



Nord Stream AG

# Offshore pipeline through the Baltic Sea

Details on the area in Sweden close to the Swedish/Finnish EEZ

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### **Appendix**

Appendix 1: Alignment sheet



# 1. The area inside Sweden close to the Swedish/Finnish EEZ

## 1.1 Definition of area

The area inside Sweden close to the Swedish/Finnish EEZ where transboundary impacts to Finland may occur from construction activities is shown on Figure 1.1. The area where transboundary impacts into Finnish EEZ may occur is based on the results of sediment dispersion and re-sedimentation from ref. /1/.

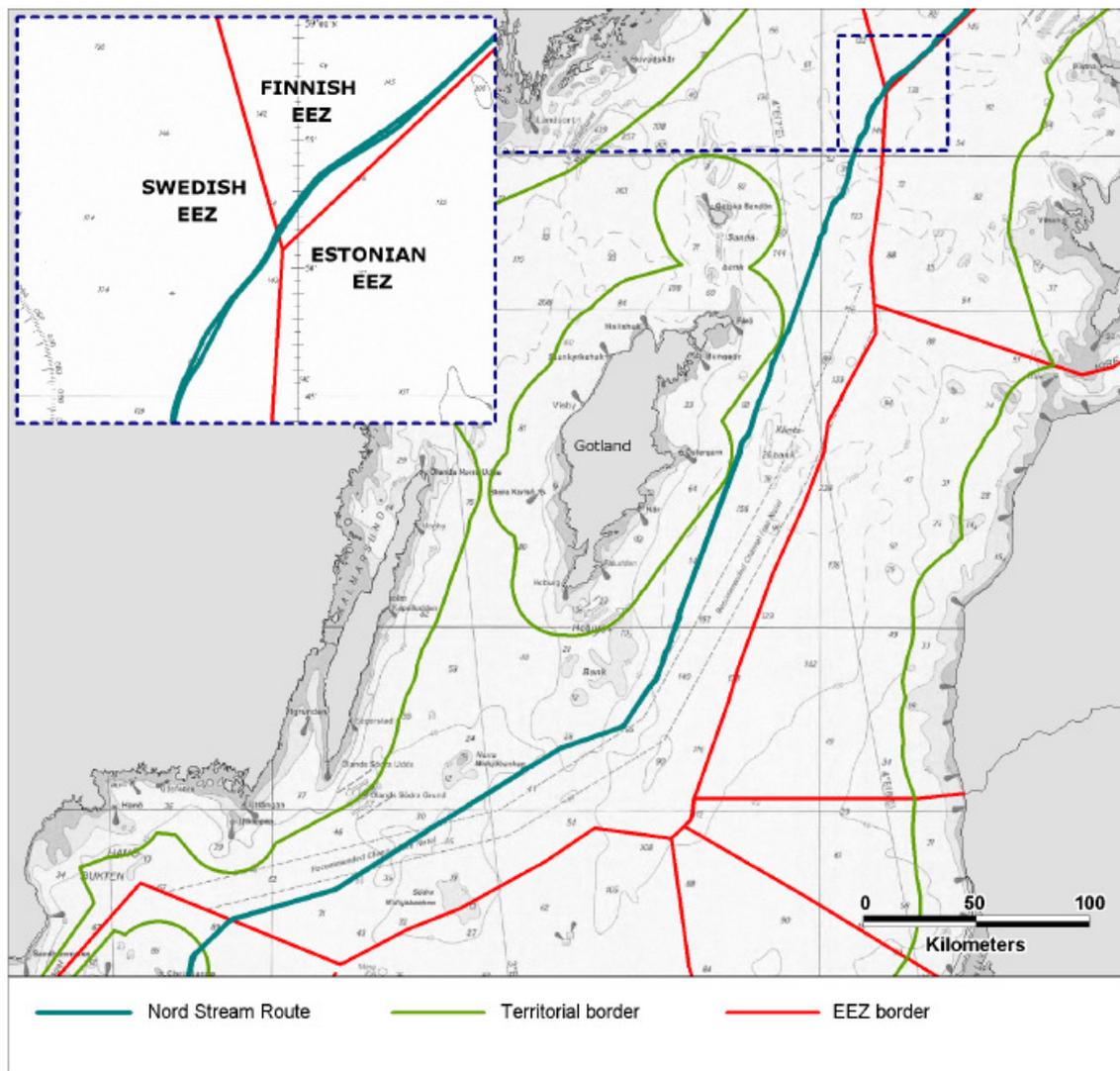


Figure 1.1 Area inside Sweden close to the Swedish/Finnish EEZ where transboundary impacts from construction activities is evaluated

## 1.2 Construction activities inside Swedish EEZ

The construction activities within the Swedish EEZ close to the Swedish/Finnish EEZ border include the following activities:

- Pipe lay of both pipelines (Line 1 and Line 2) directly on the seabed, using an anchored lay barge.
- Rock placement for Line 2 at location KP 499.94 km and at location KP 499.99 km, approximately 1.7 km from the Swedish/Finnish EEZ border.

There will be no rock placement for Line 1 close (<25 km) to the Swedish/Finnish EEZ. Rock placement for Line 1 will therefore have no transboundary impacts inside Finnish EEZ.

The rock placement locations for Line 2, the amount of rocks to be used, soil type and approximate water depth are shown in Table 1.1.

**Table 1.1** Locations close to Swedish/Finnish EEZ border where rock placement is carried out for Line 2.

Location (km)	Rock placement (Amount m <sup>3</sup> )	Soil type	Depth (m)
KP 499.94	4,400	Very soft clay	Approximately 175
KP 499.99	4,200	Very soft clay	Approximately 175

Transboundary impacts may result from sediment dispersion and re-sedimentation from the following activities:

- Pipe lay of the pipelines direct on the seabed.
- Anchor handling during pipe lay.
- Rock placement at the two locations.

Transboundary impacts from noise during construction will be insignificant and will not be evaluated further.

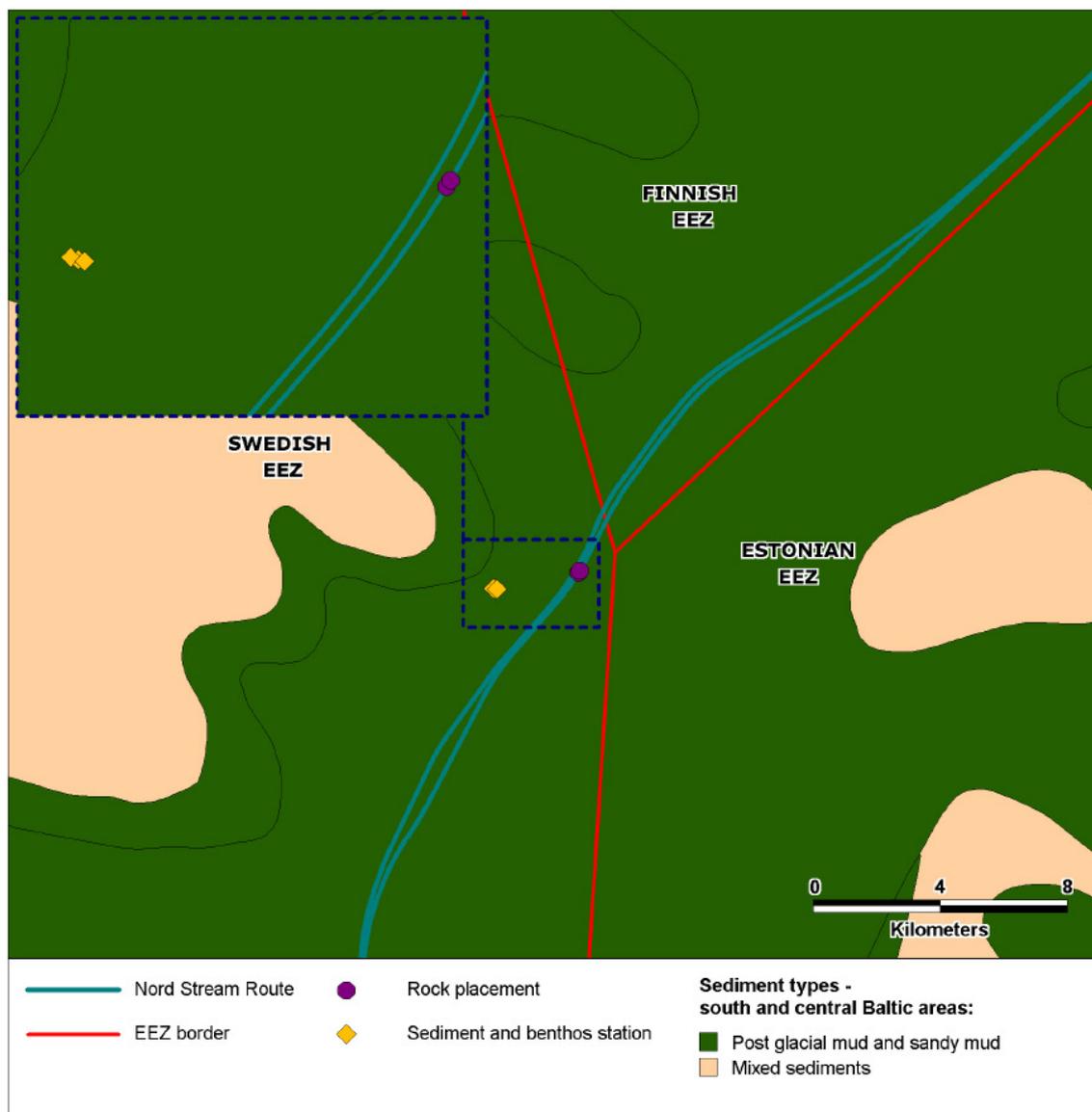
## 1.3 Baseline data of the environment

The depth profile of the seabed in the area close to the Swedish/Finnish EEZ is varying from approximately 170 – 200 m depth (up to 5 km from the Swedish/Finnish EEZ).

In the northern part of the pipeline route inside Swedish EEZ no benthic fauna was detected during the Nord Stream survey that was carried out by the Geological Survey of Sweden (SGU) in 2007. Further hydrogen sulphide H<sub>2</sub>S odour was observed from the sediment samples indicating low oxygen content (anoxic conditions) at the seabed sampling sites.

It is assessed that this situation – with no benthic fauna – also applies for the Finnish part near the Swedish/Finnish EEZ at water depths from 170 – 200 metres.

Figure 1.2 shows the two locations where rock placement will be carried out near the Swedish/Finnish EEZ border. The sediment and benthos sampling station (3 sub-stations) from the Nord Stream survey carried out by SGU in 2007 is also shown on Figure 1.1. Due to the close proximity of the two rock placement locations and the three sediment/benthos sub-stations, one single marking in the map indicates these locations/stations.



**Figure 1.2** Two rock placement locations approximately 1.7 km from the Swedish/Finnish EEZ border for Line 2 inside Swedish EEZ, and the sediment and benthos sampling station (3 sub-stations) from the SGU survey in 2007.

The mean concentration of contaminants and nutrients (Total-N and Total-P) in surface sediment from the sediment sampling station (results from three sub-stations) shown on Figure 1.1, is shown in Table 1.2.

**Table 1.2** The mean concentration of contaminants and nutrients in surface sediment from the sediment sampling station (results from three sub-stations).

Substance	Unit	Mean
<b>Heavy metals</b>		
Arsenic (As)	mg/kg DW	24.1
Cadmium (Cd)	mg/kg DW	4.0
Cobalt (Co)	mg/kg DW	19.3
Chrome (Cr)	mg/kg DW	47.7
Copper (Cu)	mg/kg DW	106
Mercury (Hg)	mg/kg DW	0.13
Mangane (Mn)	mg/kg DW	1115
Nickel (Ni)	mg/kg DW	79.3
Lead (Pb)	mg/kg DW	39.9
Vanadium (V)	mg/kg DW	139
Zinc (Zn)	mg/kg DW	516
<b>Nutrients</b>		
N-total	mg/kg DW	9447
P-total	mg/kg DW	1133
<b>Organic contaminants</b>		
SUM PAH (16 EPA PAH)	mg/kg DW	2.09
SUM 7 PCB	µg/kg DW	4.21
Hexachlorobenzene	µg/kg DW	0.14
SUM HCH	µg/kg DW	<0.44
SUM DDT	µg/kg DW	<1.98
SUM chlordane	µg/kg DW	<0.21

The geological conditions inside Sweden close to the Finnish EEZ are shown on the detailed survey alignment sheet presented in Appendix 1. The alignment sheet presents the data collected during the detailed geophysical survey campaign. The bathymetry is shown together with an overview of the seabed sediment types. Seismic profiles for both route alignments show the geological layering to a depth of 30 m below the seabed surface. Slopes along the pipeline route are calculated and indicated in the alignment sheet. In the area the seabed surface mainly consist of soft clay with patches of coarser sediments and the layers below consists of soft clay overlain on coarser sediments. Water depths range from 170 m to 200 m.

#### 1.4 Transboundary impact assessment

The area in the vicinity of the Swedish / Finnish EEZ border is devoid of life on the seabed due to the water depths between 170 m and 200 m and the prevalent conditions. Benthic fauna are only expected to be found in waters with sufficient oxygen and are therefore usually found in shallower water (less than 60 to 80 m deep). The below described intervention works need to be considered in this context.

Disturbance of the seabed has been evaluated and described in ref. /2/. It is assessed that only the uppermost centimetres of the sediment will be brought into suspension during rock placement, as the rock placement will be carried out with a fall pipe only a metre/few metres above the seabed /2/.

The material used for rock placement is very coarse and it is anticipated that any sediment spill from rock placement activities will be related to suspension of the natural sediment due to the induced momentum of the placed rock material. The material will be placed via a fall pipe in order to fulfil construction requirements (accurate placement). The rock will consequently not fall freely through the water column, and consequently the induced momentum is reduced.

Dedicated modelling has been carried out for the two rock placements. The total release of sediment resulting from the two rock placement sites is estimated to be respectively 61,1 tonnes and 58,4 tonnes equivalent to a total of 119,5 tonnes.

Model results shows that the maximum sedimentation due to rock placement at the two sites is causing sedimentation of maximum  $0.74 \text{ kg/m}^2$  in the very close vicinity to the rock placement locations. Consequently the effects due to construction are not causing sedimentation that exceeds  $1 \text{ mm/m}^2$  ( $\sim 1 \text{ kg/m}^2$ ).

Exceedance of sedimentation of  $0.1 \text{ kg/m}^2$  (the cumulative effect from both rock placement locations) is limited to a square of  $0.62 \text{ km} \times 0.62 \text{ km}$ , or  $0.38 \text{ km}^2$ , in the near vicinity of the two rock placement locations. More than 95 tonnes out of the 119,5 tonnes suspended sediment will re-settle within this area. In total 99,7% of the suspended material will re-settle within 1 km from the construction area.

The settling velocity of the sediment that is brought in suspension is associated with some uncertainty due to the content of organic matter. If the sediment has a lower settling velocity than anticipated it would cause the sediment to be in suspension longer and consequently be transported over a longer distance and be subject to dispersion over a larger area.

Assuming that the settling velocity was a factor 10 lower it would mean that the sediment would stay in suspension approximate 10 times longer, and be subject to two-dimensional dispersion (longitudinal and transverse dispersion). Further this would result in increase of the area ( $\text{km}^2$ ) affected and in reduction in the amount of sedimentation ( $\text{kg/m}^2$ ) by up to a factor of 100. Consequently the maximum concentration in the very close vicinity to the construction locations would be reduced from  $0.74 \text{ kg/m}^2$  to  $0.0074\text{-}0.074 \text{ kg/m}^2$ , and so would the area affected with  $0.1 \text{ kg/m}^2$  decrease from  $0.38 \text{ km}^2$  to zero.

It is in ref. /1/ described that concentrations of approximately  $10 \text{ mg/l}$  may result in avoidance reactions of fish species, as Herring. A concentration of suspended sediment of  $10 \text{ mg/l}$  is only exceeded inside an area of  $0.44 \text{ km}^2$  ( $0.21 \text{ km} \times 0.21 \text{ km}$ ). A concentration of  $1 \text{ mg/l}$  is calculated not to exceed a radius of 500 m from the rock placement locations.

The total amount of sediment, contaminants and nutrients that is brought in suspension during rock placement at the two locations have been calculated based on mean values for the concentrations in surface sediment, and is shown in Table 1.3. Both contaminants and nutrients that are related to the pore water fraction have been included in the assessment, as the chemical analysis of the concentration of contaminants and nutrients in the sediment have included the fraction of these substances in pore water.

**Table 1.3** Total amount of heavy metals, organic contaminants and nutrients to be suspended at the two rock placement locations inside Swedish EEZ.

<b>Substance</b>	<b>Unit</b>	<b>Total amount of suspended substances (based on mean content of substances in the sediment from the sediment station located close to the two rock placement locations inside the Swedish EEZ)</b>
<b>Sediment</b>		
Sediment in suspension	Tons	119.5
<b>Heavy metals</b>		
Arsenic (As)	g	2,880
Cadmium (Cd)	g	478
Cobalt (Co)	g	2,306
Chrome (Cr)	g	5,700
Copper (Cu)	g	12,667
Mercury (Hg)	g	15.5
Mangane (Mn)	g	133,243
Nickel (Ni)	g	9,476
Lead (Pb)	g	4,768
Vanadium (V)	g	16,611
Zinc (Zn)	g	61,662
<b>Nutrients</b>		
N-total	Kg	1,129
P-total	Kg	135
<b>Organic contaminants</b>		
SUM PAH (16 EPA PAH)	g	250
SUM 7 PCB	g	0.5
Hexachlorobenzene	g	0.02
SUM HCH	g	<0.05
SUM DDT	g	<0.24
SUM chlordan	g	<0.03
	g	
Dioxin <sup>1</sup> (WHO-TEQ)	g	0.0028 – 0.0030
1: Based on data on surface sediment from sediment analysis in the central Baltic Proper (Sweden) ref. /3/ and from a Nord Stream survey along the planned pipeline route in the Gulf of Finland in 2009 ref. /4/.		

The pipe lay directly on the seabed and anchor handling during pipe lay of Line 1 and Line 2 inside the Swedish EEZ will have no significant effects, in relation to sediment dispersion, dispersion of contaminants or nutrients inside the Finnish EEZ - as calculated and evaluated in the Espoo EIA, and in the Swedish Environmental Study ref. /1/.

Rock placement at the two locations inside the Swedish EEZ, approximately 1.7 km from the Swedish/ Finnish EEZ border may, depending on the bottom current conditions, result in marginal effects (sediment dispersion and re-sedimentation) inside the Finnish EEZ. Based on the results of the mathematical modelling of sediment dispersion carried out for the Swedish Environmental Study impacts inside the Finnish EEZ will be confined to the following:

- The amount of sediment that will be brought in suspension during rock placement at the two locations has been calculated to be approximately 119.5 tons. It is assessed that the main part of sediment brought in suspension will settle in close vicinity to the rock placement locations. Only an insignificant amount of sediment is evaluated to settle inside Finnish EEZ. It is further evaluated that there will be no impacts on the benthic environment inside Finnish EEZ. Furthermore, the survey carried out by SGU in 2007 has not shown any benthic fauna inside the area near the Swedish/Finnish EEZ border.
- The duration of suspended sediment concentrations >10 mg/l is in the range of hours. Effects on the marine environment in relation to avoidance reactions of fish are not expected to occur inside the Finnish EEZ.
- Modelling has shown the amounts of contaminants and nutrients that will be suspended from rock placement at the two locations may result in concentrations where the predicted environmental concentration (PEC) of polyaromatic hydrocarbons (PAH) and copper (Cu) divided with the predicted no effect concentration (PNEC) of PAH and of copper is >1. If areas inside the Finnish EEZ is affected by PEC/PNEC concentrations >1 (for PAH and/or for copper) these areas will be of very limited extent, and the impact will be of very short duration (few hours). No impacts on the marine environment inside the Finnish EEZ are expected.
- The amounts of arsenic (As), cadmium (Cd), zinc (Zn), chrome (Cr), mercury (Hg), nickel (Ni), cobalt (Co), vanadium (V) and lead (Pb) that will be suspended from rock placement at the two locations will not result in concentrations in the water environment where the PEC/PNEC value will be >1, and therefore it is assessed that there will be no effects on the marine environment from dispersion of these metals in the Finnish EEZ.
- Further, dispersion of organic contaminants and nutrients that are brought in suspension will be of a magnitude that will have no short or long term effects on the marine environment. The main part of these substances is assessed to re-settle in the vicinity of the rock placement locations, the estimated total amounts of suspended organic contaminants and nutrients are presented in Table 1.2.

The total amount of dioxins to be suspended from seabed intervention works close to the Finnish EEZ has been calculated and shown in Table 1.3 for the two rock placement locations located approximately 1.7 km from the Swedish/Finnish EEZ. In total approximately 0.0028 - 0.0030 g WHO-TEQ dioxins is calculated to be brought in suspension at these locations close to the Swedish/Finnish EEZ. Based on the extremely low water solubility of dioxins, dioxins will adhere to sediment particles, and the main part of suspended dioxins is evaluated to re-settle in the very close vicinity of the construction activities.

## **1.5 Mitigation measures**

To address or reduce the significance of the identified potential impacts several mitigation measures have been implemented / are planned for the construction process, such as:

- Selection and optimisation of the pipeline route to minimize the need for seabed intervention works, such as rock placement.

- Application of the best available technology during rock placement to ensure the most precise placement of rocks. This is planned to be carried out by placing the rocks through a fall pipe, which brings the material down from the vessel to a position only a few metres above the seabed. Thereby suspension and spreading of sediment will be reduced to a minimum.
- Anchors are to be lifted clear of the seabed when repositioned and will not be dragged through the seabed.

## **1.6 Radionuclides**

Radionuclide concentrations in the Baltic Sea sediments derive preliminary from atmospheric fallout, partly from the atmospheric nuclear weapons testing in the 1960s ( $^{90}\text{Sr}$  and also  $^{134}\text{Cs}$ ), and partly from the Chernobyl accident in 1986 ( $^{134}\text{Cs}$ ). Also, river runoff has contributed in the case of  $^{90}\text{Sr}$  and to a lesser extent with  $^{134}\text{Cs}$  /5/.

Doses from naturally occurring radionuclides in seafood ( $^{210}\text{Po}$ ) have been calculated on a similar basis and compared with doses from man-made radionuclides accumulated via marine pathways. This comparison shows that dose rates and doses from natural radionuclides exceed those from man-made radionuclides except for the year 1986 /5/. The maximum annual dose to individuals from any critical group of humans in the Baltic Sea area during the period 1950 – 2000 is estimated to be 0.2 mSv/yr, which is below the dose limit of 1 mSv/yr for exposure of the general public set out in the Basic Safety Standards /5, 6/.

The construction activities on the seabed, including rock placement, are evaluated only at some locations to affect sediment at such depths, where the highest content of radionuclides from the Chernobyl accident in 1986 can be found. In general the amount of sediment dispersion from rock placement will be limited and spatially restricted, as described for dioxins above, to the deeper areas and close to the seabed. As the radionuclides are adsorbed to sediment particles, the main part of sediment to be suspended is assessed to re-sedimentate in the close vicinity to the construction sites. Based hereon the effects of suspended radionuclides on the marine environment are assessed to be insignificant, and is further concluded that there will not be any impacts on humans.

## **1.7 Cumulative transboundary impacts**

Cumulative impacts may be foreseen inside Swedish EEZ inside a minor area close to the two rock placement locations that is separated with a distance of approximately 50 metres, and located 1.7 km from the Swedish/Finnish EEZ.

Cumulative impacts may arise from impacts on the seabed from re-sedimentation. The area that may be affected with cumulative impacts is defined as the overlapping area that will be affected by re-sedimentation from the two rock placement locations. It is, based on modelling results, evaluated that there will be no cumulative transboundary impacts on the marine benthic environment inside the Finnish EEZ.

Further impacts from ordinary pipelay by using an anchor positioned lay vessel in combination with rock placement are evaluated not to results in cumulative transboundary

impacts inside Finnish EEZ.

## **1.8 Impacts on environmental monitoring stations in the Finnish EEZ**

Nord Stream is aware of the presence of marine monitoring stations in the Baltic Sea. Nord Stream is in consultation with the national research institutes and in the process of clarifying the details of those long-term monitoring stations that might be affected as a result of the construction works.

The aims of the HELCOM long-term monitoring programme in the Baltic Sea, are

- 1) to identify and quantify the effects of anthropogenic discharges/activities in the Baltic Sea, in the context of the natural variations in the system, and
- 2) to identify and quantify the changes in the environment as a result of regulatory actions.

Monitoring stations might be impacted by sediment spreading resulting from the construction works. However, laying the pipelines directly on the seabed will not result in any noteworthy sediment spread or re-sedimentation that would impact any of the HELCOM monitoring stations. Impacts to the water column are short term, whereas impacts on the bottom in some places will be long term:

- The impacts on the bottom directly beneath the pipelines and at localities with rock placement impacts on the bottom are long-term.
- At sites in close vicinity of intervention works (e.g. rock placement and trenching) re-sedimentation might have long-term impacts on bottom living animals and plants. Re-colonization will however begin relatively quickly, depending on factors such as location, water depth and type of sediment.

Only monitoring stations for zoobenthos sampling are relevant to the Nord Stream project, since these stations are sampled at the seabed directly, whereas the rest are sampled in the water column, where the effects are short term.

As there are no zoobenthos stations in vicinity of the pipeline in Finland or in the proximity of the Swedish / Finnish EEZ border there will be no impacts to the Helcom monitoring program in Finland.

## 2. Reference

- /1/ Nord Stream. Offshore pipelines through the Baltic Sea. Permit application. Installation of a pipeline system on the Swedish continental shelf outside the territorial waters. Environmental study. October 2008.
- /2/ Nord Stream AG. Offshore pipelines through the Baltic Sea. Memo 4.3A-5. Spreading of sediment and contaminants during works in the seabed. September 2008. GE-PE-PER-EIA-100-43A50000-D.
- /3/ Jensen, A,A.Kortlægning af dioxinforurening samt kilder til dioxinforurening i Østersøen. Miljøprojekt nr. 796. 2003. Miljøstyrelsen.
- /4/ Nord Stream. Offshore pipelines through the Baltic Sea. Environmental field study. July 2009. G-PE-PER-REP-100-03240000-04.
- /5/ Baltic Sea Environmental Proceedings No. 82B. Environment of the Baltic Sea area 1994 – 1998. 2002. HELCOM
- /6/ EC. European Council Directive 96/29/Euratom. Basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation. 1996.

# **APPENDIX 1**

## Alignment sheet