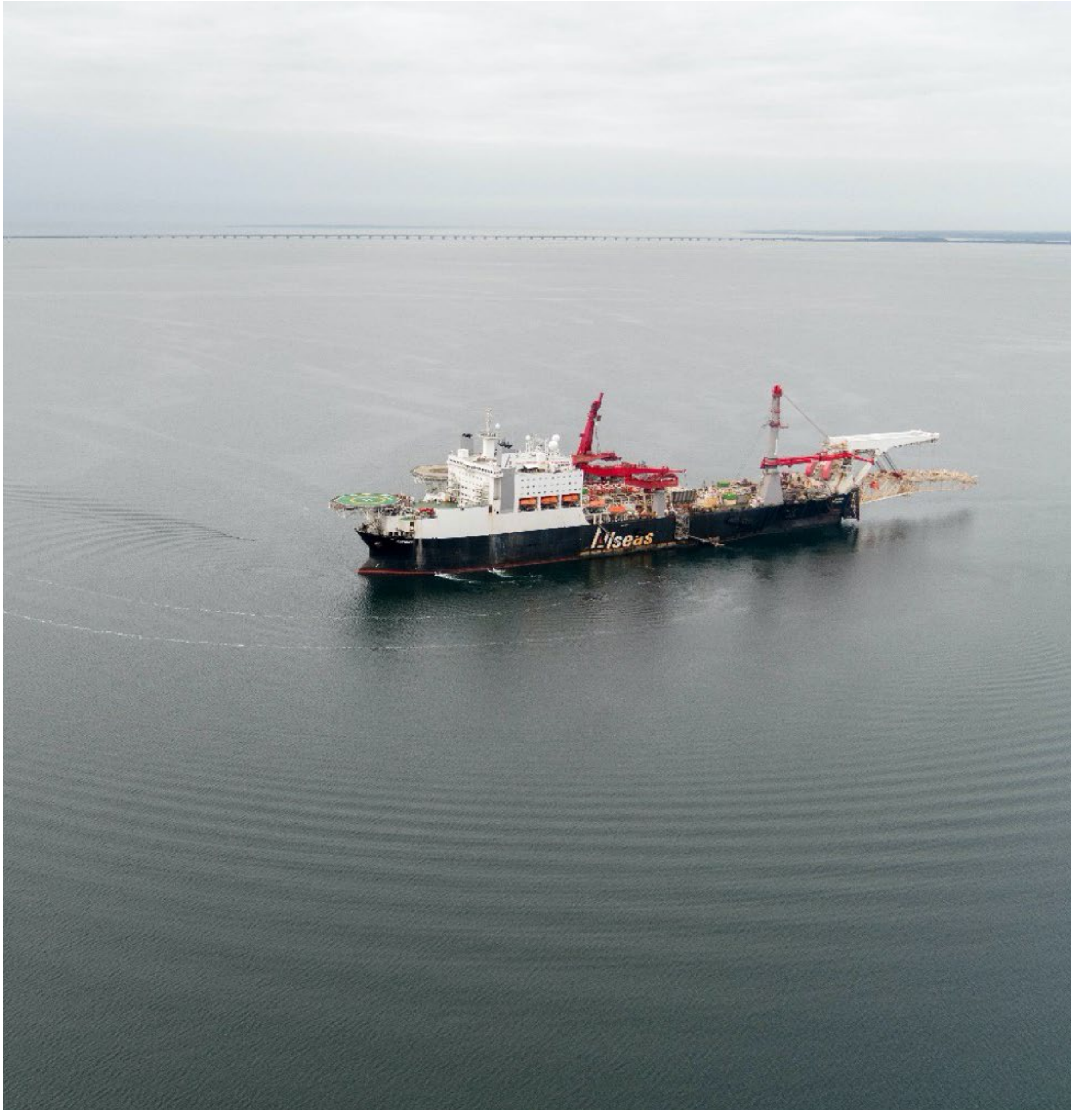
Nord Stream 2
Committed. Reliable. Safe.

Background Story: Pipeline Construction

Nord Stream 2 AG | Nov-21



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Introduction

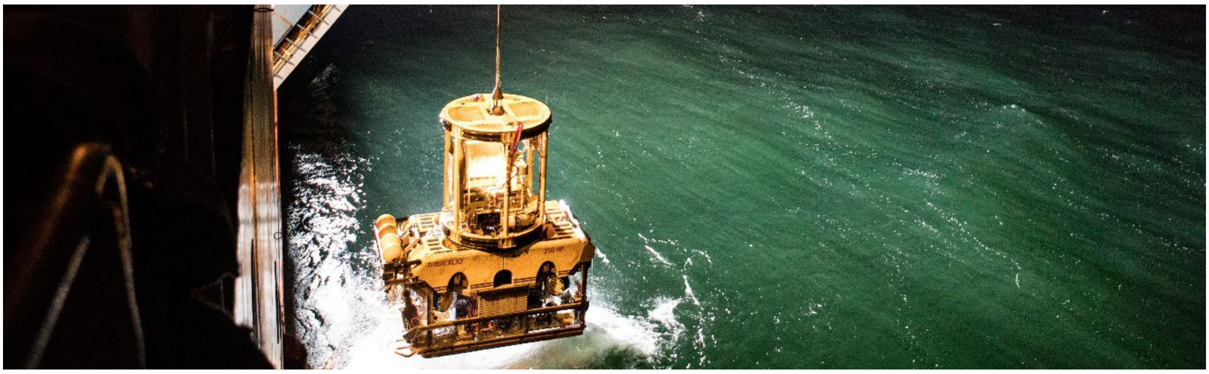
The EU's domestic gas production is in rapid decline. To meet demand, the EU needs reliable, affordable and sustainable new gas supplies. The Nord Stream 2 Pipeline will provide this by transporting gas from the world's largest reserves in Russia to the internal EU market, increasing security of supply and contributing to the objectives of the European energy policy.

With its state-of-the-art technology, the pipeline offers reliable, economic and environmentally sound natural gas supplies over the coming decades, building on the proven experience of the existing Nord Stream Pipeline system and the mutually beneficial long-term energy relationship between the EU and Russia.

The twin pipeline stretches over 1,234 kilometres through the Baltic Sea from the Russian to the German coast, running largely parallel to the existing Nord Stream Pipeline system. On each end, landfall facilities connect the system with the Russian and European networks, with the pipeline laid along the seabed in between.

Nord Stream 2 worked with some of the world's leading suppliers and applied rigorous health, safety, environmental and social standards to protect the sensitive Baltic Sea at every step of preparation and construction. All works have been carried out in compliance with national permit conditions and monitored for potential impacts on the environment and marine life.

Surveys

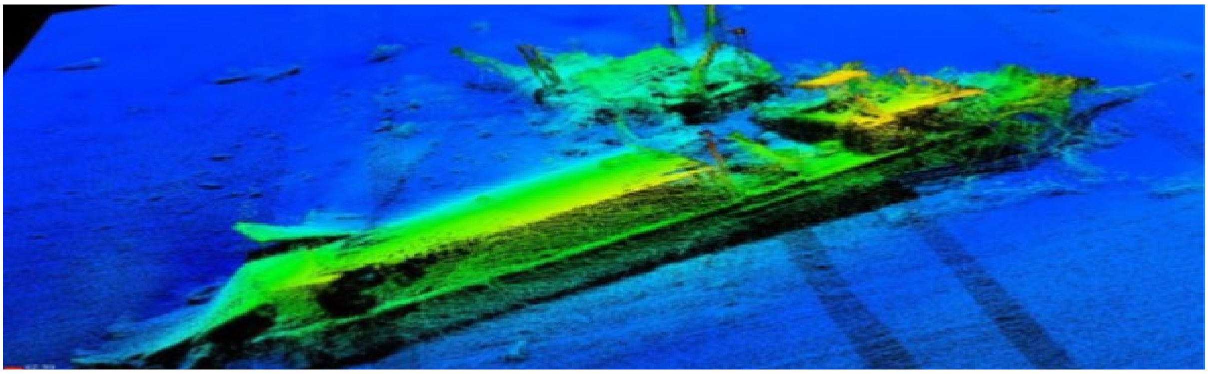


Before and during construction, Nord Stream 2 conducted thorough survey operations, which are the cornerstone of massive international infrastructure projects like an offshore pipeline. This played a pivotal role in enabling the project to move forward safely, providing critical information for engineering, route optimisation, Environmental Impact Assessments (EIA) and permitting, environmental management and monitoring, financing and insurance, quality control and operations.

By the time the project was finished, the entire Baltic Sea route from Russia to Germany was surveyed from surface to depths of more than 200 metres for around 75 000 line kilometres. To ensure a clear and safe route, every detail of the seabed shape had to be identified. This includes steep slopes, sediment types and rock outcrops, environmentally sensitive areas, water depth and any items that could affect pipeline installation and operation, from existing infrastructure to shipwrecks and unexploded ordnance (UXO).

Using the latest technology to collect some of the clearest 3-D data sets being produced today, a fleet of more than 80 high-performance vessels mapped a route that minimised the environmental impact and ensures the safe operation of the new natural gas pipeline.

Cultural Heritage



Due to the physical conditions in the Baltic Sea, the preservation of cultural heritage – objects that represent evidence of past and present human activity – is vital, and the value and scientific potential are great.

hysical disturbance of the seabed has the potential to damage cultural heritage sites or render these inaccessible for future research. The pipeline route was therefore optimised to avoid a negative impact on valuable cultural heritage sites wherever possible.

In the five countries whose waters the pipeline traverses, cultural heritage is protected by legislation. From the beginning of the planning process for the pipeline, we paid attention to the effect Nord Stream 2 might have on cultural heritage and cooperated closely with the relevant cultural heritage authorities and experts in each of these countries. In doing so, we followed the best practices used in the previously implemented Nord Stream project.

There are a large number of shipwrecks on the seabed of the Baltic Sea that reflect a diverse group of vessels. Some shipwrecks are of no archaeological interest, whereas others are unique due to their construction method, the degree of their preservation or special historical factors. Objects which are more than 100 years old are protected by legislation in the Baltic Sea Littoral States. The relevant authorities in each country may additionally decide that more recent wrecks (i.e. aircraft or ships from WWI or WWII) should also be protected.

Comprehensive surveys were conducted to identify and map features or areas of cultural heritage to be avoided or safeguarded. The mitigation measures to deal with cultural heritage finds included several aspects: avoidance, caution and salvaging finds.

To avoid interference with cultural heritage objects, a minimum buffer distance of at least 50 metres between the pipeline corridor and these objects was recommended by the experts in many countries such as Finland and Sweden. Placing pipelines at a sufficient distance from cultural heritage objects can reduce impacts. If intervention works, such as the installation of rock berms, were necessary, these were conducted with caution, and they also account for the minimum distances recommended. Any time artefacts had to be moved, Nord Stream 2 decided together with experts how to proceed: Salvaging finds and handing them over to the authorities or moving them to a safe distance from construction activities.

Russia

The route for the pipeline's Russian section, known as the Narva Bay route, runs through the area that was important for the sea trade between Russia and the West Baltic in the past. Archival evidence about numerous merchant and military ships sunken in Narva Bay confirm this.

A geophysical reconnaissance survey was carried out for the pipeline in 2015 to 2016 to gather information about anthropogenic objects on the seabed. In the corridor with a width of 1.5 kilometres, around 10 of the identified objects were classified as potential objects of cultural heritage, i.e. wrecks or wreck parts. Following this general description of the objects, further detailed marine archaeological surveys in the corridor of the planned pipeline took place in summer 2017. The purpose of the research campaign was to determine if the objects could indeed be classified as cultural heritage. Five of them were recognized as movable archaeological objects related to marine fishing and shipping. Three of them were recovered and transported to the Kingisepp Museum of History and Local Lore after field conservation. These included two horned anchors shaped by press forging and a hook, both of which were conceivably from the 19th to early 20th centuries. Another object was a water breaker with a capacity of 12 to 40 litres, which was used as reservoir storage most likely in the 18th to early 20th century. Two other objects were removed from the pipeline corridor: an admiralty anchor from as early as 1862 and a wooden capstan for a vessel from the 18th to 19th century.

Finland

In Finland, two targets of cultural historical interest were identified: an 18th century merchantman and a late 18th to early 19th century cannon barge. Two inspected Word War II targets, a cargo supply ship and an anti-submarine net installation, were also included in the list as being of historical interest and significance, even though they do not meet the over 100-year criteria as such.

Together with these sites, a total of 32 potential targets of cultural interest or potential World War II historical sites are located in an area which extends to up to 1,000 metres away from the pipeline route. In the Finnish route section, a dynamically positioned vessel was used to ensure that pipelay activities had no impact on these targets. Due to the distance of the targets to the pipeline, these targets were not further surveyed and assessed.

Sweden

No cultural heritage objects were identified in the immediate vicinity of the pipeline route in the Swedish Exclusive Economic Zone (EEZ). Six potential archaeological shipwrecks were, however, identified within 50 to 250 meters from the pipeline route. Detailed inspections by remotely operated vehicles (ROVs) were performed before and after construction to make sure they were not impacted negatively.

Experts have assessed that with the mitigation measures planned, the overall impact from the construction and operation of the pipeline on cultural heritage objects in Sweden is of no or negligible significance.

The probability of encountering submerged settlements along the route within the Swedish EEZ was very low, as these areas most likely have undergone erosion since submergence or are located at deeper water depths, where it is highly unlikely to find remains. The relevant cultural heritage authority, the Swedish National Maritime Museums (SMM), therefore recommended not to investigate the matter further.

Denmark

In Denmark, three different route options were surveyed. Seven potential wrecks were identified along the original base case route in Danish territorial waters. Two of these wrecks were found during surveys for the Nord Stream Pipeline constructed between 2010-2012, and are already in the national register of shipwrecks. Along the alternative route, stretching north-west of Bornholm, eight potential wrecks were identified. On the third, approved route running south-east of Bornholm, five wrecks of cultural heritage value were identified. All of them are located 3.5 km – 20 km from the pipeline route. Due to their distance from the construction area, these objects were not further inspected and construction was not expected to impact them.

All objects identified during surveys were assessed by marine archaeologists in consultation with the Danish Agency for Culture and Palaces. The route was developed to ensure that the pipeline avoids any areas of cultural value.

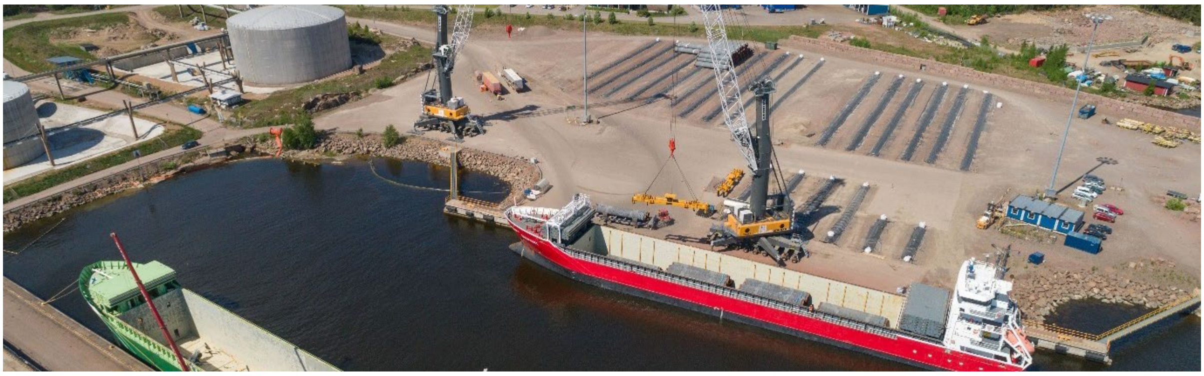
The impact of the construction and operation of the pipeline on cultural heritage objects (CHO) in Danish waters was negligible and insignificant. No dedicated monitoring of cultural heritage objects or further mitigation measures were recommended by the Danish authorities.

Germany

In German territorial waters, at the threshold of the Bay of Greifswald, there are several remains of shipwrecks of archaeological value. In 1715, the Swedish marines ballasted some 20 ships in a line to hinder enemy fleets from entering the bay.

For the construction of the Nord Stream Pipeline, remains of a ship in the historic barrier of wrecks were removed by experts and conserved for scientific and historical purposes. In 2017 and 2018, the remains of wrecks were salvaged in six locations along the route in close cooperation with the relevant authority, the State Office for Culture and Care and Preservation of Ancient Monuments and Artefacts of Mecklenburg-Western Pomerania. These locations included two at the threshold of the Bay of Greifswald, two near the Lubmin beach, and two within and outside the Bay of Greifswald.

Logistics



Nord Stream 2's logistics concept was designed to supply the materials needed in an efficient, timely and cost-effective manner, minimising impacts on the sensitive ecosystem of the Baltic Sea. Low-emissions transportation, such as ships and trains, were used with the shortest possible routes. Local workforce, services and service providers around the Baltic Sea were used as much as possible.

Production of the approximately 200,000 pipes required steps from plate production, pipe milling, welding, stretching, treatment of pipe ends (chamfering and bevelling) all the way to quality control. After quality control, every pipe received an internal anti-friction coating and an external anti-corrosion coating. The pipes for both pipelines were produced by the German company EUROPIPE GmbH (41 percent) and the Russian companies United Metallurgical Company JSC/OMK (31 percent) and Chelyabinsk Pipe-Rolling Plant JSC/ChelPipe (28 percent).

Nord Stream 2 contracted Wasco Coatings, part of the Malaysian-based energy group Wasco Energy, to provide concrete coating, storing and logistics services for the more than 2,400 kilometres of pipes needed for the project.

To ensure that the pipeline would be laid as efficiently as possible, four ports were chosen to serve as the project's logistics hubs. Kotka on the Finnish coast and Mukran on the island of Rügen, Germany, were selected as locations for the concrete weight coating plants and interim storage yards. Koverhar Harbour in Hanko, Finland, and the Port of Karlshamn in Sweden were selected as additional interim storage yards to ensure short transport distances to the pipeline route.

The steel pipes were transported from the pipe mills by rail to the concrete weight coating plants on the Baltic Sea coast: Kotka in Finland and Mukran in Germany by the Russian Railways, Finnish VR Transport and DB Cargo Deutschland AG respectively. A small number of pipes were coated in ChelPipe's subcontractor's plant in Volzhsky, Russia, and transported by rail directly to the storage yard in Koverhar in Hanko, Finland.

At the coating plants, the pipes received a concrete weight coating, doubling their weight from approximately 12 tonnes to 24 tonnes each. The extra weight is necessary to increase the pipeline's stability on the seabed and add mechanical protection during handling, transport and pipelay operations, as well as protecting it on the seabed from external damage.

Wasco concrete weight-coated approximately 102,400 pipes in its coating plant in Kotka and approximately 89,100 in Mukran. From these coating plants, pipes were then transported to interim storage yards in Koverhar and Karlsham. A total of 36,600 pipes were stored in Karlshamn and 54,200 in Koverhar before being transported to the pipelay vessel at the time of construction.

The handling and transport of the pipes to storage yards in Koverhar and Karlshamn as well as storage activities were provided by Wasco's Danish pipe transport sub-contractor, Blue Water Shipping A/S. Special pipe carrier vessels transported the pipe segments to the pipelay vessels. On board the pipelay vessels, the pipes were welded onto the pipeline and then lowered to their designated place on the seafloor.

Construction Activities

1.1 Preparatory Activities

Munitions Clearance

After the World Wars, mine lines were abandoned and numerous conventional and chemical munitions were dumped in the Baltic Sea. Nord Stream 2 has carried out extensive and detailed surveys to verify that the seabed is safe for the construction and operation of the pipeline. By the time the pipeline was completed, more than 75,000 line kilometres of seabed had been inspected, adding to the comprehensive data collected prior to the construction of the Nord Stream Pipeline, in operation since 2012.

Nord Stream 2 optimised the pipeline route to avoid munitions wherever feasible. Conventional munitions that could not be avoided through localised rerouting were cleared on location in a fashion that was consistent with safe practice and in agreement with the relevant authorities. The data and experience gained from the previous project were utilised for planning the clearance methods, mitigation measures and monitoring of the environmental impacts according to the highest standards.

Nord Stream 2 contracted international munitions clearance experts to remove and dispose of such objects where required. Generally, this included either removal or clearance through in situ detonation, the latter of which is only applicable to conventional munitions. Extensive mitigation measures were used to reduce potential environmental impacts, including the use of bubble curtains. The basic principles of the munitions clearance method involved placing a small charge next to the identified object on the seabed using a remotely operated vehicle (ROV) or divers. These charges were then detonated from a surface support ship located at a safe distance from the target. In the Finnish Exclusive Economic Zone (EEZ), munitions were cleared using ROVs, thus limiting the risk for the personnel onboard the vessels involved in the munitions clearance. In shallower waters in Germany, divers were also used.

In Finland, a detailed munition-by-munition clearance plan was developed for each individual object. The companies contracted for the clearance operation used four vessels, with two vessels working simultaneously on one munition: a main disposal vessel and a bubble curtain vessel for mitigating the noise impact of underwater explosions on marine life. Marine mammal observers on board the main vessel conducted visual observations searching for marine mammals and other sea life. Passive acoustic monitoring and fish scanning monitoring to detect marine mammals and/or fish were carried out. Operations would have been postponed should a mammal be seen within a two kilometre zone. No mammals were observed during the operations. Acoustic deterrent devices, i.e. seal scrammers, were deployed to scare any marine mammals and fish away from the clearance area within the one to two kilometre mitigation zone.

Bubble curtains mitigate the noise impact of underwater explosions on marine life.

In Germany, some 77 UXO items were identified and removed with assistance from the local authorities. No munitions were removed via in situ detonation in Germany.

In the Swedish EEZ, the route was re-routed to avoid the finds, whereas in the Finnish EEZ, a total of 74 munitions were cleared. Of these, 58 were detonated using bubble curtains.

In Russian waters, the Baltic Fleet carried out the required clearance.

In Denmark, the chosen route through Danish waters was the result of a multi-stage permitting process. The route corridor was designed to avoid any conventional or chemical munitions and was chosen by Danish authorities as the best option from both an environmental and safety perspective. Dedicated munitions screening surveys were performed during the design phase to ensure that no munitions are present within the installation corridor. All munitions findings were evaluated by munitions experts in consultation with the relevant Danish authorities. Furthermore, procedures were in place to handle unexpected munition finds during the construction and operations phase to ensure safety. Due to excellent quality data provided by earlier surveys, no unforeseen conditions were identified during construction.

The monitoring results have shown that the impacts of munitions clearance were in line with the assessments or smaller than predicted.

Trenching

Although the route was optimised, some seabed preparation works were still necessary to safely install the pipelines. Preparation works were required at different locations before and after pipelines were laid to guarantee stability, provide support and protection at crossings with existing infrastructure and ensure a stable foundation. During normal operation, the pipeline can move on the seabed. Potential changes in topography are detected by maintenance surveys, and seabed intervention works will be performed if needed.

The offshore installation of the pipelines along some sections of the route, especially in shallow waters, required additional stabilisation and/or protection against hydrodynamic loading (e.g. waves, currents), which was achieved by trenching the pipeline into the seabed where rock placement is deemed impractical.

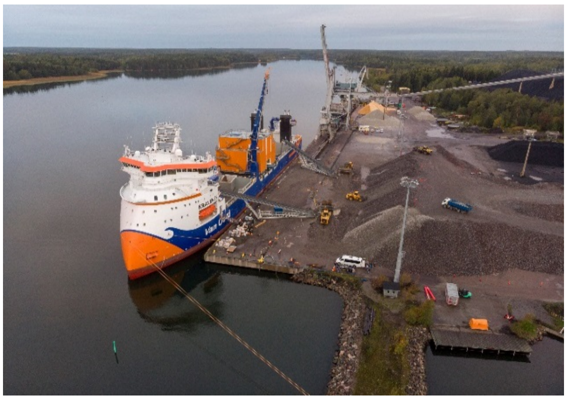
Pipeline installation in a pre-lay excavated trench by means of dredging was the preferred trenching method in these shallow-water areas, such as in the vicinity of the landfalls. In deeper waters, the most commonly used trenching method was post-lay ploughing, where trenching is performed after pipelay. During pipelay, a plough was towed by a powerful surface support vessel, creating a trough of pre-determined length, depth and width. Partial, natural backfilling occurs over time as a result of currents close to the seabed. Ploughing was implemented to entrench a short section of each pipeline in the Swedish EEZ.

At the landfalls in Russia and Germany, the pipelines were entirely buried in the seabed to ensure their stability. The excavated material was removed, temporarily stored and then used for backfilling.

Rock Placement

Due to the uneven nature of the seabed in the Baltic Sea, rock placement was required along certain sections of the route to ensure that pipeline integrity is maintained for the 50-year design lifetime of the pipeline system.

The seabed along the entire route was carefully surveyed ahead of pipelay. Rock material serves as basement structures and protection at pipeline crossing areas as well as providing stability wherever required. The types of rock placement include installation of rock berm supports (before and after pipelay) and rock cover (after pipelay) at precise locations. The rock material is granite with an average size of 60 millimetres. To minimise the environmental impact, only clean, freshly crushed rocks was used. They may not contain contaminants, such as heavy metals that could be dissolved in the water, or clay, silt, lime or vegetation.



Technicians load rock onto FPV Bravenes in Inkoo, Finland.

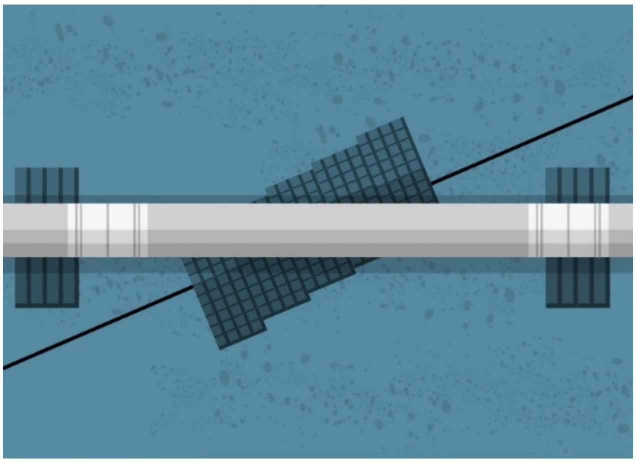
In some locations, the pipeline had to occasionally cross a ravine or valley, effectively forming a “bridge” with a free space beneath it, called a free-span. Rock placement conducted before pipelay was the main method to mitigate free-spans.

The contractor in charge of all rock placement used dynamically positioned fallpipe vessels (FPVs). Rock material was transported by the FPV to each of the positions where rock placement was required. The fallpipe traverses the water column to accurately install the rock at the pre-determined berm locations on the seabed. The lower end of the fallpipe was fitted with a state-of-the-art remotely operated vehicle (ROV) which guides the FPV during the operation to ensure that the rock is installed per design.

Most of the rock placement took place in the Gulf of Finland due to its uneven seabed. Majority of rock was used in Finnish and Russian waters, and around 10 percent in Swedish waters. Small amounts of rock were also placed in Danish and German waters to stabilise the pipeline.

Cable Crossings

The route crosses power and telecommunications cables, the two Nord Stream Pipelines and infrastructure that has been implemented in the Baltic Sea. At crossing locations, concrete mattresses were placed over the cables for their protection. When a pipeline crosses another pipeline, the placement of rock berms is often also required in addition to mattresses.



Concrete mattresses keep a pipeline separated from a cable (the black line).

1.2 Russian Landfall

Landfall Facilities

The Russian section of the pipeline is divided into a 3.7 kilometre-long onshore segment and a 114 kilometre-long offshore segment.

The starting point of the pipeline is located on the coast of Narva Bay in the Kingisepp district of the Leningrad region. Gas that flows into the Nord Stream 2 Pipeline will come from the Northern Corridor of Russia's Unified Gas Supply System (UGSS) to the Slavyanskaya compressor station, some 5 kilometres from the landfall facilities. Here, the gas will be pressurised to secure transportation without intermediate compressor stations along the route.

The compressor station and the pipeline are connected by four underground pipelines that are operated by Gazprom. The landfall is 3.8 kilometres away from the shore at the landfall facilities. It is equipped with all systems necessary to monitor the parameters of the incoming gas and ensure safe operations, including the Pipeline Inspection Gauge (PIG) trap area and shut-down valves, as well as systems to monitor gas flow.

The Russian onshore section of the pipeline passes through the Kurgalsky nature reserve. To ensure the smallest possible environmental footprint, this section was built using an innovative open-cut construction method. Use of trench boxes reduced the width of the construction corridor and related impacts by some 50 percent.

The technique also helped preserve local hydrology since no draining of the trench was required for pipeline installation. The entire area was restored once construction was complete. A 30 metre-wide corridor directly above the pipeline is being kept free of trees, as required by Russian safety standards. Vegetation is returning to this area naturally.

Onshore Pipelay

The starting point of the pipeline system is in Russia's Narva Bay in the Kingisepp district of the Leningrad region. At this location, the pipeline route crosses a protected area, the Kurgalsky peninsula, over a distance of approximately 6.2 kilometres, of which approximately 3.7 kilometres are onshore and 2.5 kilometres offshore.

Nord Stream 2 appointed a world-leading contractor to employ a design that adheres to the requirements for minimising the corridor and any other environmental impacts associated with the construction.

Following an in-depth study, the contractor came up with the trench box construction method, a method that has a substantially smaller environmental impact than the conventional approach. The method relied on trench boxes to maintain vertical trench walls and reduce the width of the trench, allowing the pipelines to be laid within a 30-metre corridor, or right of way, through the most sensitive habitat.

In addition to reducing the footprint, this method also reduced the amount of excavated material by approximately 70 percent when compared to a conventional unsupported trench. Installation in a flooded trench limited the dewatering required during construction. This ensured that groundwater levels during and after construction will not be altered, keeping surface hydrology in its natural condition and safeguarding the habitats which rely on a high water table for their survival.

The trench box method required pipe fabrication at two locations rather than alongside the trench: on the laybarge and at the gas inlet terminal. The pipeline strings were pulled from the pipe-lay barge anchored nearshore and welded at a temporary welding station established adjacent to the gas inlet facility. The two parts were welded together on the eastern margin of the dune. This installation method required almost no heavy equipment on site during pipeline installation and limited the number of vehicles used, significantly lowering the width required for the corridor as well as noise emissions and associated disturbances during the pipeline installation phase. After installation of the pipelines, the trench boxes were extracted, the trench was backfilled and a vegetation cover is being allowed to grow naturally.

Lateral thinking and the application of advanced construction techniques enabled us to find a safe, reliable and environmentally acceptable design solution that minimises habitat loss, reduces the severance effect on continuous habitats and preserves the hydrological regime of the area.

Offshore Pipelay

The seabed had to be prepared before pipelaying could begin. In the nearshore approach to the Russian landfall, this included dredging and backfilling. The pipelines were buried in the seabed to ensure that water and sand movements do not affect their stability, which required the excavation of a trench using dredgers. The excavated materials were removed, stored temporarily and then used for backfilling where possible. Nearshore and offshore construction activities used two state-of-the art pipelaying vessels, with these two sections of the pipeline welded together in a later stage in a procedure known as an Above-Water Tie-In (AWTI). During an AWTI, two previously laid pipe ends laying opposite of each other are raised above the water, welded together, tested for quality and then replaced on the seafloor.

Throughout construction, comprehensive environmental monitoring was carried out for the onshore and offshore sections. Responsible external authorities in Russia confirmed the activities did not exceed the thresholds set in the environmental impact assessment.

1.3 Offshore – Pipelaying

Pipelaying Process

Constructing an underwater pipeline is a major undertaking. Over 200,000 pipes were needed to create both strings of Nord Stream 2. Pipelay began in early September 2018 in the Gulf of Finland by pipelay vessel Solitaire, in a carefully planned and tightly managed process. During the construction phase, up to five individual pipelay vessels were building the pipeline at a rate of approximately 3-4 kilometres per day. Several measures were taken to minimise disturbance to the sensitive Baltic Sea environment, which has dense shipping traffic and historic sea mines.

Safety and environmental protection were the foremost considerations throughout construction. The individual 12-metre,12-tonne steel pipes produced at plants in Germany and Russia have a constant internal diameter of 1,153 mm and a wall thickness of up to 41 mm. They are coated internally to reduce friction, and externally to reduce corrosion. Finally, a concrete coating on top increases protection and doubles their weight, making the pipeline more stable on the seabed.

Nord Stream 2 contracted some of the world's leading contractors to install the pipeline through the Baltic Sea: Allseas, Saipem and MRTS JSC. The pipelay vessels operated by Allseas, i.e. Solitaire, Audacia and Pioneering Spirit, have installed a total of about 2,200 kilometres of the two pipeline strings. Saipem's pipelay barge Castoro Dieci pulled ashore the final section of the pipeline and connected it to the landfall in Germany. It also performed the AWTI that connected the pipeline sections of the first line in German waters. Pipelay barge Fortuna installed the starting section of the twin pipeline in the shallow waters off the Russian coast, including the two AWTIs close to the Russian landfall, two AWTIs in German waters and pipelay in the Danish section Another pipelay barge, Akademik Cherskiy, laid shorter sections of the pipelines in Danish and German waters.

Each pipelay vessel was a floating factory where the pipes were received from carrier vessels, welded together and then installed on the seabed in sections. In the first step, the pipes were delivered to the vessels by pipe carrier vessels regularly. To prepare the pipes for welding, the ends were bevelled to make them exactly the right shape to be fitted together. The inside of the pipe was then cleaned using compressed air before it was conveyed to the double-joint welding station. Here, the 12-metre pipe joints were aligned and welded together to create a double-joint segment measuring 24 metres.

The double-joint was then moved to a non-destructive testing station where every millimetre of the weld underwent automatic ultrasonic testing (AUT) to detect any unacceptable flaws. Any defects were removed and the weld was rescanned to ensure it met international standards. Following AUT, the double-joint was moved in a pipe elevator to the central assembly line. There, the insides were checked for debris and the double joint was aligned with the main pipe string in preparation for welding. The double-joint was then joined to the end of the pipeline using a semi-automatic welding process. Qualified welding inspectors oversaw each of the steps and authorities approved the welding procedures.

Following welding, 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 met international standards. Once the weld was confirmed acceptable, a corrosion resistant heat-shrink sleeve was applied over the circumferential girth weld and polyurethane foam was poured into a form surrounding the weld area. This foam hardened, providing further protection.

Following the mechanical completion of the first line in June and the second line in September 2021, the pipeline underwent rigorous testing and assessment by an independent certification body. With the safety of the pipeline assured, gas will be able to flow directly from the world’s largest natural gas reserves into the EU’s internal energy market.

Pipelay Vessels

Solitaire

- Dynamically positioned pipelay vessel, operator: Allseas Group S.A.
- Performed offshore pipelaying in deep water sections
- 2 double-joint factories (each with 3 welding stations and 1 Non-Destructive Testing (NDT) station), 5 welding stations for double joints, 1 NDT station and 4 coating stations
- Solitaire can lay pipes in depths between 18 and 2,775 metres
- Lay rate of approximately 4 km/day
- Accommodation capacity: 420 people
- Size: 300 metres by 41 metres

Pioneering Spirit

- Largest constructionvessel in the world, dynamically positioned, operator: Allseas Group S.A.
- Used for offshore construction in deep water sections
- Double-joint factory, 5 line-up stations, 2 stations for combined external/internal welding
- Firing line with 6 (double joint) welding stations, 1 NDT station and 6 coating stations
- Pipelaying can be conducted at a depth of up to 4,000 metres
- Lay rate of up to 5 km/day
- Accommodation capacity: 571 people
- Size: 382 metres by 124 metres

Audacia

- Dynamically positioned pipelay vessel, operator: Allseas Group S.A., built 2005
- Used as an anchored vessel (10 anchors) for offshore pipelay in German waters
- Firing line with 7 (single joint) welding stations, 1 NDT station and 3 coating stations
- Pipelaying from a depth of 18 metres down to 2,775 metres
- Lay rate approximately 1.2 km/day
- Accommodation capacity: 270 people
- Size: 225 metres by 32 metres

Castoro Dieci (C10)

- Anchor positioned offshore pipelay barge with low draught and no means of self-propulsion, operator: Saipem
- Used for nearshore pipelay works in Germany and landfall installation
- Up to 6 pipe lifting davits may be mounted on the main deck to facilitate the tie-in of pipelines above water
- Accommodation capacity: 168 people
- Size: 164.62 metres (with stinger) by 36.57 metres

Fortuna

- Multipurpose flat-bottomed pipelay barge, 12-point anchor barge, operator: MRTS
- Used for nearshore pipelay works in the Russian section, pipelay at a depth up to 200 metres
- 6 welding stations, 1 repair station, 2 coating stations, an anode installation station and an NDT station and a 47-metre long stinger
- Equipped with 6 davit cranes to perform above-water tie-ins
- Accommodation capacity: 310 people
- Size: 169 metres by 46 metres

Akademik Cherskiy

- Dynamically positioned, multipoint anchored, deep-water pipelay vessel
- Used for pipelay in Danish waters and for a 2.6 km section in German waters
- 4 welding stations, 1 NDE/repair station, 2 coating stations
- Accommodation capacity: 399 people
- Size: 150 metres by 36.8 metres

1.4 German Landfall

Landfall Facilities

PIG Receiving Station

The pipeline inspection gauge (PIG) receiving station is the Nord Stream 2 part of the German Landfall in Lubmin. It is the logistical link between the pipeline and the European pipeline network. The onshore facilities of the receiving station include service buildings, the PIG receivers and the important safety shut-down valves. In the event of malfunctions, these valves reliably separate the offshore section of the pipeline from the station's land area.

Once the pipeline is commissioned, gas transport through the pipeline system will be monitored and controlled 24 hours a day from the dispatching centre in Zug, Switzerland, where the project company is based. The data from the various sensors for monitoring pressure, temperature, gas quality and gas flow, among other things, are forwarded to the control centre. In addition, control consoles will be installed in Lubmin to enable on-site operation of the pipeline components.

Gas Receiving Station

From the PIG receiving station, the natural gas will flow to the adjacent gas receiving station of Gascade, and from there into the NEL (North European Gas Pipeline) and EUGAL (European Gas Link) onshore connecting pipelines.

Two connected safety shut-down valves separate the landfall area from the downstream measuring and control area of the station. In this section of the facilities, the quality of the incoming and outgoing gas flows is examined, the gas is measured and its pressure and volumes adapted for transfer to the downstream pipelines. Safety valves protect the two pipelines from exceeding the maximum permissible pressure.

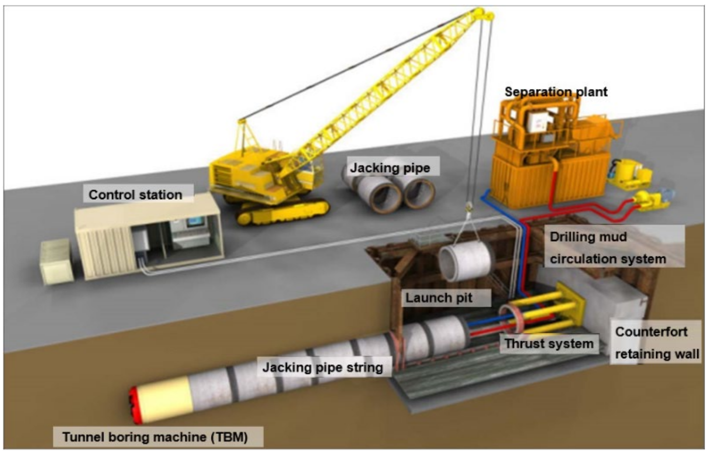
Microtunneling

In the Bay of Greifswald, the twin pipelines were laid approximately 1.5 metres below the seabed. Approximately 350 metres before Lubmin beach, the pipelines enter two microtunnels which run all the way to the PIG receiving station. The microtunnels pass under the coastal area and the infrastructure north of the PIG receiving station: the shallow water area, the beach, the dune, the coastal forest, supply lines, a road and a railway track. This construction option greatly minimised the environmental impact of the pipelines' construction works.

The two microtunnels were built by pipe jacking, a trenchless construction method. Each tunnel is about 700 metres long and consists of over 200 concrete pipes with an external diameter of 2.5 metres, a wall thickness of 225 millimetres and a length of three metres. The concrete pipe sections were prefabricated in a dedicated factory and transported to the construction site.

From a specially prepared launch pit, a tunnel boring machine (TBM) excavated the microtunnels at a depth of up to 10 metres below the waterline and the pipe sections were driven toward their target location, the offshore exit point of the pipelines. As the excavation progressed, the concrete pipes were lowered into the launch pit one after the other. Soil loosened by the TBM (drill cuttings) was separated from the drilling fluid, removed and appropriately disposed of. The cleaned drilling fluid was then reused in the drilling process.

After the TBMs reached the target location, all the equipment and fixtures required to drive the microtunnels were dismantled and removed. The TBMs were recovered at the offshore exit point using an appropriately equipped vessel. The tunnels were then prepared for the installation of the pipelines. The annular gap between the inner walls of the tunnels and the gas pipeline was insulated and filled with a special mortar.



Schematic illustration of microtunnel construction equipment

Because Nord Stream 2 was built in several phases, various sections, such as the offshore and onshore sections, needed to be connected in an AWTI. In German waters, there were three AWTI operations. Each time, two previously laid pipe ends opposite of each other were raised above the water, welded together, tested for quality and then replaced on the seafloor.

Environmental Monitoring

Independent contractors have been monitoring the actual impacts on the environment and marine life before, during and after construction along the pipeline route to ensure that construction impacts remain within the limits laid out in approved permitting documents.

Environmental monitoring takes place in a wide range of different categories: water quality, seabed sediments, underwater noise, bird populations, marine mammals, flora and fauna, fish and fisheries, cultural heritage, munitions, maritime traffic, onshore environment, and Natura 2000 areas. National monitoring programmes approved in the countries whose waters the pipeline passes through verify compliance with the project's permit provisions. The results are being provided to the national authorities and summary reports disclosed on the Nord Stream 2 website.

Water quality is measured according to turbidity, or cloudiness caused by suspended seabed sediment, to ensure that it did not exceed relevant threshold values or that turbidity plume did not reach sensitive areas. Turbidity plumes have been tracked to measure levels of suspended sediment in the areas where seabed intervention works have been performed. Chemical analysis of water samples shows whether changes in water quality have occurred.

Activities that caused underwater noise, such as munitions clearance and rock placement, were monitored with hydrophones. Noise from munitions clearance was reduced where necessary with the use of bubble curtains that absorb sound.

Seabirds are monitored from land, sea and air in the coastal and marine areas near the Russian and German landfalls. These areas are particularly important for migration, nesting, and foraging. The resulting data are used to determine any construction impacts.

A variety of monitoring methods determine whether construction activities have an impact on marine mammal populations. Hydrophones have been used to assess if underwater noise could have any effect on the resident populations, while visual observations and tracking were conducted to evaluate potential behavioural changes.

Benthic (aquatic) flora and fauna are monitored to document changes during construction and their subsequent recovery. Epifauna is expected to colonise the finished twin pipeline in areas with favourable conditions, and growth will be recorded as part of post-construction recovery studies. Infauna was monitored where dredging or trenching could disturb the seabed to follow its recovery as well.

Potential changes to fishery patterns, fish catches or fishing behaviour are evaluated during and after the pipeline installation. Bottom trawling patterns will need to be adapted in certain areas due to the presence of the pipelines, but these could potentially become a new habitat for fish.

Objects of cultural heritage value along the route have been monitored with video surveys before and after construction. Consultations with the national cultural heritage authorities have been held to ensure that these artefacts are assessed and safeguarded.

The pipeline route was adjusted to avoid mines and munitions wherever possible, though a number of conventional munitions had to be cleared. The impact of clearance was reduced with the use of various mitigation measures. Additionally, monitoring of chemical warfare agents in seabed sediments ensures that contaminants are not spread during construction.

Extensive onshore monitoring of biological and physio-chemical parameters takes place at the landfalls in Russia and Germany. Emissions and noise levels are measured near residential areas to ensure minimal disturbance and compliance with regulatory thresholds. Baseline monitoring of flora and fauna also documents the state and variety of local populations. In the sensitive areas at the Russian landfall, **monitoring of plants and animal life** is performed throughout construction and operation of the pipeline.

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About Nord Stream 2

Nord Stream 2 is a pipeline through the Baltic Sea, which will transport natural gas over some 1,234 km from the world's largest gas reserves in Russia via the most efficient route to consumers in Europe. Nord Stream 2 will largely follow the route and technical concept of the successful Nord Stream Pipeline. The new pipeline will have the capacity to transport 55 billion cubic metres of gas per year, enough to supply 26 million European households. This secure supply of natural gas with its low CO_2 emissions will also contribute to Europe's objective to have a more climate-friendly energy mix with gas substituting for coal in power generation and providing back-up for intermittent renewable sources of energy such as wind and solar power.

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