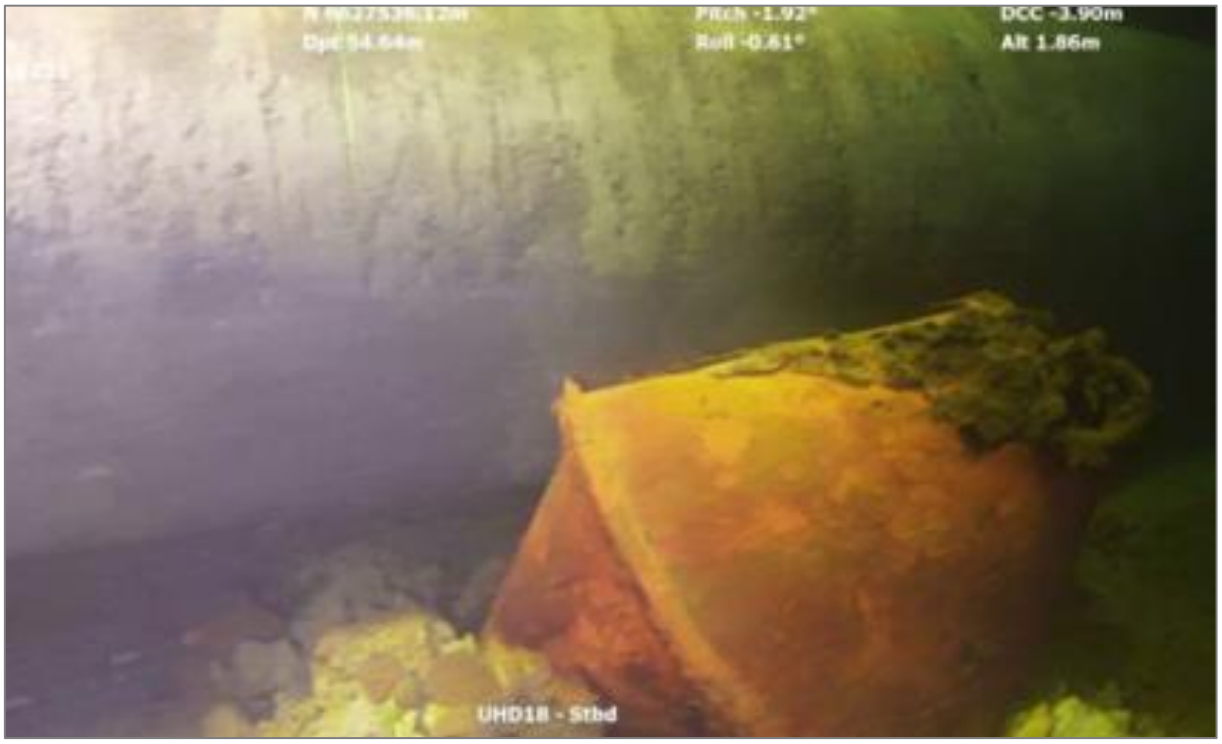


Figure 29. Example of a ROV video still image of the buoy of the anti-submarine net after the pipelay of Line B across the net in 2019 /35/. © Nord Stream 2

According to the post-lay survey results /31, 35/, both Line A and Line B were laid across the anti-submarine net mostly with a free-span, thus limiting the impacts onto the target. Some section of the pipeline is, however, in contact with the net (Figure 29).

6.7 Commercial fishery

A commercial fishery study will be performed when the operational phase will start as a survey including a questionnaire to fishermen. The aim of the survey is to monitor the trawling patterns and used trawling methods of the Finnish professional fishermen, avoidance of the pipeline area and possible changes in the fishing patterns in the Nord Stream 2 pipeline area within the Finnish EEZ during and after construction activities. The results of the commercial fishery monitoring will be available after the survey is completed.

7 TECHNICAL MONITORING

This chapter summarises the technical monitoring results of the pipeline installation accuracy of Line A and Line B, avoidance of barrels, and the compliance with the regulations for the construction work in the vicinity/across the Mussalo fairway, as requested in the Water Permit.

7.1 Pipelay accuracy

The Water Permit allows for minor modifications from the planned pipelay route within the ± 35 m security corridor. Route changes may be carried out in order to avoid munitions or other objects identified along the route. In general, the pipeline installation corridor is ± 7.5 m from the centreline on a straight section and ± 15 m on a curve. At several locations, the installation corridor has been narrowed, for example at the cable crossings and in the vicinity of known munitions and cultural heritage objects.

For Line A, minor deviation to the planned route (Rev 54) was needed between kilometre points GKP 255 and GKP 265 to accommodate the crossing with the Balticconnector gas pipeline /31/. This resulted in an 11.05 m deviation to south and it represents the only exceedance to the ±7.5 m installation corridor of Line A. The modification was done to ensure safe crossing with the Balticconnector gas pipeline by maximizing the length of a straight stretch over a berm. In addition, the narrowed tolerance limits were exceeded once, by 1.4 m at a 2.5 m limit /81/. Such narrowed limits have been ordered in locations, where the usual ±7.5 m installation accuracy is not sufficient due to structures or objects on the seafloor. A typical example is a cable crossing, where it is important to lay the pipeline exactly across the pre-installed supporting mattress.

For Line B, pipelay accuracy in the ±7.5 m corridor was largely achieved with negligible deviations (from 0.05 to 0.20 cm) /82/. In addition, there were three sites on the Line B route, where minor deviations from the route were necessary /35, 82, 83/. Between kilometre points GKP 207 and GKP 209, the 23 m deviation to north (Rev 60) was needed due to steep sloping of the seabed near several cable crossings. The deviation took the pipelay to a more even area to guarantee mattress stability at the crossings. Between kilometre points GKP 450 and GKP 453, the 14 m deviation to north (Rev 59) was necessary due to large boulders on the seafloor endangering mattress installation and thereby safe cable crossing with a cable of an unknown owner. The third minor deviation, at kilometre point GKP 256, was less than 7.5 m /35/ and therefore it falls within limits of the normal installation corridor. These minor changes in route were notified to the authorities.

In addition, for Line B, the narrowed tolerance limits (usually ± 2.5 m) were exceeded nine times /80, 82, 83, 84/. The deviation varied from 0.15 m to 1.05 m.

7.2 Avoidance of barrels

The Nord Stream 2 has stated in its application documents that it will use the best endeavour to avoid eight barrels located in the pipelay corridor in the Finnish EEZ. Three of these barrels are located along Line A and were surveyed (post-lay survey) in 2018. Five barrels are located along Line B and were surveyed (post-lay survey) in 2019. None of the barrels were disturbed by construction activities. Details of the studies are reported in the Annual Monitoring Report 2019.

7.3 Construction in the vicinity of the Mussalo fairway

The Water Permit provisions state that the pipelines and any related construction and protection in the Mussalo fairway must be at a water depth of at least 20 m measured from the mean water (i.e. average water surface level). The draft of the Mussalo fairway is 15.3 m /85/. The pipeline crosses the fairway area at approximately from kilometre point GKP 118 to kilometre point GKP 127.

The depth of the pipeline at any given point is reported in the as-laid reports that are based on the post-lay ROV-surveys. For Line A, the shallowest depth measured from the top of the pipeline is 44.4 m at kilometre point GKP 123 /79, 86/. For Line B, the corresponding shallowest depth is 38.6 m at kilometre point GKP 122 /80/.

The highest point of a rock berm is typically a maximum of 2 m above the highest point of the pipelines /87/. It is assessed that all parts of the pipeline system will be located at much greater depths than 20 m within the Mussalo fairway. The final minimum water depths will be reported after the post-construction survey has been performed.

8 EVALUATION OF RESULTS

This chapter discusses the main observed impacts of the Nord Stream 2 construction in the years 2018–2020. The impact receptors discussed here are presented under themes Physical and chemical environment, Biotic environment and Socio-economic environment, and in relation to the Marine Strategy and Water Framework Directives. In addition, transboundary impacts are considered. In this chapter, the results of the Nord Stream 2 monitoring are also compared to the assessments presented in the EIA and in the application documents, and with the monitoring results of the Nord Stream Project. For assessing the significance of impacts on the environment, the Imperia methodology is used. It takes into account both the sensitivity of the receptor and the magnitude of change.

8.1 Physical and chemical environment

8.1.1 Seabed morphology and sediments

In the Finnish EEZ, more than 90 % of the approximately 374 km long pipeline is located at depths of more than 60 m. Approximately 60 % of the total project area in the Finnish EEZ consists of soft sediments. The seabed along the pipeline route does not have special geological value, and the sensitivity of the seabed was assessed as low in the EIA. However, near the Sandkallan Natura 2000 area and near the Porkkala area (see Figure 23 for approximate locations), reef-like hard seabed types can potentially be found, and in those areas the sensitivity was assessed as medium (Table 17).

The main impacts of the project are related to the construction activities that cause the relocation of sediments from the seafloor. Of these, munitions clearance and rock placement were predicted to have negligible or minor impact on the seabed morphology and sediments in the EIA (Table 17). Pipelay using dynamically positioned (DP) pipelay vessels was assessed to have negligible impacts and is not discussed further in this report.

Munitions clearance lifts sediments from the seafloor, resulting in a crater and a sediment plume in the near-bottom water layers. Such craters are nearly permanent on hard seafloor, but on soft bottoms they may even out over time. The resuspended solid substances in the sediment plume resettle, with the smallest particles travelling furthest away from the crater.

In the EIA, 20 m^3 and 42 m^3 crater volumes were used for medium and large detonations, based on the experience from the Nord Stream Project. These were assessed to have a low impact in the EIA (Table 17). Later, a more detailed modelling of individual munitions along the route in the Finnish EEZ resulted in an estimate of the crater diameters varying from 2 m to 10 m and the crater volumes varying from 7 m^3 to 205 m^3, depending on the munition charge weight and the type of sediments at the location /72/. The monitoring by the clearance contractors, however, shows that the actual sediment displacement through the detonations exceeded 5 m^3 only at ten locations. Of these, nine craters were smaller than 15 m^3 and the largest crater was 30.8 m^3 – only 15 % of the estimated highest volume. The results are in line with the results of the Nord Stream Project, in which the radius of the craters created by munitions clearance varied between 0–7.6 m and the crater volume varied from 0 to 40 m^3.

The monitored impact was much smaller than estimated in the modelling. It is assessed to have negligible magnitude of impact, resulting in negligible significance of impact (Table 17).

Similar to munitions clearance, rock placement also disturbs the seafloor, creating a sediment plume. In addition, construction of rock berms changes seabed morphology. The latter impact is irreversible, but local, and the impact was assessed to be negligible or minor in the EIA (Table 17). Construction works were completed in May 2020. The final volume of installed rock was 89 % of the volume, for

which the impact assessment has been done. It is concluded that the magnitude of impact is low, as assessed during the EIA, resulting in negligible to minor significance of the impact in the different areas.

The significance of impact of the re-sedimentation of the sediment plume was assessed to be negligible in the updated EIA, as the impact is negligible compared to natural resuspension and resettling processes occurring during storms. The monitoring results confirm this assessment. The effects of the sediment relocation on water quality are discussed in the Chapter 8.1.2.

Although the overall impact of contaminant relocation, coupled to the resettling sediments, was assessed as negligible in the updated EIA, the spreading of heavy metals and explosive residuals around the munitions clearance sites was studied in the Nord Stream 2 Project. The results confirm that detonations did not increase the concentrations of harmful substances in the surface sediments.

In addition to construction activities, the permanent structures constructed in the project have an impact on the seabed. As they have been estimated to cover approximately 0.03 % of the seabed in the Finnish EEZ, the structures were predicted to have a negligible to minor impact (Table 17). The volume of rock material installed was within the planned volume. The number of mattresses installed at the infrastructure crossings (completed in 2018) was 15 mattresses less than planned, due to changes in the design of one crossing during the detailed survey prior to mattress installation. It is therefore concluded that the magnitude of impact of the structures is similar or lower than assessed, resulting in minor impact significance.

Table 17. Assessment of impact significance for seabed morphology and sediments. Receptor sensitivity is assessed in the EIA, as well as predicted magnitude of change. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

	Receptor	Magnitude of change		Overall significance	
Impact	Sensitivity	Predicted	Assessed	Predicted	Assessed
Munitions clearance, other areas	Low	Low	Negligible	Negligible	Negligible
Munitions clearance, Sandkallan and Porkkala	Medium	Low	Negligible	Minor	Negligible
Rock placement, other areas	Low	Low	Low	Negligible	Negligible
Rock placement, Sandkallan and Porkkala	Medium	Low	Low	Minor	Minor
Structures on seabed, other areas	Low	Low	Low	Negligible	Negligible
Structures on seabed, Sandkallan and Porkkala	Medium	Low	Low	Minor	Minor

In the Nord Stream Project, the permanent structures finally covered 2.8 times larger area (footprint) and had 28 % higher total volume than was originally assessed. Still, the impact remained local and of minor significance.

8.1.2 Hydrography and water quality

The assessment of the sensitivity of the sea water ecosystem in the EIA was based on the variable oxygen concentration, and thereby living conditions for biota. These vary together with the stratification conditions along the pipeline route. The sensitivity of the water layers near the seafloor was assessed as low in the western and mid-section of the route, where the conditions are almost permanently poor, and as medium in the eastern part of the route (Table 18).

The impacts that the Nord Stream 2 Project may have on hydrological conditions in the Finnish EEZ are limited to potential changes in the pattern and magnitude of near-bottom currents. This is due to structures on the seafloor, and changes in temperature due to temperature difference between the gas inside the pipeline and the water surrounding the pipeline. Both were assessed to have negligible impacts with the exception of minor local impacts predicted for the near-bottom currents /4/. These impacts are not assessed further in this report.

The impacts on water quality mainly arise from the relocation of sediments during construction activities. In addition, anodes protecting the pipeline from corrosion may release heavy metals into the water /4/. The latter effect may start already during the construction phase and will continue throughout the operation phase.

To assess sediment relocation and elevating turbidity and resulting potential impacts on living conditions of fish, benthic fauna and marine mammals, the concentration of resuspended solids in the water column was modelled. In addition to momentary turbidity peak immediately after the impact, the persistence of turbid conditions was modelled for various hydrological conditions ranging from calm, stratified summer conditions to stormy winter conditions with high current speeds. Based on the modelling results, the impacts were predicted to be minor (Table 18). In addition, the Natura 2000 assessment for the Area South of Sandkallan (SAC FI0100106) concluded that the Nord Stream 2 construction activities will neither increase turbidity nor sedimentation and will not deteriorate the conditions for the biota at the Sandkallan Natura 2000 site /88/.

Table 18. Assessment of impact significance for hydrography and water quality. Receptor sensitivity is assessed in the EIA, as well as predicted magnitude of change. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

Impact	Receptor sensitivity	Magnitude of change		Overall significance	
		Predicted	Assessed	Predicted	Assessed
Munitions clearance, other areas	Low	Low	Low	Minor	Minor
Munitions clearance, eastern Gulf of Finland	Medium	Low	Low	Minor	Minor
Rock placement, other areas	Low	Low	Low	Minor	Minor
Rock placement, eastern Gulf of Finland	Medium	Low	Low	Minor	Minor

Water quality monitoring in the Sandkallan monitoring site confirmed the conclusions of the Natura 2000 assessment, as increased turbidity was only observed at the Sandkallan site in July – August 2019. This was due to natural variability in oxygen conditions that induced the flocculation of metal oxides, causing turbidity. No water quality effects due to construction activities were detected at the Sandkallan long-term monitoring site (Table 19).

Turbidity was monitored in the vicinity of two munitions clearance sites and two rock placement sites in 2018. The measured impacts were generally lower than predicted and briefer in duration (Table 19). For munitions clearance, the measured impacts were significantly lower than predicted. However, it is possible that the monitoring setup did not record the complete extent of the spreading sediment plume at the munitions clearance sites. It is unlikely that the extent of the impact would exceed the modelled values, considering that the impacts of rock placement were significantly lower than modelled impacts. In addition, the monitored impacts were similar to those measured in the Nord Stream Project for similar targets /1/. In Nord Stream Project, the overall impact of munitions clearance was minor. In Nord Stream 2, due to the uncertainty about the recording the full extent of the impact, the impact magnitude for the munitions clearance is assessed as low instead of negligible, resulting in minor overall impact

significance (Table 18). Based on monitoring results obtained from Sandkallan site, the measured turbidity levels remained low until the end of monitoring period in 2020. No impacts from rock placement were seen.

The maximum turbidity caused by rock placement exceeded the values modelled for the calm summer conditions, but the values were lower than predicted for stormy conditions in more than 99 % of cases (Table 19). The duration of slightly elevated turbidity was shorter than predicted for calm conditions, and the high turbidity period, exceeding 10 FNU, was significantly shorter than predicted for calm conditions (Table 19). The impact magnitude is assessed as similar to predicted, low, resulting in minor overall impact significance (Table 18), similar to the assessment in the Nord Stream Project.

So far, there are no reports on the release of heavy metals from the anodes protecting the pipeline from corrosion. During the monitoring performed for the Nord Stream pipeline in August 2012 the concentrations of heavy metals (Cr, Cu, Hg, Co, Zn, Ni, Pb, Cd and As) in sea water near the anode were low or under the detection limit /1/. Next anode monitoring campaign was conducted in July 2018. Results showed the concentrations of heavy metals in sea water near the anode were low /95/. Monitoring will be continued but its schedule and extent is not yet confirmed.

Table 19. Monitored impacts on water quality (turbidity) related to construction activities (rock placement and munitions clearance) vs. predicted in the modelling for the EIA and in the Natura Assessment for the Water Permit application. Data was collected during the construction phase of the Nord Stream 2 Project, and the Nord Stream Project.

IMPACT SOURCE: Turbidity caused by rock placement and munitions clearance. Potential impact receptors: fish, benthic fauna, marine mammals	
PREDICTED *	**MONITORED**
Rock placement: The maximum modelled turbidity is 61 FNU in stormy winter conditions and 22 FNU in calm summer conditions.	The maximum measured turbidity was 64 FNU. Only one result out of 3456 measurements exceeded the maximum value modelled for stormy conditions, and 82 results exceeded the maximum value modelled for calm conditions.
Rock placement: The modelled duration of the impact exceeding 2 FNU is 165 h in calm summer conditions and 24 h in stormy winter conditions.	The duration of the impact exceeding 2 FNU was 44 h.
Rock placement: The modelled duration of the impact exceeding 10 FNU is 19 h in calm summer conditions and 7 h in stormy winter conditions.	The duration of the impact exceeding 10 FNU was 6.5 h.
Munitions clearance: The modelled maximum turbidity is 107 FNU.	The maximum measured turbidity was 9.2 FNU.
Munitions clearance: The modelled duration of the impact exceeding 2 FNU is 23 h in calm summer conditions and 20 h in stormy winter conditions.	The measured duration of the impact was 12 h.
Munitions clearance: The modelled duration of the impact exceeding 10 FNU is 9 h in calm summer conditions and 7 h in stormy winter conditions.	The measured impact never exceeded 10 FNU. The maximum measured turbidity was 9.2 FNU.
Construction activities will neither increase turbidity nor sedimentation and will not deteriorate the conditions for the biota at the Sandkallan Natura 2000 site.	Increased turbidity was only observed at the Sandkallan site in relation to natural variability in oxygen conditions. There were no water quality effects due to construction activities.
Nord Stream monitoring results: The maximum recorded turbidity impact originated from rock placement was 53 FNU. The duration of the impact exceeding 10 FNU was between 12–24 hours. The maximum measured turbidity impact originated from munitions clearance remained below 10 FNU. Increased turbidity values were measured in near-bottom waters up to 10–15 metres above the seabed in an area having a radius of approximately 250 m around the munition.	

* Turbidity was modelled as solid matter concentration (mg/l) and measurements are expressed as turbidity units (FNU). In this report the common conversion factor 1:1 has been used. It is based on the original definition of turbidity as well as on very large number of parallel measurements in the Gulf of Finland. The same factor can be used throughout the scale.

8.1.3 Underwater noise

International regulations, such as the Marine Strategy Directive, aim at ensuring that the degree of impulsive and continuing noise is not increasing, is at a level that does not exceed natural noise levels, and does not cause harmful effects on the ecosystem, or economic harm to the coastal and marine industry. However, quantitative indicators have not been developed so far, and the baseline status for the underwater noise conditions in the Baltic Sea remains to be defined.

The underwater noise from the construction activities may have impacts on receptors, such as marine mammals and protected areas (via effects on living conditions of marine mammals). These impacts are described in chapters 8.2.2 Marine mammals and 8.2.3 Protected areas.

Despite the lack of actual quantitative indicators, underwater noise was modelled for the EIA in order to enable the estimation of the impacts on sensitive receptors. Modelling was done for munitions clearance and rock placement, which have been assessed to be the activities most likely to generate significant underwater noise.

The modelling results indicated that even with the planned, behaviour-based mitigation measures, such as acoustic deterrent devices, munitions clearance could lead to blast injuries or hearing threshold shifts to marine mammals, and the risk area could extend to several kilometres from the detonation site /4/. Therefore, the Nord Stream 2 decided to implement the bubble curtain as a further noise mitigation technique for around 20 munitions that were either large or located in the vicinity of protected areas and/or near areas with sensitive marine mammal population. This reduced the extent of risky areas by 59 –73 % /58/. In the final phases of permitting, when detailed studies of the munitions to be cleared were finalized, the Nord Stream 2 committed to using the bubble curtain for nearly all munitions – 80 of the planned 87 detonations. This reduced further the extent of risky areas, resulting in a revised assessment, which predicted minor impacts on marine mammals /89/.

The detailed modelling in the Water Permit application was based on detailed surveys and took into account the extended use of the bubble curtain /72/. Still, the modelling results overestimated the noise impacts. The measured peak levels were lower and the calculated areal coverages much smaller than modelled (Table 20). This was due to the conservative approach in modelling, where the munition charge, when exact value could not be determined, was estimated to be rather higher than lower, and the attenuation of noise due to the bubble curtain was estimated to be rather lower than higher, as there was no experience from the use of the bubble curtain in conditions similar to those in the Baltic Sea (shallow, low salinity, stratified). In several cases, the munition charge was smaller than predicted. It is also possible that the bubble curtain mitigated noise more effectively than expected. Sound attenuation is also naturally effective in the shallow areas of the northern Gulf of Finland.

Similar to the Nord Stream 2 Project, also in the Nord Stream Project the peak pressure levels (the only data gathered in the project) were lower than predicted. The peak pressure levels, corrected to the 300 m measuring distance, were on average 225 dB in the Nord Stream Project, which is about 15 dB higher than in the Nord Stream 2 Project. As the dB scale is logarithmic, there is a significant difference in the peak pressure levels, demonstrating the efficiency of the bubble curtain as a mitigation method.

Table 20. Underwater noise impacts from munitions clearance predicted in /72, 89, 90/; for the Water Permit application, impacts monitored during the construction phase of the Nord Stream 2 Project, and impacts recorded during the Nord Stream Project.

IMPACT SOURCE: Underwater noise created by munitions clearance. Potential impact receptor: marine mammals	
PREDICTED	**MONITORED**
The modelled Peak Sound Pressure level range is 172–238 dB re 1 µPa.	The monitored Peak Sound Pressure level range (corrected to 300 m measuring distance) was 130–234 dB re 1 µPa, on average 210 dB; 253 out of 254 levels were lower than modelled.
The whole Natura 2000 site of Kallbådan is covered by the TTS zone from the five largest munitions.	No TTS area of any clearance operation extended to the Kallbådan Natura 2000 site. The highest measured SEL at the long-term monitoring stations was 163.3 dB re 1 µPa²s (below TTS threshold 164 dB re 1 µPa²s) measured at Kallbådan A, closest to the clearance operations. The SEL measured at Kallbådan B of this same clearance operation, at a distance of 180 m outside the Natura site, had attenuated to 154,8 dB re 1 µPa²s.
The modelled highest PTS distance with the bubble curtain mitigation is 15,100 m.	The monitored highest PTS distance with the bubble curtain mitigation was 4,900 m.
The modelled PTS distance with the bubble curtain mitigation is higher than 10,000 m for 10 munitions.	The highest 10 monitored PTS distances ranged from 1,620 to 4,900 m.
Of the modelled PTS distances, 87 % exceed 2 km, and 42 % exceed 5 km.	Of the monitored PTS distances, 9 % exceeded 2 km, and none exceeded 5 km.
The modelled PTS zone area range, with the bubble curtain mitigation when needed, is 13–49 km^2	Monitored PTS zone areas were smaller than modelled in all but one case. The areas were on average 24.4 % of the modelled.
Nord Stream monitoring results: Peak pressure level data was collected by clearance contractors during munitions clearance operations for the Nord Stream Project. Measured peak pressure levels (corrected to 300 m measuring distance) were generally below 232 dB, and on average 225 dB. Only in four cases out of 70 the actual peak pressure level was higher than the predicted.	

8.2 Biotic environment

8.2.1 Biodiversity

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. The measurement of biodiversity in natural ecosystems is a challenging task, for which the methodology is still largely debated in the scientific community. For the purpose of the monitoring reporting, the impact on biodiversity is assessed according to the indications of the Marine Strategy Framework Directive: the report will assess the impacts on biodiversity in terms of species and habitat levels. Impacts at the ecosystem levels (e.g. food webs) will not be assessed, as they would require trans-national assessments. The specific targets identified to be potentially affected and for which monitoring data was collected are benthic species and their habitats, marine mammals and their habitats and species inhabiting protected areas.

Benthic biodiversity is sensitive to eutrophication, physical disturbance, habitat loss /48/ and fishing (trawling) /52/. In the EIA, all impacts of the Nord Stream 2 construction activities and operation phase on biodiversity were assessed to be negligible, except for marine mammals. The significance of impacts on marine mammals is discussed in Chapter 8.2.2.

More than 90 % of the gas pipeline corridor in the Finnish EEZ is located in deep waters, where the diversity of benthic fauna is low or sparse and consists only of few organisms that can survive in the sediments with low oxygen content. However, habitats of high sensitivity with zonation of benthic communities are located near the pipeline, such as the reef formations at the Sea Area South of Sandkallan, areas adjacent to it and along the pipeline section in front of the Porkkala Peninsula (Table 21).

Munitions clearance increased turbidity due to displacement of sediments from the seafloor. The impacts of sediment resuspension were restricted to near-bottom layers, and at 15 m above the seafloor no effects could be measured. Water column was stratified during munitions clearance, limiting the spreading of resuspended sediments, which reduced the risk of resuspended sediments reaching shallower habitats with higher biodiversity. The impact magnitude of munitions clearance on benthic biodiversity is assessed to have been negligible.

Like munitions clearance, rock placement increased turbidity due to displacement of sediments from the seafloor. During the monitoring campaign near the rock placement sites in 2018, the water column was stratified, preventing the spreading of resuspended sediments to shallower areas /68/. The rock placement takes place to large extent in areas, where nearly permanent salinity stratification limits the mixing of the water layers, like the conditions during the monitoring campaign. Due to these impact mitigating conditions, together with the fact that at these depths the biodiversity is very poor, it is assessed that the impact magnitude of rock placement on benthic biodiversity is negligible. Altogether, the impacts of construction activities on benthic biodiversity are assessed to have been negligible (Table 21).

Table 21. Impact significance analysis for biodiversity. Receptor sensitivity is assessed in the EIA, as well as predicted magnitude of change. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

Impact	Receptor sensitivity	Magnitude of change		Overall significance	
		Predicted	Assessed	Predicted	Assessed
Munitions clearance, other areas	Low	Negligible	Negligible	Negligible	Negligible
Munitions clearance, Sandkallan and Porkkala	High	Negligible	Negligible	Negligible	Negligible
Rock placement, other areas	Low	Negligible	Negligible	Negligible	Negligible
Rock placement, Sandkallan and Porkkala	High	Negligible	Negligible	Negligible	Negligible

During the munitions clearance operations some bird activity was observed during the pre-watch. However, no birds were detected before detonation in the vicinity of the detonation area. Similarly, no schools of fish were detected in the detonation area prior to detonation. No systematical monitoring of fish was included in the monitoring.

Impacts of construction activities on marine mammals are discussed in detail in Chapter 8.2.2 and impacts on protected areas in Chapter 8.2.3.

The environmental monitoring in the Nord Stream Project confirmed that the effects on the benthic communities were in line with the estimated effects: minor, temporary and local. The poor state of the benthic communities in the vicinity of the pipeline route in these deep areas is due to the unfavourable living conditions that result from the present state of the Gulf of Finland /1/.

8.2.2 Marine mammals

Marine mammals are sensitive receptors of underwater noise. The impacts on the Baltic Sea marine mammals were carefully assessed at several stages of the project planning, and the level of mitigation was increased to minimize the impacts on marine mammals. The main effects of the Nord Stream 2 construction activities on marine mammals were assessed to consist of the underwater noise created by munitions clearance detonations, rock placement and increased vessel traffic. All other possible effects, such as increased turbidity, were assessed to have negligible impacts.

At both the population level and individual level, the impacts were assessed to be minor for both the grey seal and the Baltic ringed seal /62, 89/ (Table 22). The updated EIA considered the use of the bubble curtain only for 20 munitions. In later stages of permitting, the Nord Stream 2 committed to using the bubble curtain for nearly all munitions to be cleared. The effect of this extensive mitigation significantly reduced the potential impact on marine mammals /72, 89/. The impacts of rock placement and vessel traffic were assessed as minor in the EIA /89/. The third marine mammal species in the Baltic Sea, the harbour porpoise, occurs very seldom in the Gulf of Finland /55/. Therefore, it is not included in this assessment.

The sensitivities of marine mammals and their habitats, and magnitude of impact (underwater noise, sediment spill and release of contaminants) have been discussed among specialists in the 2016 expert assessment /91/.

Table 22. Assessment of impact significance for underwater noise from munitions clearance on marine mammals. Receptor sensitivity is assessed in the updated EIA. The predicted magnitude of change is assessed in the updated EIA and in a re-assessment /89/ after the detailed modelling done for the Water Permit application. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

	Receptor	Magnitude of change		Overall significance	
Impact	sensitivity	Predicted	Assessed	Predicted	Assessed
Grey seal, individual level	Medium	Low	Low	Minor	Minor
Grey seal, population level	Low	Low	Low	Minor	Minor
Ringed seal, individual level	Medium	Low	Low	Minor	Minor
Ringed seal, population level	Medium	Low	Low	Minor	Minor

Based on the monitoring results, the sensitivity of **grey seals** is low at population level and medium at individual level. Grey seal population is stable and increasing and grey seals occur in the Finnish EEZ regularly, but not in high abundances. The assumption of scarcity was confirmed by on board marine mammal observers, who made no visual observations of any marine mammals during munitions clearance despite high visibility. In addition, passive acoustic monitoring gave no indication of the presence of marine mammals in the monitored area during the detonation phase.

The **ringed seal** population is fragmented into different sea areas, and the Gulf of Finland population is recognised as a special concern by HELCOM, due to a notable decrease in population during the past three decades, the existing very small population size, and sensitivity to anthropogenic and natural stressors.

Based on telemetry studies and small population size, ringed seals occur in the Finnish EEZ only in low or medium densities. The assumption of scarcity was confirmed by the visual monitoring and the passive acoustic monitoring that showed no marine mammals in the monitored area during the munitions clearances. Based on the monitoring results, the sensitivity of the ringed seal at population and individual level is assessed to be medium in the Finnish EEZ.

The munitions clearance created less noise than predicted in the modelling. Often the munition charge turned out to be smaller than predicted, and in addition, part of the old charge may have dissolved in the water over the years. In addition, effective mitigation methods were used. Acoustic deterrent devices were used to scare the animal away from the area, and marine mammal observer visually confirmed the absence of animals in the vicinity of the detonation area. The bubble curtain was used in 78 % of detonations to attenuate the noise (all munitions with a total explosive quantity of 22 kg or more and all detonations taking place in a sensitive area). Lower charge combined with effective mitigation measures indicate that the impacts of munitions clearance on marine mammals did not exceed the expected impacts; rather, they were lower. This was confirmed by the underwater noise monitoring results, in which 99.6 % of measured peak levels were lower than the modelled values. The results of the Metsähallitus seal behaviour monitoring using remote recording camera equipment at the Kallbådan area show that seals were not stressed by the detonation noise. Modelling of the measured noise levels, together with actual measurements close to the Kallbådan seal sanctuary, indicate that noise at the level that would even temporarily affect the hearing of the seals did not reach any protected areas designated for seals.

Based on the use of the efficient mitigation methods, the results of monitoring and absence of seals during munitions clearance, the impact of munitions clearance on marine mammals is assessed to be minor for both seal species at both the individual and population level.

Underwater noise from rock placement was not monitored in the Nord Stream 2 Project. In the EIA, it was stated that the effect is strictly local, temporary and of low intensity. Similarly, the disturbance caused by construction vessel noise was estimated to be local and temporary, and insignificant compared to the general noise level of shipping in the Baltic Sea.

Resuspension of sediments may affect seals by visual impairment or behavioural changes, but these effects are assessed to be temporary, as the sediment disperses and sinks, and therefore not to affect any of the species at the population level. Similarly, the effects are temporal at the individual level. The significance of impact was assessed to be negligible in the EIA. Resuspension of sediments from the seafloor may also release contaminants to the food web. However, turbidity monitoring revealed that the amount of resuspended sediment was lower and the duration of turbid conditions shorter than assessed in the EIA. Therefore, the impact of sediments and resuspended contaminants on marine mammals are assessed to be negligible, as assessed in the EIA.

In the Nord Stream Project, underwater noise was not monitored, but based on the pressure waves measured by the munitions clearance operators, the impacts from munitions clearance were assessed to have been minor. No injuries, fatalities or other significant impacts were reported /92/ either during munitions clearance or during other Nord Stream construction activities. Only minor negative impacts on individual marine mammal behaviour were observed due to break-up of ice during rock placement during winter /1/. In the Nord Stream monitoring, the effects of pipelay (touchdown of the pipeline and effect of vessel presence/activity) on sediment spill were assessed to be non-existent or negligible /69/.

8.2.3 Protected areas

In the EIA, underwater noise and spreading of sediments were identified as possible risks for the protected areas. Noise created by munitions clearance and turbidity of water as a result of sediment resuspension due to munitions clearance and rock placement could lead to deteriorated conditions for marine mammals. Settling of resuspended sediments could also negatively affect benthic habitats.

The sensitivity of the Natura 2000 areas with reefs or seals as conservation objectives is high. However, in the updated EIA that also included two Natura assessment studies and two Natura assessment screening studies covering four Natura areas, it was concluded that the Nord Stream 2 pipeline will not significantly deteriorate the Natura values, due to which the Natura sites were included in the Natura 2000 network.

A Natura assessment was performed for the Kallbådan Islets and Water, including the Kallbådan seal sanctuary /90/. Based on the assessment, all the impacts of both construction and operation of the pipeline were assessed to be negligible, with the exception of underwater noise created by munitions clearance, which was assessed to have minor significance due to the mobility of grey seals (Table 23). Individuals outside of the Natura area during detonation were assessed to potentially experience the onset of PTS. However, it was noted that due to the mitigating effect of the bubble curtain, seals in the distance of 4–5 km from the Natura area would not be affected by the offset of PTS.

Similarly, for the other Natura areas, all the impacts of both construction and operation of the pipeline were assessed to be negligible, with the exception of underwater noise created by munitions clearance, which was assessed to have minor significance, based on high sensitivity of ringed seal to disturbances. The use of the bubble curtain in sensitive areas was estimated to reduce the likelihood that any ringed seal would be affected during detonations, and the overall significance for grey seals and ringed seals was assessed to be minor at the population level (Table 23) /62/.

All impacts on receptors in the protected areas with underwater habitats and/or birds as conservation objectives were assessed to be negligible in the updated EIA (Table 23) /62/.

Table 23. Assessment of impact significance for the protected areas. Receptor sensitivity is assessed in the EIA, and predicted magnitude of change in the updated EIA. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

Impact, conservation object	Receptor sensitivity	Magnitude of change		Overall significance	
		Predicted	Assessed	Predicted	Assessed
Underwater noise, seals area 1	High	Low	Low	Minor	Minor
Underwater noise, seals area 2	Low	Low	Low	Minor	Minor
Underwater noise, seals area 3	Low	Negligible	Negligible	Negligible	Negligible
Underwater noise, birds	Low	Negligible	Negligible	Negligible	Negligible
Underwater noise, underwater habitats	Medium	Negligible	Negligible	Negligible	Negligible
Sediment spreading, all seal areas	Low	Negligible	Negligible	Negligible	Negligible
Sediment spreading, birds	Low	Negligible	Negligible	Negligible	Negligible
Sediment spreading, underwater habitats	Medium	Negligible	Negligible	Negligible	Negligible
Seal protection area 1: Kallbådan Islets and Waters Natura site, Kallbådan seal sanctuary Seal protection area 2: Sandkallan seal sanctuary, Stora Kölhällen seal sanctuary, Söderskär and Långören Archipelago, Pernaja bay and Pernaja Archipelago, Open Sea Area Southeast from Hanko, Söderskär and Långören Archipelago Ramsar site, Bird Wetlands of Hanko and Tammisaari Ramsar area, The Tammisaari Archipelago National Park Seal protection area 3: all other protection areas with seals as protection objectives					

The evaluation of the monitoring results confirms that the estimates of impact significance presented in the updated EIA were accurate.

The significance of impacts of construction activities on marine mammals, based on the monitoring results of underwater noise and water turbidity, was assessed to be minor (see Chapter 8.2.3 for details) (Table 23). This was also confirmed by the Metsähallitus monitoring of seal behaviour, in which it was found that the seals did not react to the construction activities.

Turbidity created by munitions clearance was dramatically lower than assessed and, consequentially, also lasted for a shorter period than estimated in the modelling for the updated EIA. The spreading was limited to 1.5 km from the detonation at the Munitions clearance site 1, and to a distance of 2.2 km at Munitions clearance site 2 /16/, confirming that resettling occurs fast, making the impact rather local.

The modelling of effects of rock placement also overestimated the extent of effects. About 2.3 % of measured values exceeded the modelled value, with the majority being much lower. High turbidity conditions were monitored to last for 6.5 h instead of 19 h, as modelled for the calm summer conditions prevailing during the monitored rock placement work. Similarly, the period with slightly elevated turbidity was monitored to be four times shorter than predicted for the summer conditions. The monitoring of turbidity took place about 200–300 m from the construction work. As water masses spread further, resettling and mixing caused a decrease in the concentration of sediment particles in the water. Therefore, neither high turbidity conditions nor significant resettling extended far from construction activity.

Based on these monitored effects and the long distance to the protected areas, spreading and resettling of sediments due to munitions clearance and rock placement are assessed to have non-existent or negligible impacts on the biodiversity of reefs along the pipeline (Table 23).

It is assessed that the integrity of the Natura 2000 network was not threatened by any impacts from the Nord Stream 2 Project construction in the Finnish EEZ during 2018–2020.

Neither monitoring directly related to the Natura 2000 areas nor underwater noise monitoring were carried out within the Nord Stream monitoring. As summarized in Chapter 8.2.2, the effects were similar in the Nord Stream 2 Project (minor).

8.3 Socio-economic environment

8.3.1 Cultural heritage

In the EIA /4/, all cultural heritage sites within 250 m of the pipeline route were evaluated from the detailed high-resolution data by a marine archaeologist. These sites included two significant wrecks and two World War II historical sites. Underwater wrecks, wreck parts and other individual man-made objects that may be considered over 100 years old are protected by the national law and international conventions and assessed as having high sensitivity. The sensitivity of the World War II historical sites is medium.

Mechanical damage can occur to cultural heritage objects during construction work. However, in case of both wrecks the impact was assessed as negligible in the updated EIA /62/, due to the negligible probability of the construction and operation activities affecting the site. Similarly, the impact was assessed to be negligible for one of the World War II sites. In case of the submarine barrage (S-R09-09806), rock placement for the support of the pipelines buries part of the object, and therefore the magnitude of impact was assessed to be low. The impact of pipelay on the barrage is direct and permanent. If only relatively small parts of the barrage remain under the pipeline, the magnitude of change was assessed as low. Therefore, the impact significance for this site was assessed as minor (Table 24).

The Water Permit provisions require that construction work in the proximity must be carried out in the way that minimises damage to the submarine barrage. According to as-laid reports, both Line A and Line B were laid across the barrage mostly with a free-span, thus limiting the impacts onto the target in line with the Water Permit provisions. Some section of the pipeline is, however, in contact with the anti-submarine net. It is therefore assessed that the impact significance is minor (Table 24).

Due to the proximity of the pipelines to one of the wrecks, a cannon barge from the 18th or 19th century (S-R05-7978), the Water Permit provisions require the establishment of a 50 m safety zone around the cannon barge. No construction activities have been carried out in the safety zone. For the Line B, a reduced lay tolerance in the vicinity of the barge was respected, with the Line B laid at the distance of about 63 m from the target (planned distance according to the updated EIA was 58 m). The Line A was laid at a distance of 130 m in 2018. No further construction activities, such as maintenance rock placement are planned in the surroundings. It is therefore assessed that the impact significance is negligible (Table 24).

Table 24. Assessment of impact significance for cultural heritage. Receptor sensitivity is assessed in the EIA, as well as predicted magnitude of change. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

Impact	Receptor sensitivity	Magnitude of change		Overall significance	
		Predicted	Assessed*	Predicted	Assessed*
Burial of the submarine barrage	Medium	Low	Low	Minor	Minor
Disturbance of the cannon barge	High	Negligible	Low	Minor	Negligible

* final assessment to be made after the construction activities in the Finnish EEZ have been completed

A thorough post-survey of both targets will be carried out after the construction activities have been completed to confirm that no damage to the monitoring targets have occurred by any construction activity during the implementation of the project.

Based on the surveys performed between 2009–2013 for the Nord Stream Project, no impacts were recorded on known wrecks near the installation corridor during different pipeline construction activities.

8.3.2 Ship traffic

The construction of the Nord Stream 2 gas pipeline took place along the major sea routes. The temporary safety zones around the construction vessels have an impact on other ship traffic in the area.

In the EIA, the impact of the construction phase on the ship traffic in the Gulf of Finland was assessed to be mainly negligible due to integrated mitigation through marine notifications. However, there were two exceptions, the TSS areas Off Kalbådagrund and Off Porkkala Lighthouse (Table 25). Near Kalbådagrund the area suitable for marine traffic north of the westbound lane is very narrow. When the construction vessels are working in the area, the temporary safety zones make it even narrower. Near Porkkala the traffic patterns are complicated due to crossing shipping routes.

Table 25. Assessment of impact significance of construction work safety zones on ship traffic. Receptor sensitivity is assessed in the EIA, as well as predicted magnitude of change. Assessed magnitude of change is based on the monitoring results. Overall significance is assessed based on those two variables.

Impact	Receptor sensitivity	Magnitude of change		Overall significance	
		Predicted	Assessed	Predicted	Assessed
Ship traffic	Low	Negligible	Negligible	Negligible	Negligible
Ship traffic at the TSS Off Kalbådagrund and at the TSS Off Porkkala Lighthouse	Medium	Low	Negligible	Minor	Negligible

During the construction, the Nord Stream 2 Project has provided general implementation plans to the Finnish authorities to inform them about construction activities well in advance. The main vessels have provided weekly and daily notifications regarding their activities and schedules (Chapter 3.6). The established safety zones were agreed with the Finnish Transport Infrastructure Agency/VTS Centre. The radius of the safety zone was determined based on the construction activity and the vessel in question. One nautical mile (NM) was applied for the pipelay vessels, except at the Kalbådagrund TSS area, where a reduced safety zone with a radius of 0.5 NM was established. Around the munitions clearance vessels, a safety zone with a radius of 1.5 – 2.5 km was established based on the size of the munition to be cleared. A safety zone with a radius of 500 m was established around the rock placement, mattress installation and survey vessels. Third party ships were not allowed to enter the safety zones.

For the time of pipelay near the 13 m shallow close to Kalbådagrund, a tug was stationed nearby in order to respond to ship emergencies, such as danger of grounding, under the request of the Finnish Transport Infrastructure Agency (Table 26). The tug was on standby to assist the contractor and third-party vessels by towing and pushing, if necessary. No such incidents occurred either in 2018 or 2019.

No incidents related to ship traffic were reported in 2018–2020. It is therefore assessed that the impact significance is negligible for the whole route in the Finnish EEZ.

Table 26. Presence of an intervention tug at the Kalbådagrund shallow in 2018 and 2019.

Pipelay of Line A in 2018	Pipelay of Line B in 2019
Intervention tug Esvagt Connector	Intervention tug Thor
October 7 to October 16, 2018	August 7 to August 14, 2019

In the Nord Stream Project, experiences during the construction work confirmed the validity of the assessments that there were no significant impacts on ship traffic.

8.3.3 Commercial fishery

In line with the monitoring programme, no commercial fishery monitoring was carried out during the years 2018–2020. Monitoring of commercial fishery is planned to be performed when the pipeline has been in operation for two years.

During the construction phase, the Nord Stream 2 submitted Notifications to Fishermen to inform them about the activities in the Finnish EEZ. The notifications included locations of the work planned for the forthcoming month, vessels to be used and their call signs and the radius of the safety zones around the vessels as well as sources of further information (e.g. /93/).

8.4 Marine Strategy and Water Framework Directives

The common goal for water management and marine management is to protect, improve and restore the waters and the Baltic Sea so that the status of surface water and ground water or the Baltic Sea will not deteriorate and their environmental status is at least good. Water management and marine management planning is performed and implemented in a coordinated way observing convergent objectives. The directives obligate the member states to evaluate all proposed projects in relation to these goals, and to grant permits only to projects that do not prevent the achievement of the good status.

The possible impacts of the Nord Stream 2 Project that would affect the national compliance with the Marine Strategy Directive were assessed in the EIA /4/ and later in the updated EIA /62/. For all impacts, the assessments state that the Nord Stream 2 Pipelines will not prevent the achievement of the long-term goals for good environmental status. In case of introduction of underwater noise to the sea, the assessment points out the lack of quantitative indicators. To date, these indicators have not been developed.

The analysis made within the EIA states that the project will not prevent the achievement of any of the goals set up in the Government Decision December 13, 2012 (the first part of the Finnish Marine Strategy). The project will neither prevent the achievement of goals set in the programme of measures of the Finnish Marine Strategy for the period of 2016–2021, adopted by the Finnish Council of State on December 3, 2015 (the third and final part of the Finnish marine strategy). This was also noted on a general level by the EIA Authority in the EIA Statement and confirmed by the Updated Assessment.

Similarly, the possible impacts of the Nord Stream 2 pipeline that would affect the national compliance with the Water Framework Directive were assessed in the EIA and later in the updated EIA. It was concluded that the Nord Stream 2 Project will not increase the pressures related to eutrophication, and therefore the Nord Stream 2 Project will not be contrary to the objectives and initiatives set out in the Water Framework Directive.

Since the monitoring results 2018–2020 indicate that the impacts were either in line or below the assessed impacts, it is confirmed that the construction of the Nord Stream 2 Project in 2018–2020 does not have an impact on Finland's ability to reach the Good Environmental Status (GES). The project has not caused eutrophication outside of the water management areas. Therefore, impacts on actual water management areas have neither been discovered.

The Summary Table 27 presents the descriptors of the good environmental status as defined in the Marine Strategy Framework Directive, the environmental status of the Gulf of Finland in 2011–2016 by various receptors /46/, the predicted impact of the Nord Stream 2 Project on those receptors /4, 62/, and the assessed impact, based on the results of the Nord Stream 2 Project monitoring in 2018–2020.

Table 27. The descriptors of the good environmental status as defined in the Marine Strategy Framework Directive, the environmental status of the Gulf of Finland in 2011–2016 by various receptors /46/, the predicted impact of the Nord Stream 2 Project on those receptors (EIA and updated EIA), and the assessed impact, based on the results of the Nord Stream 2 Project monitoring in 2018–2020.

		Impact on reaching the GES	
Descriptors of GES	**Status 2011–2016**	**Predicted**	**Assessed**
1. Biodiversity is maintained			
Reef habitats (outer archipelago)	Good	Minor/Negligible	Negligible
Offshore sea-floor habitats	Deteriorated	Negligible	Negligible
Offshore plankton	Deteriorated	Not assessed	Not monitored
Grey seal	Good	Negligible	Negligible
Ringed seal	Deteriorated	Negligible	Negligible
Harbour porpoise	Deteriorated	Negligible	Not monitored
Sea trout	Deteriorated	Negligible	Not monitored
2. Non-indigenous species do not adversely alter the ecosystem			
Non-indigenous species	Good	Negligible	Not monitored
3. The population of commercial fish species is healthy			
Commercial fish stock	Good/Deteriorated	Negligible	Not monitored
4. Elements of food webs ensure long-term abundance and reproduction			
Food webs	Deteriorated	Negligible	Not monitored
5. Eutrophication is minimized			
Eutrophication	Deteriorated	Negligible	Not monitored
6. The sea floor integrity ensures functioning of the ecosystem			
Seabed integrity	Status not available	Minor	Minor
7. Permanent alteration of hydrographical conditions does not adversely affect the ecosystem			
Hydrographical conditions	Good	Negligible	Negligible
8. Concentrations of contaminants give no effects			
Hazardous substances	Good/Deteriorated	Negligible	Negligible
Radioactivity	Deteriorated	Not assessed	Not monitored
9. Contaminants in seafood are below safe levels			
Contaminants in fish and seafood	Good	Negligible	Not monitored
10. Marine litter does not cause harm			
Marine litter	Status not available	Not assessed	Not monitored
11. Introduction of energy (incl. underwater noise) does not adversely affect the ecosystem			
Underwater noise	Status not available	No quantitative indicators available	

8.5 Transboundary impacts

The only transboundary environmental impacts of the Nord Stream 2 Project, assessed to deviate from negligible, were the impacts on marine mammals. These were assessed to be minor when all mitigation measures are being used /72, 89/. The underwater noise monitoring at the two stations in the Estonian waters, carried out in 2018, confirmed that while most of the munitions clearance operations were detected at the Malusi station, and the clearance operations east of Helsinki were additionally detected at the Uhtju station, the noise levels never exceeded the TTS, nor the PTS limits (Annual Monitoring Report 2018). As sound travels further in the deep, open Estonian coast than in the shallow Finnish coast, the impact was conservatively assessed as minor, as predicted.

During the updated EIA it was assessed that the Nord Stream 2 Project does not prevent the achievement of the long-term good environmental status in Estonia /62/. The assessment is confirmed by the monitoring results that confirm that the impacts did not exceed the predicted impacts.

In the Nord Stream Project, underwater noise was not monitored. Only the impact of construction activities on the concentrations of harmful substances in sediments across the border were measured. Based on the monitoring results the construction activities in the Finnish EEZ in 2010-2012 did not cause any measurable transboundary impacts in the Estonian EEZ.

9 RECOMMENDATIONS FOR FUTURE ENVIRONMENTAL MONITORING

The Nord Stream 2 monitoring programme is based on the Nord Stream 2 EIA and the experiences gained during the monitoring of the earlier Nord Stream Project. In addition to the mandatory programme, further monitoring activities were implemented through specialist studies to diversify the assessment of impacts from the Nord Stream 2 Project and to enhance scientific knowledge of the Baltic Sea environment. The monitoring carried out is comprehensive enough to enable reliable assessment of the environmental impacts of the construction of the Nord Stream and the Nord Stream 2 Pipelines.

The following general recommendations for future large-scale marine construction projects are based on the evaluation of the monitoring results and experience of the Nord Stream 2 Pipeline construction in 2018–2020 in the Finnish EEZ.

The need to monitor background water quality at both below and above halocline was recognized to be important during the monitoring of the Nord Stream Project and Nord Stream 2 Project in order to understand seasonal and annual variability in the Baltic Sea. In addition, it is recommended here to position the control stations so that the background information of natural, seasonal changes in sea water quality reflects the conditions along the pipelay route. This may, however, be technically challenging, as pipelay often takes place at deep areas in the open sea and/or at shipping lanes.

So far, there is a limited number of studies on the water quality and underwater noise impacts of munitions clearance and other construction activities, especially in shallow but stratified waters. The monitoring of underwater noise is recommended in any future project that includes activities generating underwater noise.

10 CONCLUSIONS

Construction activities in the Finnish EEZ in 2018–2020

The Nord Stream 2 construction activities in 2018 included munitions clearance, rock placement, mattress installation and pipelay. Pipelay continued and it was completed in 2019. Rock placement continued in 2020 and it was completed in the end of May 2020.

Munitions clearance activities were successfully completed in 2018. In total, 74 munitions were cleared. The lower number of cleared munitions, compared to the permitted number (87 munitions), is due to the detailed pre-clearance surveys on site.

Rock placement continued in spring 2020. Pre-lay rock placement was completed in 2019. Post-lay rock placement was completed in May 2020. Maintenance rock placement took place in November for a single berm.

Mattress installation is conducted to support and protect the pipeline crossings with existing cables and other pipelines. In total, 492 mattresses were installed on the seabed in 2018. The number of mattresses was lower than permitted (607) due to changes in the design during the detailed survey prior to mattress installation. Mattress installation was completed in 2018.

The pipelay of Line A in the Finnish EEZ started in 2018 and the pipelay of Line B started in 2019. Both pipelines were completed in 2019. Pipelay corridor was locally adapted at the crossing with the Balticconnector pipeline for Line A and for Line B. For Line B, minor route deviations were necessary in three locations. One of them was at the crossing with the Balticconnector pipeline and took place within the installation corridor. Two deviations exceeded the installation corridor width (< 7.5 m). In addition, minor deviations from the narrowed pipelay corridor occurred once for Line A and 11 times for Line B.

Six unplanned events occurred during construction work in 2018–2020. These were small leaks of biodegradable oil that were notified to the appropriate authorities. No actions were required.

Environmental monitoring

The environmental monitoring during 2018–2020 was performed in line with the environmental monitoring programme prepared for the Nord Stream 2 project. The results of monitoring were compared to modelled impacts and assessments /4, 62, 89/ presented in the Water Permit application, as well as to the monitoring results from the Nord Stream project /1/.

Underwater noise

The modelling done for the Water Permit application overestimated the noise generated during the munitions clearance work. The measured peak levels were lower and the calculated PTS areas much smaller than modelled. Munition charge was often smaller than predicted, and it is also possible that the bubble curtain mitigated noise more effectively than expected. Sound attenuation is also naturally effective in the shallow areas of the northern Gulf of Finland.

The impacts that underwater noise had on biodiversity (via marine mammals) were minor and in protected areas negligible, as it was predicted in the modelling for the Water Permit application.

In the Nord Stream Project, only peak pressure levels of noise were measured. These were lower than predicted in the modelling. The peak pressure levels (distance corrected to enable comparison) were on average 225 dB in the Nord Stream Project and approximately 210 dB in the Nord Stream 2 Project. The 15 dB difference is significant and highlights the efficiency of the bubble curtain as a mitigation method in the Nord Stream 2 Project.

Water quality and currents

The impacts created by the relocation of sediments on water quality during construction activities (munitions clearance and rock placement) were predicted to be minor. Construction was predicted not to deteriorate the conditions for the biota at the Sandkallan Natura 2000 site.

According to the results of the short-term monitoring of turbidity and currents around two munitions clearance sites and two rock placement sites in 2018, the turbidity impacts were generally lower than predicted and briefer in duration. At the long-term monitoring stations, including Sandkallan, only natural variation in turbidity could be detected from April 2018 to May 2020.

The impacts of construction work on water quality were minor, as predicted, and the integrity of the Natura 2000 network was not threatened by any impacts from the Nord Stream 2 pipeline construction in the Finnish EEZ during 2018–2020.

The monitoring results are in line with those from the Nord Stream Project, in which rock placement and munitions clearance were both assessed to have had a minor negative impact on water quality, and no impacts on protected areas.

Sediment contaminants

Although the overall impact of contaminant relocation was assessed as negligible in the updated EIA, the spreading of heavy metals and explosive residuals around the munitions clearance sites was studied. The results of 17 sediment samples confirm that detonations did not increase the concentrations of harmful substances in the surface sediments. No explosive residuals were detected in the samples, and the heavy metal concentrations, like those found in earlier studies in the Gulf of Finland sediments, varied randomly on the seafloor. There was no correlation between the distance to the detonation site and concentration.

Marine mammals

A series of mitigation measures were successfully implemented to reduce the environmental impacts of underwater noise due to munitions clearance. Acoustic deterrent devices were used to drive marine mammals out of the clearance area. Trained marine mammal observers and passive acoustic monitoring confirmed the absence of animals in the vicinity of the detonations. The noise released by the clearances was minimized by surrounding the munitions with the bubble curtain during detonations.

Both the permanent and temporary threshold shift zones were much smaller than predicted, limiting the possibility that any marine mammal would have experienced damage from the construction work noise. Threshold shift zones (PTS and TTS) did not extend to any Natura 2000 areas with marine mammals as conservation objects. Based on the Metsähallitus remote video camera monitoring, noise did not cause any behavioural impacts on grey seals at the Kallbådan seal reserve.

The monitored impacts of underwater noise on marine mammals were minor, and in line with the predicted impacts for both grey seals and for Baltic ringed seals at both individual and population level.

In the Nord Stream Project, underwater noise was not monitored, but based on the pressure waves measured by the munitions clearance operators, the impacts from munitions clearance were assessed to have been minor.

The resuspension of sediments may affect seals by visual impairment or behavioural changes and may also release contaminants to the food chain. Turbidity monitoring revealed that the amount and duration of resuspended sediment were lower than assessed in the EIA, in which the significance of the impact was assessed to be negligible. Therefore, the impact of sediments and resuspended contaminants on marine mammals are assessed to be negligible, as it was assessed in the EIA.

Commercial fishery

The impacts on commercial fishery in the Finnish EEZ, via possible changes in trawling patters, will be assessed when the operational phase of the pipeline will start.

Cultural heritage

All cultural heritage sites within 250 m of the pipeline route were evaluated by a marine archaeologist, and two targets were identified to require precaution during construction work. In the EIA, only the anti-submarine net was assessed to have minor impacts; all other targets were assessed to have negligible impacts from the construction activities of the Nord Stream 2 Project.

With regard to the World War II submarine barrage, the construction activities in the proximity had to be carried out in the way that minimised the damage to the target. As the anti-submarine net spreads across a long distance in the Gulf of Finland, it could not be completely avoided. To limit the damage to the target, pipeline was laid across the barrage mostly with a free-span. Some section of the pipeline is, however, in contact with the net, and therefore the impact is assessed to have been minor.

A safety zone of having a radius of 50 m was required around the cannon barge from the 18th or 19th century due to the proximity of the pipelines to a wreck. No construction activities were carried out within the safety zone. Line B was laid at a distance of about 63 m from the target in 2019, and Line A was laid at a distance of 130 m in 2018. No further construction activities, such as rock placement were conducted or are planned in the surroundings. Therefore, it is assessed that the impact on the target has been negligible.

Similar to these results, no impacts were recorded on known wrecks in the Nord Stream Project.

Ship traffic

The impact of the Nord Stream 2 Project on ship traffic is caused by the temporary safety zones established around the construction vessels. The impacts on ship traffic in the Gulf of Finland were assessed to be mainly negligible and minor for the TSS areas Off Kalbådagrund and Off Porkkala Lighthouse.

The Nord Stream 2 provided general implementation plans and monthly plans, and contractors have submitted weekly and daily notifications to the Finnish authorities to inform them about construction activities well in advance. The established safety zones were agreed with the Finnish Transport Agency/VTS Centre. Third party ships were not allowed to enter the safety zones. In addition, for the time of pipelay near the 13 m shallow close to Kalbådagrund, a tug was stationed nearby in order to respond to contractor and third-party ship emergencies, such as danger of grounding. No emergencies occurred during the construction period in 2018–2020.

No incidents related to ship traffic were reported during the construction period in 2018–2020. It is therefore assessed that the impact was negligible for the whole route.

In the Nord Stream Project, a few minor ship traffic incidents occurred in 2010 and 2011. While there were no significant impacts, the overall impact was assessed as minor, due to the incidents.

Transboundary impacts

The only potential transboundary environmental impacts of the Nord Stream 2 Project were the impacts on marine mammals. The underwater noise monitoring at the two stations in the Estonian waters confirmed that the Nord Stream 2 Project construction activities related noise levels in Estonia never exceeded the TTS, nor PTS limits. It is assessed that the impact significance was minor, as predicted.

It was assessed in the updated EIA that the Nord Stream 2 Project does not prevent the achievement of long-term good environmental status in Estonia /62/. The assessment is confirmed by the monitoring results that show that the impacts did not exceed the predicted impacts.

In the Nord Stream Project in 2010 - 2012, the only monitored transboundary impact was the harmful substance concentration in the sediments. The construction activities in the Finnish EEZ did not cause any measurable transboundary impacts in the Estonian EEZ.

Overall conclusions

The as-laid reports confirm that the construction of the Nord Stream 2 pipeline in 2018–2020 has been performed according to plans presented in the Water Permit application.

The environmental monitoring results in 2018–2020 confirm that all monitored environmental impacts related to the Nord Stream 2 Project are in line or lower than assessed in the application documents.

The construction of the Nord Stream 2 pipeline does not have an impact on the goals set in the Marine Strategy Framework Directive for the Finnish waters to achieve the good environmental status. The Nord Stream 2 Project does not increase the pressures related to eutrophication and, therefore, the Nord Stream 2 Project does not contradict the objectives and initiatives set out in the Water Framework Directive.

The integrity of the Natura 2000 network is not threatened by any impact related to the Nord Stream 2 pipeline construction.

Potential transboundary impacts of the Nord Stream 2 Project construction were limited to underwater noise associated with munitions clearances which could affect marine mammals. Monitoring showed that harmful levels of noise did not reach the Estonian EEZ.

LIST OF REFERENCES

Permits and consents

TEM/1810/08.08.01/2017. Suostumus Suomen talousvyöhykkeen taloudelliseksi hyödyntämiseksi. Päätös. Valtioneuvosto, 5.4.2018. Unofficial translation, W-PE-LEG-PFI-PER-961-EEZPEREN-01: Nord Stream 2. Consent to exploit Finland's exclusive economic zone. TEM/1810/08.08.01/2017. April 5, 2018.

53/2018/2. Päätös vesilupahakemuksesta: Kahden maakaasuputken sijoittaminen Suomen talousvyöhykkeelle ja valmistelulupa. Drno. ESAVI/9101/2017. ESAVI (= Regional State Administrative Agency of Southern Finland), 2018. Unofficial translation, W-PE-LEG-PFI-PER-961-WATPEREN-01: Nord Stream 2. Placing two natural gas pipelines within the Finnish EEZ and authorisation for preparation. Regional State Administrative Agency, Southern Finland, Decision 53/2018/2, Reg. No ESAVI/9101/2017. April 12, 2018.

325/2018/06.06.02. Päätös. Tutkimus- ja liikkumislupa melun mittaamiseen Kallbådanin ja Sandkallanin-Stora Kölhällenin hylkeidensuojelualueille sekä muille valtion vesialueille liittyen Nord Stream 2 maakaasuputkien ympäristövaikutusten rakentamisaikaiseen seurantaan. Metsähallitus. March 12, 2018. (Decision. Research and trespassing permit for measuring noise in Kallbådan and Sandkallan-Stora Kölhällen seal protection area related to Nord Stream 2 Project.)

5395/2018/06.06.02. Päätös. Tutkimus- ja liikkumislupa melun mittaamiseen Kallbådanin ja Sandkallanin-Stora Kölhällenin hylkeidensuojelualueille sekä muille valtion vesialueille liittyen Nord Stream 2 maakaasuputkien ympäristövaikutusten rakentamisaikaiseen seurantaan. Metsähallitus. December 7, 2018. (Decision. Research and trespassing permit for measuring noise in Kallbådan and Sandkallan-Stora Kölhällen seal protection and other state water areas related to Nord Stream 2 Project.)

UUDELY/9564/2017a. Tarkkailuraporttien toimittamisaikataulun hyväksyminen. Esitys tarkkailun tulosten vuosiraportoinnin ajankohdasta 15.2.2019. Uudenmaan ELY-keskus 22.2.2019. (Approval of proposal A clarification on the schedule of submission of the annual monitoring reports to Uusimaa ELY Centre on February 15, 2019. Uusimaa ELY Centre. February 22, 2019.)

UUDELY/9564/2017b. Tarkkailun muutosesityksen hyväksyminen. Tarkkailun muutosesitys 9.10.2019. Uudenmaan ELY-keskus 8.11.2019. (Approval of proposal for amendment in monitoring. Amendment proposal October 9, 2019. Uusimaa ELY Centre. November 8, 2019.)

Literature and internet

1. G-PE-EMS-MON-100-0321ENG0-B. Nord Stream Gas Pipeline Construction and Operation in the Finnish EEZ, Environmental Monitoring 2012, Annual Report. Ramboll. July 3, 2013.
2. W-PE-EMS-PFI-REP-805-032300EN-11. Nord Stream 2. Natural gas pipeline route through the Baltic Sea – Environmental monitoring programme, Finland. Ramboll. February 1, 2018.
3. IMPERIA (2015) Guidelines for the systematic impact significance assessment – The ARVI approach. IMPERIA Project Report, December 31, 2015. https://jyx.jyu.fi/bitstream/handle/123456789/49498/Guidelines_for_impact_significance_assessment.pdf?sequence=1&isAllowed=y. Date of access April 29, 2019.
4. W-PE-EIA-PFI-REP-805-030100EN-09. A Natural Gas Pipeline through the Baltic Sea. Environmental Impact Assessment Report, Finland. Ramboll, 2017.
5. JNCC (2010). JNCC guidelines for minimising the risk of injury to marine mammals from using explosives. JNCC, Marine Advice, UK. August 2010.

6. W-PE-EMO-PFI-MIS-800-MUNMONEN-01. Nord Stream 2. Guidance Note: Deployment of Mitigation Measures for Marine Mammals, Fish and Birds during Munitions Clearance in Finland. March 22, 2018.
7. W-SU-UXO-PFI-REP-808-EODSUREN-02. Nord Stream 2. EOD Summary Report, Route Clearance and UXO Removal, UXO Clearance Survey, Bay of Finland, May-June 2018. MMT Sweden Ab. August 2, 2018.
8. W-SU-UXO-PFI-REP-831-GEOFRREN-03. Nord Stream 2. Munitions Clearance Finnish EEZ, EOD Summary Report, MV Geosund. Sea and Bodac, August 1, 2018.
9. W-OF-RDU-POF-PRO-830-ROTEMSEN-04. Rock Testing Method Statement. Boskalis Offshore Contracting B.V. & Van Oord Offshore B.V. (BOVO). January 17, 2018.
10. Routama V, Virtanen T (2019). Statement on rock quality in Skogsmora Quarry, Karjaa. Rudus OY. March 31, 2020.
11. W-OF-RDU-POF-PRO-830-RTMSKOEN-05. Rock Transportation Method Statement Kotka. Boskalis Off-shore Contracting B.V. & Van Oord Offshore B.V. (BOVO). January 19,2018.
12. Elzenga J (2020). RE: Rock for Nord Stream 2 Project from Skogsmora quarry - Anno Domini 2018 & 2019. E-mail notification from Boskalis to Nord Stream 2 Project. Sent February 24, 2020.
13. W-SU-OFP-PFI-STG-800-CONPCSEN-03. Nord Stream 2. Construction and Post Construction Surveys. Finnish Exclusive Economic Zone. October 3, 2017.
14. 800-961-PE-EIA-PFI-EMA-180326EN. Nord Stream 2: General Implementation Plan for Rock Placement, Munitions Clearance and Mattress Installation in the Finnish EEZ. Notification to the Finnish Border Guard and Finnish Transport Agency. March 26, 2018.
15. 800-961-PE-EIA-PFI-EMA-180921EN. Nord Stream 2: Second amendment to the General Implementation Plan for rock placement, munitions clearance and mattress installation in the Finnish EEZ. Notification to the Finnish Border Guard and Finnish Transport Agency. September 21, 2018.
16. W-PE-EMO-PFI-REP-892-ANNREPEN-08. Nord Stream 2. Annual Monitoring report 2018. Sitowise. October 21, 2019.
17. W-OF-RDU-POF-CRB-830-ASBREGEN-15. Nord Stream 2. As-Built Register, Rock Placement Works. Boskalis Offshore Contracting B.V. & Van Oord Offshore B.V. (BOVO). December 16, 2019.
18. W-PE-EMO-PFI-RQU-892-RQU120EN-04. Nord Stream 2 Natural Gas Pipeline construction and operation in the Finnish EEZ. Environmental and Technical Monitoring. Quarterly Report Q1 2020. Sitowise. June 8, 2020.
19. W-PE-EMO-PFI-RQU-892-RQU220EN-03. Nord Stream 2 Natural Gas Pipeline construction and operation in the Finnish EEZ. Environmental and Technical Monitoring. Quarterly Report Q2 2020. Sitowise. September 7, 2020.
20. W-PE-EMO-PFI-REP-892-AR2019-08. Nord Stream 2 Natural Gas Pipeline construction and operation in the Finnish EEZ. Environmental and Technical Monitoring. Annual monitoring Report 2019. Sitowise. May 26, 2020.
21. W-OF-RDU-POF-CRB-830-ASBREGEN-21. Nord Stream 2. As-Built Register, Rock Placement Works. Boskalis Offshore Contracting B.V. & Van Oord Offshore B.V. (BOVO). June 25, 2020.
22. W-PE-EIA-PFI-PER-999-WATREPEN-02. Water Permit Application for the Nord Stream 2 Project to the Southern Finland Regional State Administrative Agency. September 19, 2017.
23. Chidlow R (2020). RE: Rock volumes at the crossing with NSP1 in Finland. E-mail from Chidlow to DeLuca. Internal correspondence of Nord Stream 2 Project. March 10, 2020.
24. W-SU-CRO-GEN-REP-800-UNKNOWEN-03. Cables in Finland: Unknown Owners. Surveys and Confirmation Status: Out-of-Use. Nord Stream 2. December 18, 2017.

25. W-OF-PLA-POF-PRO-850-PROM01EN-05. Nord Stream 2. Pipelay and Associated Works. Mattress Installation Procedure – Oceanic. Allseas Group S. A. June 25, 2018.
26. W-OF-PLA-POF-DPR-800-18115OC-01. Nord Stream 2. Oceanic (Nord Stream 2 Project Rep WSR8) - Mattress Installation Campaign. E-mail from Duncan Rae and Matt O'Mahony. October 25, 2018.
27. W-EN-OFP-POF-MTO-804-D70123EN-04. Nord Stream 2 Offshore Pipeline Detail Design. Saipem. August 29, 2018.
28. Lilaco Offshore Ltd (2019a). Matinkylä – Kagumae, Route Elisa Finest. Daily ship progress report 02, November 24, 2019.
29. Lilaco Offshore Ltd (2019b). Matinkylä – Kagumae, Route Elisa Finest. Daily ship progress report 03, November 25, 2019.
30. Eastern Light (2019). Eastern Light dark fiber build-out. https://easternlight.se/build-out/. Accessed March 29, 2019.
31. 800-961-PE-EIA-PFI-EMA-200327EN. Minor route deviations and additional berm. Notification to the ELY Centres Uusimaa, Southwest Finland and Southeast Finland. March 27, 2020
32. 800-961-PE-PER-PFI-LET-200625EN. Consent to Exploit Finland's Exclusive Economic Zone TEM/1810/08.08.01/2017, 5 April 2018: Permit Provision 16, Completion of Construction. Notification to Ministry of Economic Affairs and Employment. June 25, 2020.
33. 800-961-PE-PER-PFI-LET-200703EN. Consent to Exploit the Finnish Exclusive Economic Zone TEM/1810/08.08.01/2017, 5 April 2018: Permit Provision 17, Delivery of As-laid Pipeline Coordinates. Notification to authorities. July 3, 2020.
34. 800-961-PE-PER-PFI-LET-200707EN. Decision No 53/2018/2, register number ESAVI/9101/2017 by the Southern Finland Regional State Administrative Agency, Permit Provision 45, Completion of Construction of the Nord Stream 2 Project in the Finnish EEZ. Notification to authorities. July 8, 2020.
35. B-OF-POL-PFI-REP-850-ASL011EN-01. As-laid Survey (MOCV Fortitude), Line B, Finland, GKP 219.032 to GKP 260.638 (FKP 105.000 to FKP 146.606). Allseas Group S. A. August 7, 2019.
36. INC-SOL-407010-06. Incident reporting – Investigation report Solitaire. Incident date 2018-10-22. Allseas Group S.A. February 18, 2019.
37. 800-961-PE-EIA-PFI-EMA-200720EN. General Implementation plan for Nord Stream 2 Post Construction Survey over a 20 km section in the Finnish EEZ. Notification to authorities. July 20, 2020.
38. Finnish Meteorological Institute (2020). 2020 – warmest year since Finland started keeping records. FMI Press release January 12.1.2021. https://en.ilmatieteenlaitos.fi/press-release/3j2EOkB0jThiRSUOo7Gj37. Accessed February 10, 2021.
39. Finnish Meteorological Institute (2012). Tilastoja Suomen ilmastosta 1981-2010. (Finnish weather statistics 1981-2010). Ilmatieteen laitoksen raportteja 2012:1.
40. Finnish Meteorological Institute. Open data. www.ilmatieteenlaitos.fi
41. Finnish Meteorological Institute (2020). Kaikkien aikojen leudoin jäätalvi 2019–2020 (The mildest ice winter of all time in 2019-2020). https://www.ilmatieteenlaitos.fi/jaatalvi-2019-2020. Accessed February 10, 2021.
42. EU Copernicus /42/ ESA Copernicus Sentinel Data.
43. W-PE-EIA-PFI-REP-812-FINBESEN-04. Environmental Baseline Surveys in the Finnish Exclusive Economic Zone. Luode Consulting. October 21, 2016.
44. Ministry of the Environment (2015). Ministry of the Environment guidelines on sediment dredging and deposition (2015). Ympäristöhallinnon ohjeita 1/2015. 72 pp.

45. W-PE-EMS-PFI-REP-812-WQLT01EN-05. Water quality and current monitoring in the Gulf of Finland. Long-term monitoring. Luode Consulting. September 17, 2020.
46. SYKE (2018). Suomen meriympäristön tila 2018 (State of the marine environment in Finland 2018). Korpinen S, Laamanen M, Suomela J, Paavilainen P, Lahtinen T. Ekebom J (eds.). 248 pp. SYKE Publications 4.
47. HELCOM (2013). HELCOM Copenhagen Ministerial Declaration: Taking Further Action to Implement the Baltic Sea Action Plan - Reaching Good Environmental Status for a healthy Baltic Sea. Copenhagen, Denmark. October 3, 2013.
48. HELCOM (2018). State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016. Baltic Sea Environment Proceedings 155.
49. BIAS (2016). The BIAS Project. https://biasproject.wordpress.com. Accessed January 24, 2020.
50. ICES (2018). HELCOM registry of impulsive events. http://ices.dk/marine-data/data-portals/Pages/underwater-noise.aspx
51. BIAS (2017). BIAS Layman's report. https://biasproject.files.wordpress.com /2017/01/bias_laymansreport_v7.pdf. Accessed January 25, 2020.
52. Thrush SF, Hewitt JE, Cummings VJ, Dayton P (1998). Disturbance of the Marine Benthic Habitat by Commercial Fishing: Impacts at the Scale of the Fishery. Ecological Applications 8(3):866-879.
53. Teilmann J, Galatius A, Sveegaard S (2017). Marine mammals in the Baltic Sea in relation to the Nord Stream 2 Project. - Baseline report. Aarhus University, DCE – Danish Centre for Environment and Energy, 52 pp. Scientific Report from DCE – Danish Centre for Environment and Energy No. 236.
54. Anon (2016). ASCOBANS. Recovery Plan for Baltic Harbour Porpoises (Jastarnia Plan).
55. SAMBAH (2016) Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise (SAMBAH). Final report under the LIFE+ project LIFE08 NAT/S/000261. Kolmårdens Djurpark AB, Sweden. 81 p.
56. Miettinen M, Halkka A, Högmander J, Keränen S, Mäkinen A, Nordström M, Nummelin J, Soikkeli M (2005). The ringed seal in the Archipelago Sea, SW Finland: population size and surveys techniques. International conference on Baltic seals. Helsinki, Finland. February 15–18, 2005.
57. Nord Stream 2 AG (2018). Telemetry Studies of the Baltic ringed seals in the Gulf of Finland. Nord Stream AG, October 2018.
58. W-PE-EIA-OFR-REP-999-INTR19EN-01. Ringed seal telemetry in the Gulf of Finland. Technical report. Pro Mare MTÜ and St. Petersburg Scientific Centre of the Russian Academy of Sciences. Interim report 2019.
59. HELCOM (2016). Population trends and abundance of seals. HELCOM core indicator report. January 2016.
60. Ministry of Agriculture and Forestry 2018. Decree of the Ministry of Agriculture and Forestry on hunting of grey seal under the regional quota during the hunting year 2018–2019. Collection of Finnish legislation 587/2018. July 31, 2018.
61. Ministry of Agriculture and Forestry 2019. Decree of the Ministry of Agriculture and Forestry on hunting of grey seal under the regional quota during the hunting years 2019–2022. Collection of Finnish legislation 897/2019. July 15, 2019.
62. W-PE-EIA-PFI-REP-805-032200EN-10. Nord Stream 2. A Natural Gas Pipeline through the Baltic Sea. Updated Project Description and Offshore Impact Assessments. Ramboll. February 21, 2018.
63. Finnish Government (2018). Valtioneuvoston päätös Euroopan unionin Natura 2000-verkoston Suomen ehdotuksen ja ilmoituksen täydentämisestä sekä Natura 2000 –alueiden tietojen tarkistuksista. (Government decision to supplement the Finnish proposal and notification of the

Natura 2000 network of the European Union and to revise the information on Natura 2000 sites). December 5, 2018.

64. Ministry of Environment (2019). Luonnokset asetuksista koskien Uudellemaalle perustettavia valtion luonnonsuojelualueita. Lausuntopyynnön diaarinumero VN/5011/2018. Draft regulations concerning state nature reserves to be established in Uusimaa. Request referral number VN/5011/2018. January 17, 2019.
65. W-SU-UXO-PFI-REP-831-FMASWNEN-01. Munitions clearance Finnish EEZ, Field Report 001, Anti-Submarine Net, Verification Survey. ARK-Sukellus, Rami Kokko July 10, 2018.
66. LUKE (2020). Natural Resources Institute Finland. Commercial marine fishery in Finland. https://stat.luke.fi/kala-ja-riista. Accessed March 3, 2020.
67. LUKE (2019). Natural Resources Institute Finland. Commercial marine fishery in Finland. https://stat.luke.fi/kala-ja-riista. Accessed April 10, 2019.
68. Vesikartta-application. http://paikkatieto.ymparisto.fi/vesikartta. Updated ecological classification of Finnish waters. SYKE and ELY Centres. Accessed March 23, 2020.
69. G-PE-EMS-MON-100-0306ENG-B. Nord Stream gas pipeline construction in the Finnish EEZ. Environmental monitoring 2010. Annual report. Ramboll. 2011.
70. W-PE-EMS-PFI-REP-812-WQCR01EN-05. Water quality and current monitoring in the Gulf of Finland. April – September 2018, Luode Consulting Oy. January 14, 2019.
71. W-PE-EMS-PFI-REP-812-SEDTOXEN-03. Results of sediment toxicity analysis for targets R-R08-5261 and R-R09-7495. Luode Consulting. September 26, 2018.
72. W-PE-EIA-PFI-REP-999-MBYM00EN-08. Nord Stream 2. Munitions clearance. Environmental impacts on Munition by Munition basis. Finnish EEZ. ACRB. July 25, 2018.
73. W-PE-EIA-PFI-REP-805-030600EN-06. Nord Stream 2. Underwater noise modelling, Finland. Ramboll. December 7, 2016.
74. W-PE-EIA-PFI-REP-805-031700EN-06. Nord Stream 2. Natura 2000 Underwater noise modelling, Finland. Ramboll. September 27, 2017.
75. Monitoring of Grey Seals in Kallbådan Seal Reserve in 2018-2020. Antti Below, Metsähallitus 2021.
76. W-PE-EMO-PFI-SPE-961-METSTAEN-01. Statement regarding the monitoring of the Kallbådan Seal Reserve in Kirkkonummi in 2018. Antti Below, Metsähallitus 2019.
77. W-SU-DET-POF-REP-808-CHO001EN-01. Cultural heritage object inspection report S-R05-07978. MMT Sweden. May 2018.
78. W-SU-DET-POF-REP-808-WRK014EN-03. Cultural heritage target inspection S-R09-09806 and SD-ALT1-3372. MMT Sweden. November 2016.
79. A-OF-POL-PFI-REP-850-ASL003EN-02. Nord Stream 2. As-laid Survey (OCV Oceanic), Finland Line A, GKP123.796 to GKP165.796 (FKP10.000 to FKP52.000). Allseas Group S. A. January 11, 2019.
80. B-OF-POL-PFI-REP-850-ASL013EN-02. As-laid survey (CSV Normand Poseidon), Finland Line B, GKP 114.032 to GKP 164.032 (FKP 0.00 to FKP 50.000). Allseas Group S. A. December 2, 2019.
81. A-OF-POL-PFI-REP-850-ASL008EN-02 Nord Stream 2. As-laid Survey (OCV Oceanic), Finland Line A, GKP413.796 TO GKP488.104 (FKP300.000 TO FKP374.308). Allseas Group S. A. September 9, 2019.
82. B-OF-POL-PFI-REP-850-ASL117EN-01. As-laid survey (MOCV Fortitude), Finland Line B, GKP 419.032 TO GKP 487.943 (FKP 305.000 TO FKP 373.911). Allseas Group S. A. June 9, 2019.
83. B-OF-POL-PFI-REP-850-ASL012EN-02. As-laid Survey (MOCV Fortitude), Line B, Finland, GKP 164.032 to GKP 219.032 (FKP 50.000 to FKP 105.000). Allseas Group S. A. October 16, 2019.
84. B-OF-POL-PFI-REP-850-ASL120EN-01. As-laid Survey (MOCV Fortitude), Line B, Finland, GKP 334.032 to GKP 419.032 (FKP 220.000 to FKP 305.000). Allseas Group S. A. July 1, 2019.

85. Finnish Transport Infrastructure Agency (FTA) (2020). Fairway database, downloaded from WFS on February 18, 2020. https://julkinen.liikennevirasto.fi/inspirepalvelu/avoin/wfs?request=getcapabilities
86. A-OF-POL-PFI-REP-850-ASL119EN-01. Nord Stream 2. As-laid Survey (OCV Oceanic), Finland Line A, GKP113.796 TO GKP123.796 (FKP0.000 TO FKP10.000). Allseas Group S. A. September 9, 2019.
87. W-PE-EIA-PFI-PER-999-REJWPAEN-01. Rejoinder to the statements issued in the Water Permit application. February 22, 2018.
88. W-PE-EIA-PFI-REP-805-032000EN-05 Natura assessment for Natura site Sea Area South of Sandkallan, Porvoo (FI0100106). Ramboll. September 4, 2017.
89. W-PE-EIA-PFI-REP-805-033300EN-02. Nord Stream 2. Statement on the changes in assessments after the submission of permit applications. Ramboll. January 19, 2018.
90. W-PE-EIA-PFI-REP-805-031400EN-08. Natura assessment for Natura site Kallbådan Islets and Waters (FI0100089). Ramboll. September 5, 2017.
91. W-PE-EIA-PFI-REP-805-DCE020EN-05. Nord Stream 2. Marine mammals in Finnish, Russian and Estonian waters in relation to the Nord Stream 2 Project – Expert assessment. DCE/Institute for Bioscience, Aarhus University March 2016.
92. G-PE-EIA-REP-000-MRMCLFIE-B. Nord Stream munitions clearance in the Finnish EEZ. Final monitoring results on Munition by munition basis. Witteween + Bos. January 31, 2011.
93. Nord Stream 2 AG (2018). Notification to Fishermen on July 26, 2018.
94. 800-961-PE-EIA-PFI-EMA-201020EN. Nord Stream 2: Maintenance rock placement at one berm in the Finnish EEZ. Notification to authorities. October 20, 2020.
95. C-OP-PER-MON-100-032019EN-A. Nord Stream Gas Pipeline operation in the Finnish EEZ – Environmental monitoring 2018 Annual report. Ramboll 2019.

Maps and GIS data

Background admiralty charts, 2018. Charts are not to be used for navigation. © Crown Copyright and/or database rights. Unauthorized copying prohibited. Reproduced in Sitowise Oy by permission of the Controller of Her Majesty's Stationery Office and the UK Hydrographic Office (*www.GOV.uk/UKHO*) and Bundesamt für Seeschifffahrt und Hydrographie (BSH). Other copyright holders include Finnish Transport Infrastructure Agency, Department of Navigation and Oceanography of the Ministry of Defence of the Russian Federation, and Estonian Maritime Administration.

Baltic Sea Hydrographic Commission, 2013, Baltic Sea Bathymetry Database version 0.9.3. Downloaded from http://data.bshc.pro/ 2018.

European Environmental Agency (EEA) 2018. Natura 2000 sites. © Directorate-General for the Environment (DG ENV).

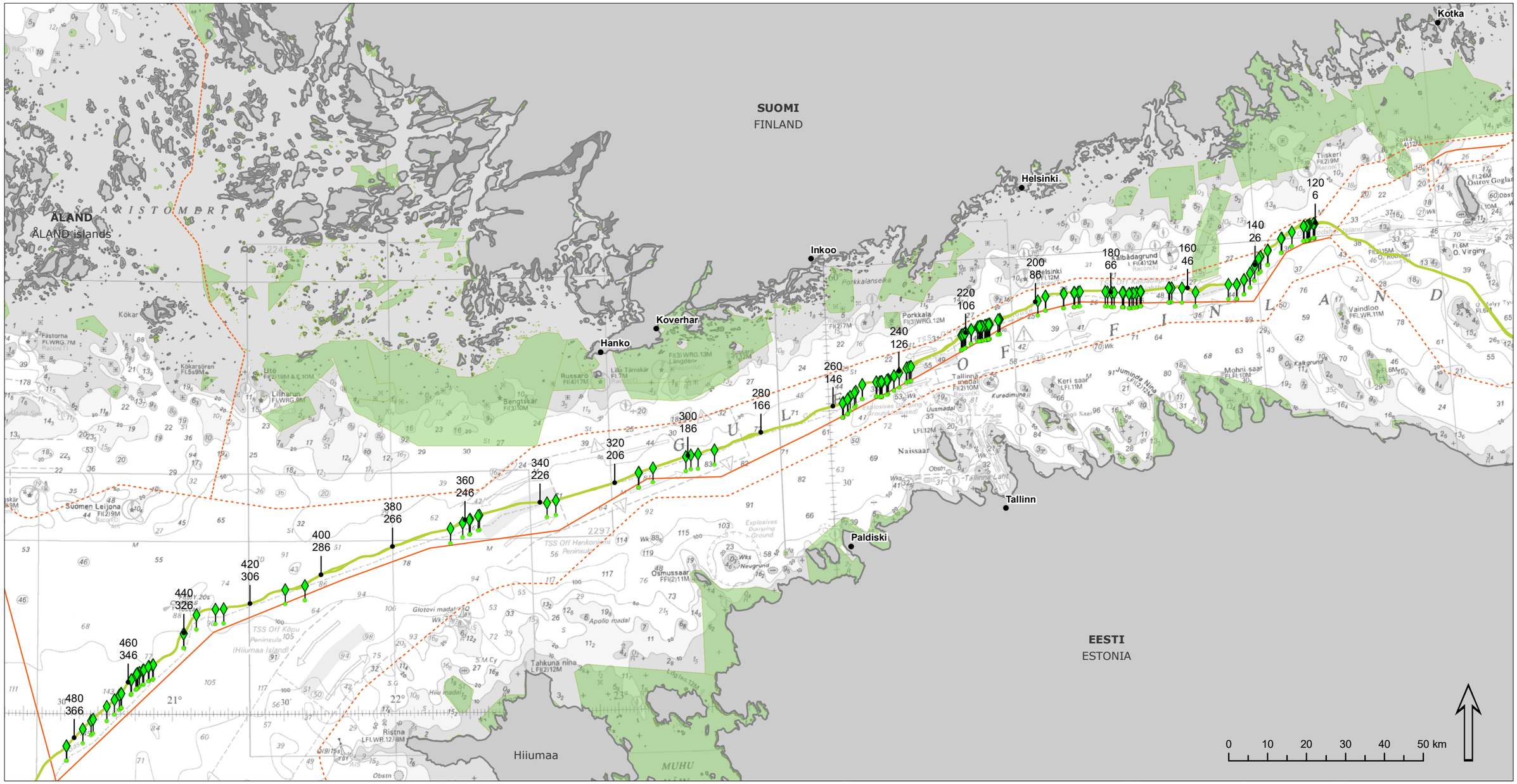
Finnish Environmental Institute (SYKE) 2018. Natura 2000 sites.

HELCOM 2018b. PLC Subbasins.

International Boundaries Research Unit (IBRU) 2010. Borders of Exclusive Economic Zones and Territorial Waters.

Finnish Transport Infrastructure Agency (FTA) 2020. Fairway database, downloaded from WFS on February 18, 2020. https://julkinen.liikennevirasto.fi/inspirepalvelu/avoin/wfs?request=getcapabilities

ANNEX 1



Nord Stream 2 Construction activities in 2020

Rock placement

- Post-lay

Reference data

- NSP2 Route
- Territorial water border
- Åland border
- EEZ border
- GKP / FKP — Global and Finnish kilometre point
- Natura 2000 site (coastal and offshore areas)

References:
- Limits of Exclusive Economic Zones and Territorial Waters: IBRU May 2010
- Background sea charts are "Not to be used for navigation"
- Background sea chart; © Crown Copyright and/or database rights. Unauthorized copying prohibited. See further copyright descrpition in the report.
- Natura 2000 sites. EEA and SYKE 2019.

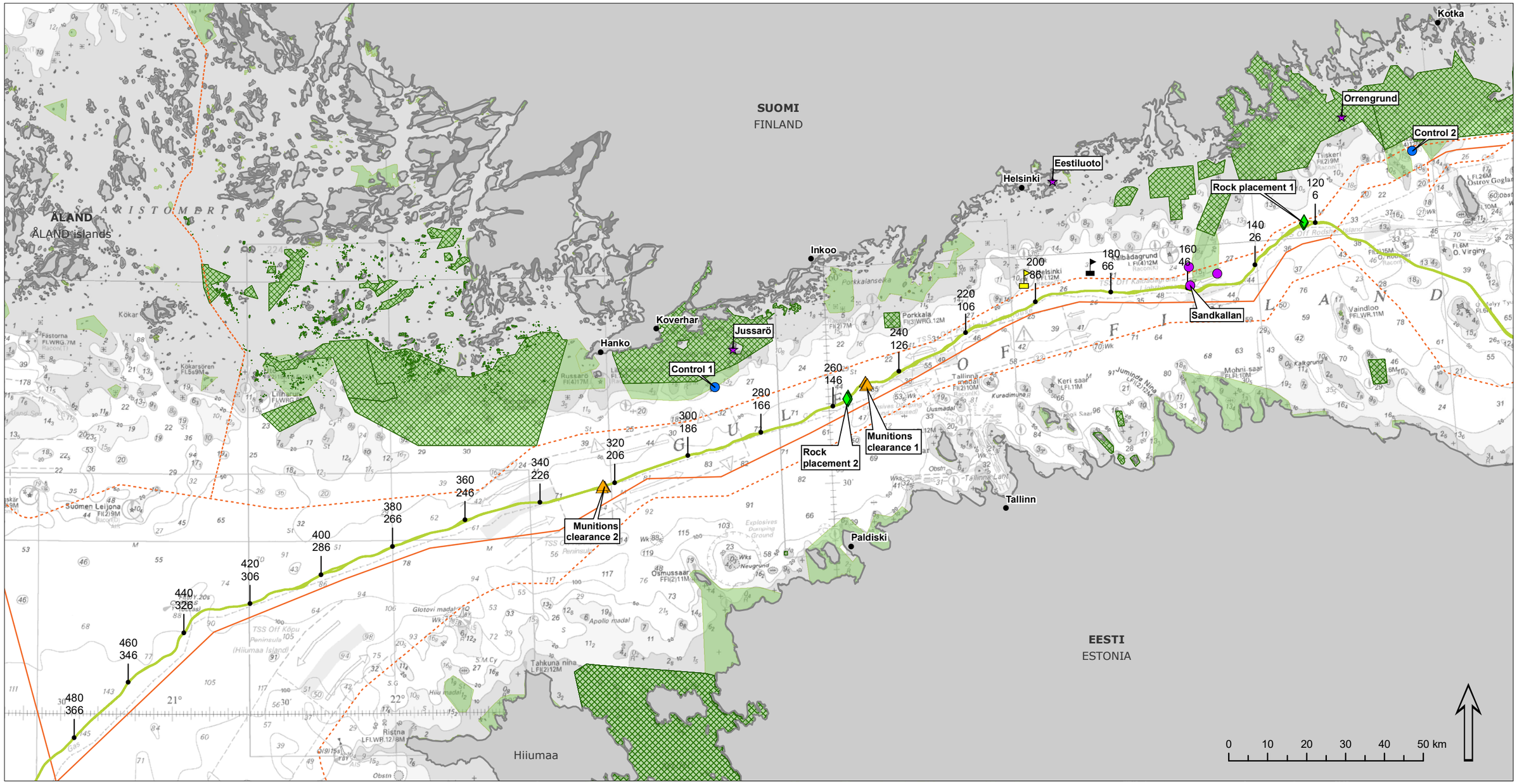
Annex 1

Version: 2020 Annual report EN ver1
Code: W-PE-EMO-PFI-REP-892-AR2020EN-01
Date: 2.11.2020
Prepared: Antti Kinnunen
Controlled: Sanna Vaalgamaa

Construction activities in 2020

SITOWISE

ANNEX 2



Nord Stream 2 Environmental monitoring stations 2018-2020

Water quality monitoring

- Long term monitoring 2018-2020
- Long-term monitoring 2018-2019
- Short-term monitoring (munitions clearance) 2018
- Short term monitoring (rock placement) 2018

FMI monitoring stations

- Meteorological station
- Wave data
- Wind data

Reference data

- NSP2 Route
- Territorial water border
- Åland border
- EEZ border
- GKP / FKP — Global and Finnish kilometre point
- Natura 2000 site designated for seals
- Natura 2000 site (coastal and offshore areas)

References:
- Limits of Exclusive Economic Zones and Territorial Waters: IBRU May 2010
- Background sea charts are "Not to be used for navigation"
- Background sea chart; © Crown Copyright and/or database rights. Unauthorized copying prohibited. See further copyright descrpition in the report.
- Natura 2000 sites. EEA and SYKE 2019.

Annex 2

Version: 2020 Annual report EN ver1
Code: W-PE-EMO-PFI-REP-892-AR2020EN-01
Date: 2.11.2020
Prepared: Antti Kinnunen
Controlled: Sanna Vaalgamaa

Environmental monitoring stations 2018-2020

SITOWISE