

Fehmarnbelt Fixed Link (coast-coast)

# TRANSBOUNDARY ENVIRONMENTAL IMPACT ASSESSMENT

Summary Report



Femern  
*Sund ≈ Bælt*



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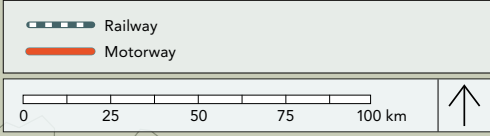
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# 1 INTRODUCTION TO THE FEHMARNBELT FIXED LINK

This report, hereafter the Espoo Report, constitutes the trans-boundary environmental impact assessment for the Fehmarnbelt Fixed Link to be used for the consultation of the Baltic Sea countries and Norway in accordance with the Espoo Convention on Environmental Impact Assessment in a Transboundary Context, hereafter "the Espoo Convention" or "the Convention".

The Fehmarnbelt Fixed Link is a joint Danish and German transport infrastructure project across the Fehmarnbelt. The project has been planned in accordance with the 2008 Treaty between the Kingdom of Denmark and the Federal Republic of Germany for a fixed link across the Fehmarnbelt.

The Kingdom of Denmark is responsible for the planning, construction, and operation of the Fehmarnbelt Fixed Link. In order to carry out this task, the government of Denmark has established the company Femern A/S, which is 100 % owned by the Danish State, represented by the Danish Ministry of Transport.

The Fehmarnbelt Fixed Link has been planned as a consequence of Denmark and Germany recognising that the transport infrastructure between the two states must be improved in order to promote the European and regional transport of goods and people.

A fixed link across the Fehmarnbelt would lead to an appreciable improvement in the transport of goods and people between the two countries, and also between continental Europe and Scandinavia, as well as to a promotion of rail traffic and a strengthening of integration, vitality, competition, and development in the regions.

The fixed link across Fehmarnbelt will extend to stretch across the 18 kilometre wide Fehmarnbelt between the Danish island of Lolland and the German island of Fehmarn in the western part of the Baltic Sea.

The Fehmarnbelt Region is demarcated as the northern part of Germany, the eastern part of Denmark and the southern part of Sweden. The region has a population of almost 9 million, approximately 1.2 million in the Swedish part, 2.5 million in the Danish part and 5.2 million in the German part.

The Fehmarnbelt Fixed Link covers areas on Lolland (Denmark), Fehmarn (Germany) and a marine area (Denmark and Germany). The project crosses the national border between Denmark and Germany.

Construction work will take place within the national jurisdictions of both countries.

Femern A/S has investigated four technical solutions.

The Fixed Link is planned as an approximately 18 kilometre long immersed tunnel; because the investigations and planning indicate that an immersed tunnel is the best solution in terms of e.g. technical construction risks, construction investments, and environmental factors.

The four technical solutions investigated are: An immersed tunnel, a bored tunnel, a cable-stayed bridge, and a suspension bridge. For each technical solution, possible alignments have been investigated, and a comparison of the technical alternatives has been performed.

A summary of the investigations as well as background for the final selection of the technical solution is presented in this report. As the immersed tunnel is the project being applied for and hereby the preferred solution, focus in this report is on the immersed tunnel.

## 2 BACKGROUND FOR ESPOO PROCESS

The Fehmarnbelt Fixed Link is subject to a transboundary environmental impact assessment according to the Espoo Convention and the EU Directive 85/337/EEC, as the Fehmarnbelt Fixed Link can potentially cause transboundary environmental impacts.

The Espoo Convention's primary aim is to prevent, mitigate and monitor environmental damage by ensuring that explicit consideration is given to transboundary environmental factors before a final national decision is as to whether to approve a project.

In addition, the objective of the Espoo Convention is to identify and communicate potential transboundary impacts to stakeholders via the an impact assessment.

According to Article 3 of the Espoo Convention, the Parties of Origin are responsible for the content and acknowledgement of receipt of

notifications, and for the exchange of relevant information to/from the potentially affected countries.

For a transnational project such as the Fehmarnbelt Fixed Link, both Denmark and Germany are parties of origin.

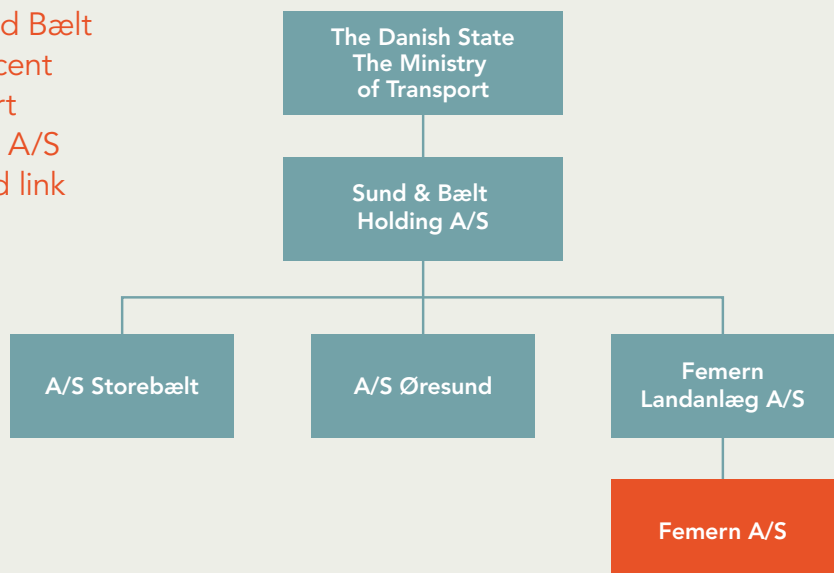
In Denmark, the Danish Ministry of Environment is responsible for the above-mentioned exchange of relevant information to and from the potentially affected countries in connection with the Danish Espoo procedure.

According to Article 3 of the Espoo Convention, Germany and Denmark must notify affected parties. In relation to the Fehmarnbelt Fixed Link, the possible affected parties, apart from Denmark and Germany, could be countries around the Baltic Sea: Sweden, Poland, Finland, Estonia, Latvia, Lithuania, the Russian Federation, and Norway.

The Espoo documentation is focused on providing sufficient background information, including baseline data, in order to facilitate the identification of transboundary impacts, but does not replicate all of the detailed material that is required of the national EIAs. The Espoo Report methodology corresponds to the Danish EIA report methodology, and therefore it describes the impacts expected from the project as well as mitigation measures.

According to the Espoo Convention all potentially affected parties are notified and invited to participate in the EIA procedure. Responses to this notification have been evaluated and taken into account by Femern A/S, the State Company for Road Construction and Transport of Schleswig-Holstein, and the Danish Ministry of the Environment, and are addressed in the Espoo Report.

Femern A/S is part of Sund and Bælt Holding A/S, which is 100 percent owned by the Danish Transport Ministry. Sund & Bælt Holding A/S is also responsible for the fixed link across the Great Belt.





### 3

## PLANNING OF ALIGNMENT – IMMERSSED TUNNEL

To find the most expedient location of the coast-to-coast project, the alignment has been decided on the basis of an environmental sensitivity analysis and an alignment analysis. The analyses were conducted in an early phase of the project, based on existing knowledge, and concentrated on the most significant differences between the alignment alternatives.

In both the marine area and on Lolland and Fehmarn, the environmental sensitivity analysis suggested that the eastern project corridor has a lower environmental impact than a western corridor, since it passes through fewer areas with a high conflict potential.

On the basis of the environmental sensitivity analysis, four approaches on both Lolland and Fehmarn were identified within the eastern and western corridors, giving a total of 16 different combinations of alignment for both a tunnel solution and a bridge solution.

An alignment analysis was prepared for each of the technical solutions to accommodate different interests and to allow for material goods in the seabed, such as submarine cables.

The identification of the alignment for the tunnel solution is based on two limitations:

1. The ferry operation between Rødbyhavn and Puttgarden must be operable during the construction and operation phase
2. The submarine cable, located below the seabed between Lolland and Fehmarn, must not be impacted

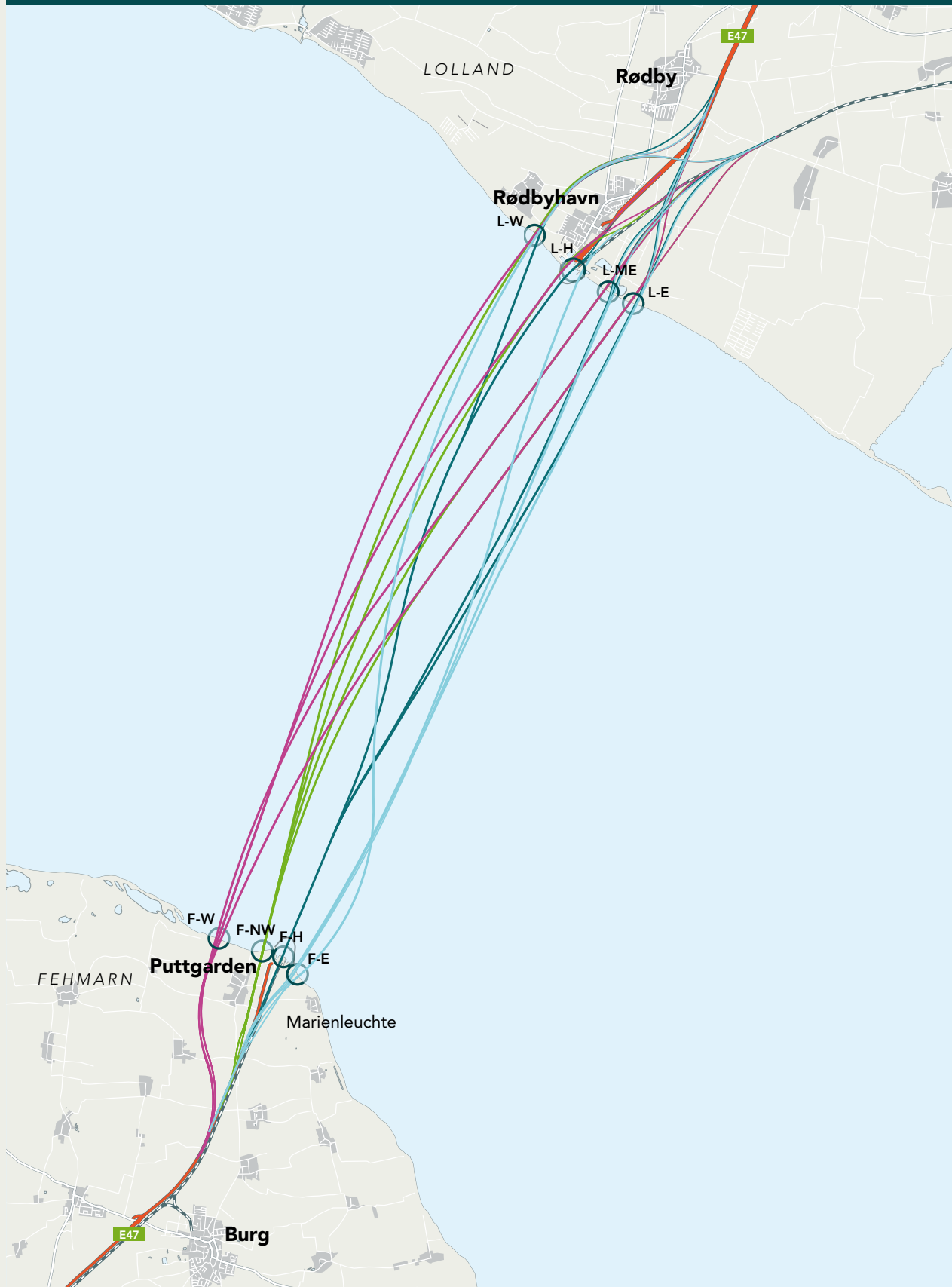
Due to these limitations, alignments which fully or partly make use of the harbour facilities, impact the submarine cable or intersect with the ferry route have been rejected.

Based on an environmental assessment, the alignment alternatives west of Rødbyhavn harbour and Puttgarden harbour for both the tunnel and bridge are considered less expedient and have been rejected, thereby reducing the number of alignment alternatives to two for both the tunnel and bridge solutions. The two preferred alternatives have an approach on Lolland either 1 or 1.5 km east of Rødbyhavn on Lolland and the same approach east of Puttgarden on Fehmarn. Comparison of the two alignments showed only minor differences, with a small advantage to the approach 1 km east of Rødbyhavn.

Based on these results, Femern A/S has concluded that the eastern corridor is the project corridor that has the lowest environmental conflict potentials. Furthermore, Femern A/S has presented its proposal for the alignment of the immersed tunnel which is located within the eastern corridor. After publication of proposals for the alignment in 2010, this has formed the basis of a continued planning process and dialogue with authorities and landowners.



FIGURE 1 Alignment alternatives – immersed tunnel



# 4

## IMMERSED TUNNEL – TECHNICAL DESCRIPTION

Based on investigations of different technical solutions, Femern A/S has chosen an immersed tunnel as the preferred technical solution for a fixed link between Lolland in Denmark and Fehmarn in Germany.

From an early point in the project, analyses were carried out to define a project corridor and possible alignments with the least possible impact on the environment. Based on existing knowledge, the different alternatives and alignments were

compared, and an immersed tunnel between land approaches east of Rødbyhavn and east of Puttgarden was chosen as the most expedient solution for a fixed link (Figure 2).

From coast to coast, the project comprises an approximately 18 km long immersed tunnel with a four lane motorway and dual track railway, as well as permanent and temporary structures in connection with the construction and operation of an immersed tunnel.

### THE MAIN ELEMENTS IN THE IMMERSED TUNNEL SOLUTION AS THE FIXED LINK BETWEEN FEHMARN AND LOLLAND ARE:

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- A dual track railway and a four lane motorway link with emergency lanes in both directions in an immersed tunnel
- Cut-and-cover tunnels at each approach on the Danish and German sides, linking the immersed tunnel to the portal buildings
- Portal building at each tunnel mouth
- Ramps for the road and railway in connection with the tunnel
- Road and railway connections on both sides, linking the tunnel to existing infrastructure
- Land reclamation areas on both coasts
- Toll station – on the Danish side
- Facilities for operation and maintenance, including facilities for customs and emergency authorities
- Modifications to the surrounding secondary road network, including the construction of new local roads, etc.

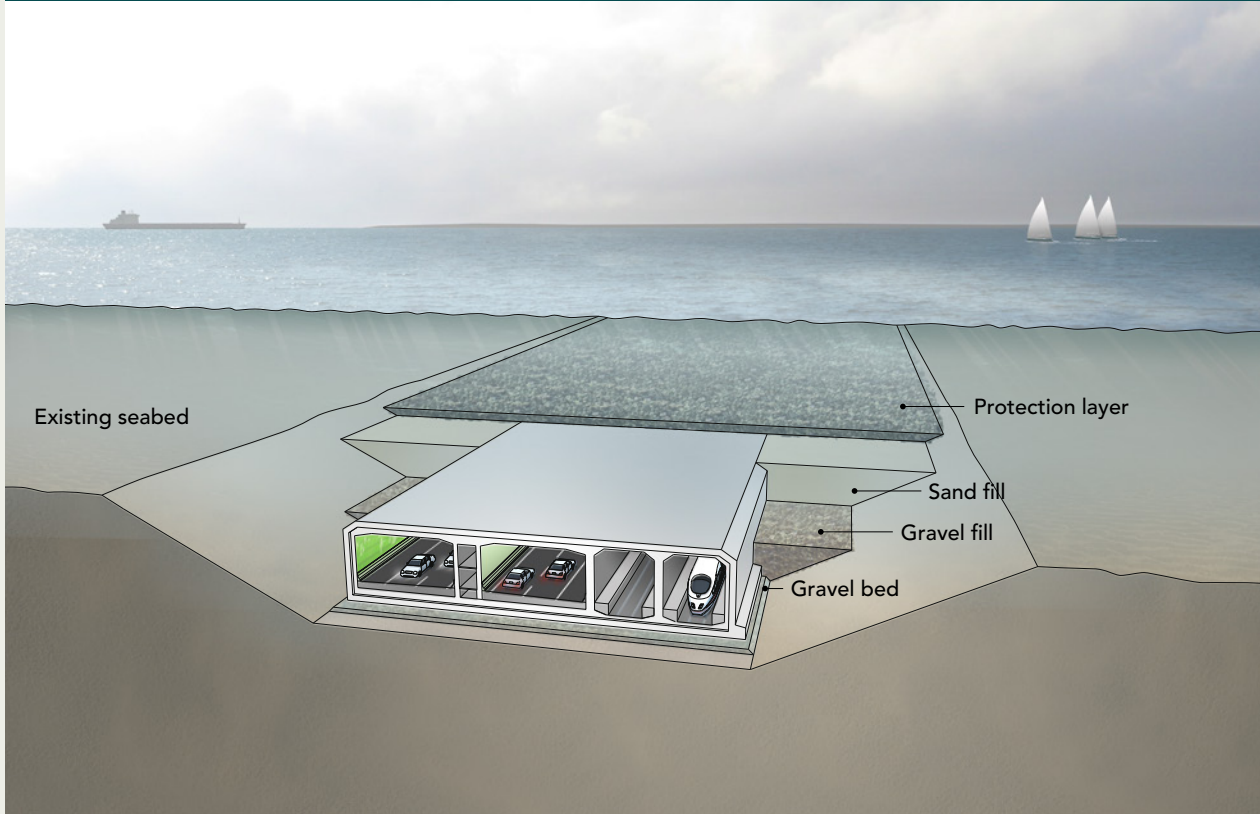
### THE DESIGN SPEEDS OF THE TUNNEL:

- Passenger train traffic: Maximum 200 km/h
- Goods train traffic: Maximum 140 km/h
- Road traffic: Maximum 130 km/h

FIGURE 2 Conceptual design of an immersed tunnel – Alignment for the fixed link across the Fehmarnbelt



**FIGURE 3** Conceptual design of an immersed tunnel – Cross section of dredged trench with tunnel element and backfilling



## PERMANENT STRUCTURES

The planned immersed tunnel across the Fehmarnbelt will consist of a cut-and-cover tunnel at the two approaches and an immersed tunnel between the two approaches. The immersed tunnel will be placed in a tunnel trench and backfilled with sand and locking fill. The top of the immersed tunnel is planned to be covered with an approximately 1 meter thick layer of rocks. This top layer protects the immersed tunnel from marine activities such as sinking ships and anchors, and it is designed as an environmental optimisation in order to prevent impacts on the marine environment (Figure 3).

At both the Danish and German approach, a portal building is

planned to be established on top of the cut and cover tunnel. Coastal protection in the form of dikes are planned to be placed around the portal and ramp with a height which will prevent flooding in the event of extreme high-water and wave conditions.

A toll station is planned to be located in accordance with the state treaty between Denmark and Germany on the Danish side. In the same place approximately 1 kilometre from the coastline, border control facilities and a technical supervision and communication centre will be placed.

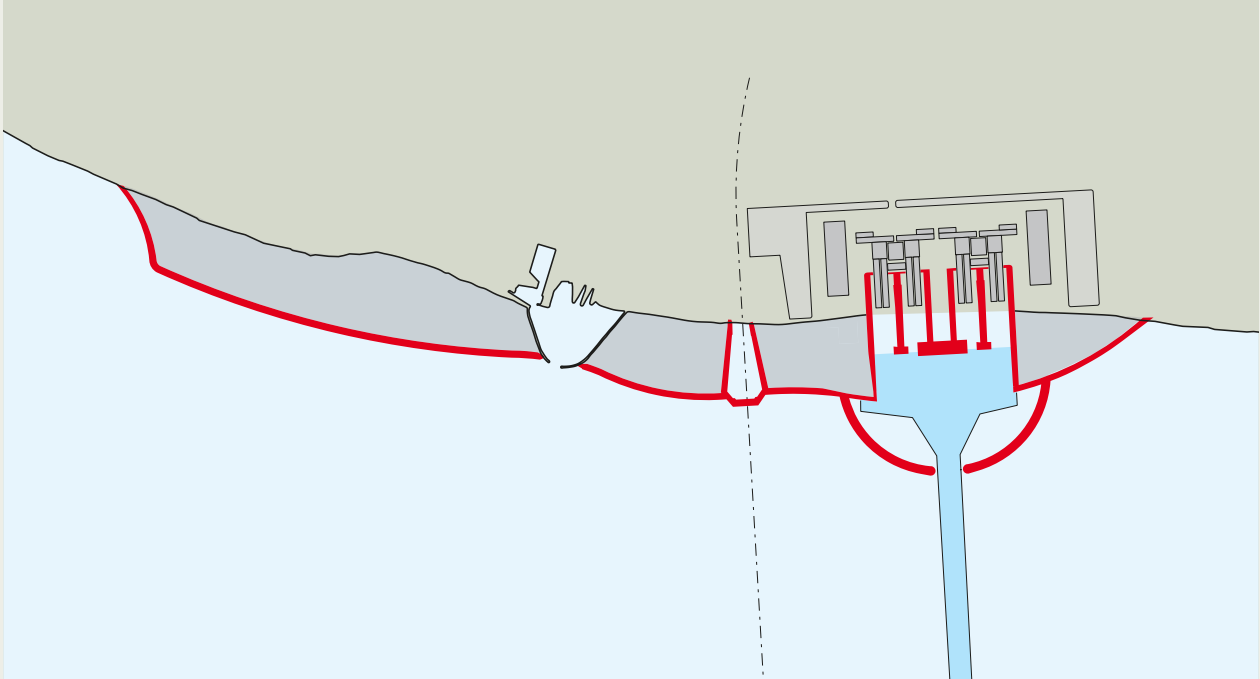
A new drainage system for the immersed tunnel, motorway, railway, toll station etc. will be established on both the Danish and German

side. Rainwater accumulated by the immersed tunnel and water from cleaning the immersed tunnel is planned to be collected in pump wells placed by each portal building. From here the water is pumped to existing water treatment plants in either Rødbyhavn or Puttgarden. Rainwater collected from the land works is planned to be led to rain-water basins, in order to treat run-off and contain any polluted spillages. From the basins the water will run through existing or altered channels to be discharged into Fehmarnbelt.

Furthermore the construction of a motorway requires diversion or alteration of some local roads and paths on both the Danish and the German side.



**FIGURE 4** Placement of the tunnel portal production facility east of Rødbyhavn. Principle of establishment of the land reclamation area at Lolland with dikes around the landfill



## LAND RECLAMATION AREAS

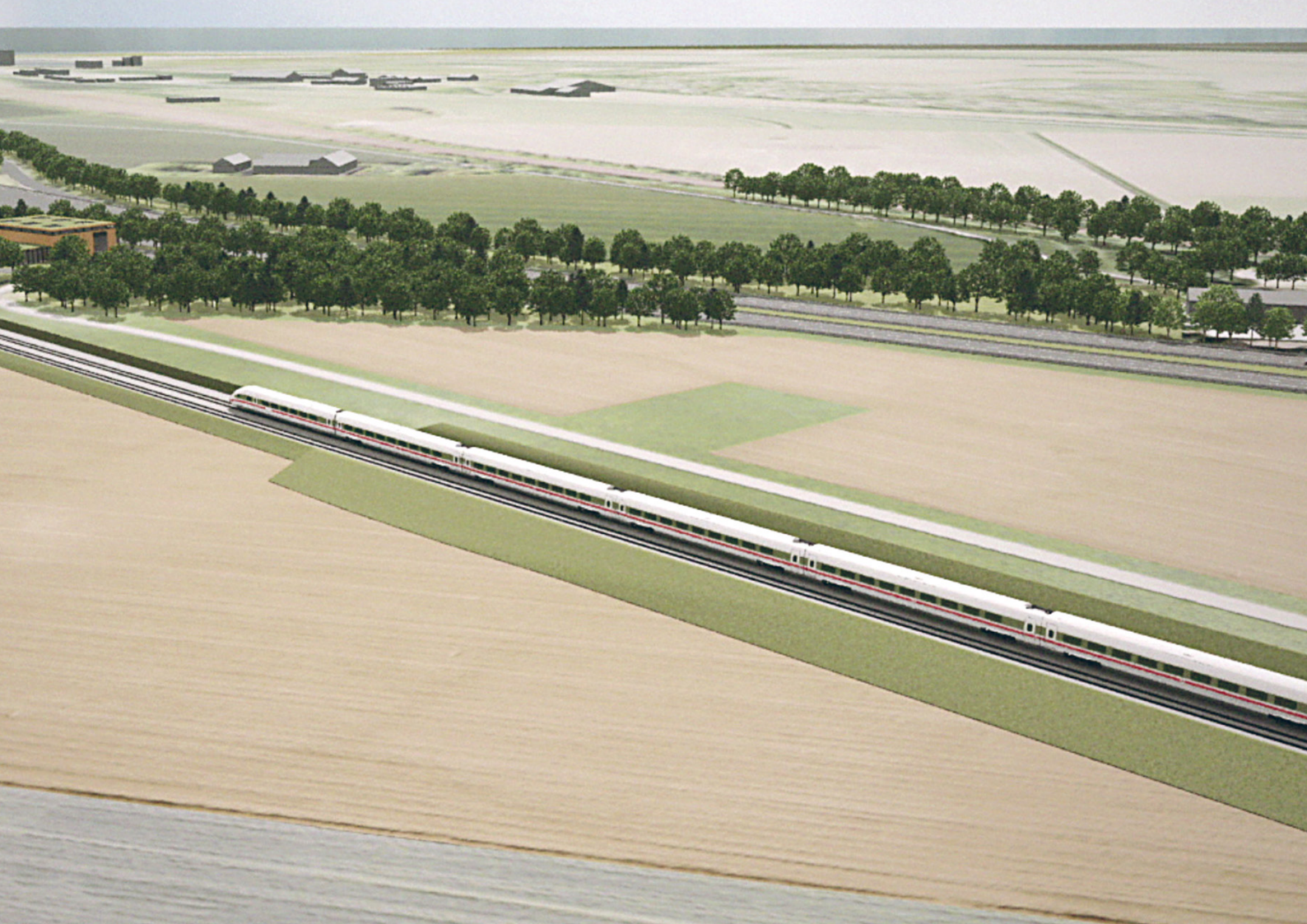
The conceptual design for the immersed tunnel solution includes the establishment of land reclamation areas at both Lolland and Fehmarn. The purpose of the reclamation is to utilise excess seabed material from the dredging of the tunnel trench and the work harbour for purposes which will add natural and recreational value to the local area. On Lolland, the area will also be used as the location for part of the replacement of nature areas which Femern A/S must establish, having appropriated nature areas on Lolland for the purpose of the project.

It is estimated that the dredging volume of marine sediment will be approximately 19 million m<sup>3</sup>. Most of the sediment is planned to be used in the construction of the land reclamation area at Lolland (approximately 17 million m<sup>3</sup>), while about 2 million m<sup>3</sup> will be used on German territory as new land reclamation or within the project.

The land reclamation area on Lolland is planned on each side of the work harbour and extends from this point approximately 3.5 km to the west and approximately 3.7 km to the east. The total area is approximately 330 ha, measured as area of seabed and including water areas inside the reclamation area, and it will comprise both natural and recreational areas including

beaches, dunes and salt meadows (Figure 4).

The planned land reclamation on the Fehmarn coast in Germany extends about 500 m along the existing coast east of the ferry harbour, and about 500 m from the existing coast line into the Fehmarnbelt. The total area is planned to be approximately 32 ha, measured as area of seabed and including water areas inside the reclamation area. The land reclamation area is withdrawn from the tip of the jetties at the existing ferry harbour at Puttgarden to minimise the impacts on the marine environment. The area will comprise pastures and grassland as well as a new beach near Marienleuchte.



## THE CONSTRUCTION PHASE

First the cut-and-cover tunnels are planned to be established, beginning with dredging work, and then the tunnels will be cast in-situ and ultimately covered. On top of the cut-and-cover tunnels, the portal buildings on both the Danish and the German side will be constructed.

The immersed tunnel is planned to be constructed from prefabricated tunnel elements cast in an element factory. The tunnel elements are planned to be tugged from the production site by boat to the alignment, where they will be immersed and assembled in a dredged tunnel trench.

### Production facility

An area east of Rødbyhavn in Denmark has been designated for the construction of a purpose-built casting factory at which the tunnel elements are to be produced. The production facility is partly located onshore and partly off the existing coastline (Figure 4).

### Cut-and-cover tunnel and portal building at Lolland

The cut-and-cover tunnel on Lolland must be constructed in a dammed area just south of the existing coastline. Here dredging is planned to be performed in an initially dammed area of approximately 500 x 250 m. Then the cut-and-cover tunnel is planned to be cast in-situ and the first immersed tunnel element to be installed in continuation of the cut-and-cover tunnel. The portal building and the permanent coastal protection will then be established, and the cut-and-cover tunnel will be covered and the final terrain formed.

### Cut-and-cover tunnel and portal building at Fehmarn

A work harbour is planned to be established at Puttgarden in Germany. As it was the case on Lolland, the cut-and-cover tunnel on Fehmarn is planned to be constructed in a dammed area just north of the existing coastline. Here dredging will initially be performed to approximately the level of the underside of the cut-and-cover tunnel. Then the cut-and-cover tunnel is planned to be cast in-situ, and the first tunnel element to be immersed in continuation of the cut-and-cover tunnel. The portal

building, the ramp structures for road and rail, and the permanent coastal protection will then be established, the cut-and-cover tunnel will be covered and the final terrain formed.

### Dredging of tunnel trench

The tunnel trench appropriates an area of the seabed of around 17.6 km \* 110 m, and dredging of the tunnel trench is expected to last approximately 1.5 years. The overall dredging works, including backfilling of the tunnel trench, is in total expected to last approximately 4.5 years.

### Construction estimate

The construction estimate for the immersed tunnel is calculated to approximately EUR 5.5 billion (2008 prices).

TABLE 1 Conceptual design of an immersed tunnel – Expected time schedule for the construction phase							
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Signing of contract	■						
Mobilisation	■						
Detailed planning	■	■					
Campsite and tunnel element factory establishment	■	■					
Dredging work (tunnel trench etc.)		■	■				
Tunnel element production			■	■			
Tunnel element immersion				■	■		
Removal of tunnel element factory and work harbour						■	■
Land area establishment		■	■	■	■	■	■
Construction works, Lolland		■	■	■	■	■	■
Construction works, Fehmarn		■	■	■	■	■	■
Technical installation works				■	■	■	■
Testing					■	■	■
Expected opening							■

The time schedule shows activities from the start-up in the last six months of year 0 until the end of the construction phase 6.5 years later



# 5

## ALTERNATIVE TECHNICAL SOLUTIONS AND ALTERNATIVE ALIGNMENTS

Femern A/S has investigated four technical solutions for a fixed link over the Fehmarnbelt: An immersed tunnel, a bored tunnel, a cable-stayed bridge, and a suspension bridge. For all four technical solutions planning for possible alignments has been conducted and the preferred alignment selected. Based on the results of the technical investigations of the four solutions, the immersed tunnel is chosen as the preferred technical solution and the other solutions are deselected.

A 0-alternative has also been described for comparison of the immersed tunnel with reference conditions. The 0-alternative describes a situation where the fixed link across the Fehmarnbelt would not be constructed, where the ferry service Rødby-Puttgarden would continue and where consequently no Danish or German land works would be needed.



# 6 TRANSBOUNDARY IMPACT ASSESSMENT

It has been examined whether the construction and operation of an immersed tunnel under the Fehmarnbelt will result in transboundary impacts between Germany and Denmark (countries of origin), and between the countries of origin and third party countries.

This chapter summarises the transboundary impacts of the immersed tunnel during its construction and operation.

The investigations carried out show that the transboundary impacts of the Fehmarnbelt Fixed Link are only temporary, and mostly limited to the construction phase. The types of planned activities with potential impacts include dredging of the tunnel trench, seabed intervention works, all construction related vessel movements and anchoring, and operation of the tunnel.

Potential impacts from the construction and operation of the tunnel have been identified and assessed. In order to determine the significance of the potential impact on the environment, the impacts have been compared with the existing environmental conditions (the baseline conditions) in the Fehmarnbelt area and the conditions at the potential extraction sites at Rønne Banke and Kriegers Flak, where sand can be extracted for production of tunnel elements and for backfilling of the tunnel trench, respectively. Both potential extraction sites are located in the western part of the Baltic Sea.

Environmental and technical investigations have been carried out, allowing optimisation of the tunnel project during the design phase thereby avoiding and minimising some of the potential impacts

caused by the construction and operation of the tunnel. Furthermore, the assessment includes proposals for mitigation measures in order to minimise possible impacts. These proposals can be found in the complete sections describing the respective components in this report.

Below is presented a summary of the results of the environmental assessment of transboundary impacts.

In 2010, Femern A/S prepared a proposal for the environmental investigation programme for the Fehmarnbelt Fixed Link project (the scoping report). The purpose of the scoping report was partly to establish the framework for the studies of natural and environmental conditions to be carried out in connection with the planning of the Fehmarnbelt Fixed Link, and partly to invite ideas and proposals for use in determining what to include in the EIA report.



## PEOPLE AND HEALTH

An infrastructure project like the construction and operation of an immersed tunnel across the Fehmarnbelt might affect people and their health. This section looks at possible transboundary impacts on people and health.

The relevant project pressures for people and health are the following:

- Air pollution from construction activities on Lolland and Fehmarn and offshore
- Noise pollution from construction activities on Lolland and Fehmarn and offshore

### Transboundary impacts

The potential transboundary impacts from these pressures are air pollution and noise, as all other pressures are of a local nature. Potential impacts on humans are assessed to be on construction workers offshore.

### Air pollution

Because of the relatively low number of construction ships, the distance to land on both sides, and the generally good air circulation at both German and Danish sides and at sea, no transboundary impacts from air pollution on human health are expected as a consequence of the construction and operation of the immersed tunnel.

### Noise

Noise from construction activities undertaken on Lolland and Fehmarn cannot have transboundary impacts, because of the distance to the opposite coast. Only construction activities in the middle of the Fehmarnbelt can be of a transboundary nature. However, because of the distance, it is assessed that the noise levels will not be heard far away, and the only persons close to the middle of the Fehmarnbelt will be construction workers.

The construction workers working offshore will be wearing hearing protection (among other protective gear) and will not be affected by high noise levels, should they occur. It is therefore concluded there will be no transboundary impacts from noise on human health as a consequence of the construction and operation of an immersed tunnel.

### Transboundary impacts between Germany and Denmark

The investigations show that during construction and operation of an immersed tunnel, the project pressures on people and health on the Danish side will not cause any significant impacts for these on the German side, and vice versa.

### Conclusion

The investigations and the environmental assessment show that there will be no transboundary impacts on people and health from the construction and operation of an immersed tunnel. The project pressures on the Danish side will not cause any impacts on people and health on the German side, and vice versa.

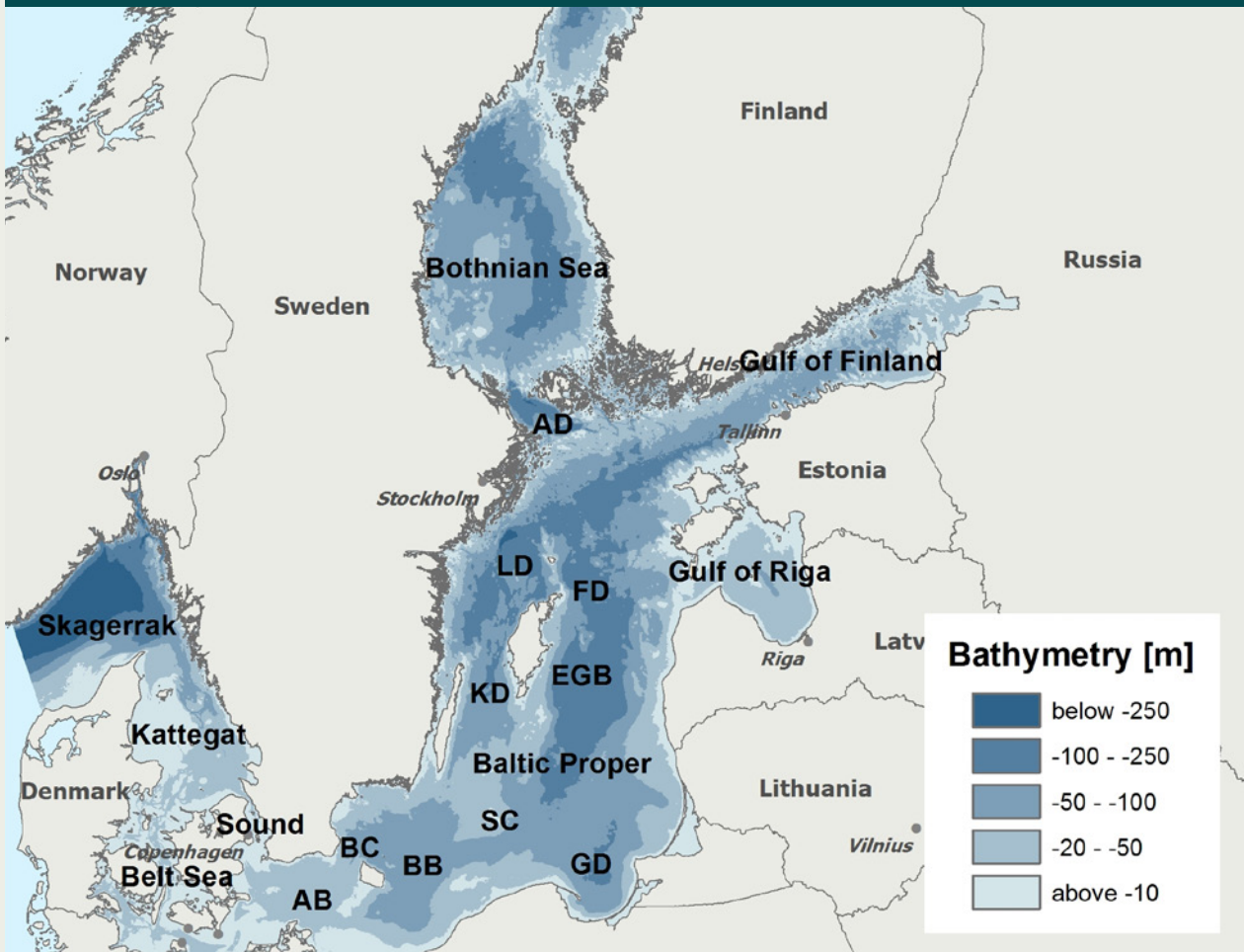
## HYDROGRAPHY

The hydrography of the Fehmarnbelt and adjacent water areas are very important, as the water flow, physical property and wave action set the frame for a number of environmental factors. The Baltic Sea is classified as an "estuary", due to its waters, which are a combination of fresh water runoff from its catchment and saline water from the North Sea. The Baltic Sea is one of the largest estuaries in the world.

The marine structures of the tunnel project may affect the hydrographical conditions in the Baltic Sea through two mechanisms, which are considered as project pressures:

- Project structures potentially cause a blocking of the exchange flow between the North Sea and the Baltic Sea and thereby may impact the salinity and water quality in the Baltic Sea
- Project structures potentially causing additional mixing between the lower (high salinity) and upper (low salinity) layers of water in the Fehmarnbelt and thereby having an effect on the salinity and stratification of waters in the Baltic Sea. In relation to these hydrographical conditions, factors such as water exchange flows, current speeds, water levels, salinity, temperature and stratification have been investigated in German and Danish territories and transboundary waters

**FIGURE 5 Bathymetry and geographical structures of the Baltic Sea**



**Transboundary impacts**

The results of the investigations show that the blocking of the water exchange flow with the Central Baltic Sea in the construction period is estimated to be -0.01 %, which is similar to the permanent conditions after the construction period. This indicates that the work harbour and production facility impacts, which are project pressures during the construction period on the water exchange, are negligible. This also implies that there is no significant impact on the hydrography of the Central Baltic Sea in the construction period. The small blocking percentage is due to the minimal impact of the project structures on the flow through the Fehmarnbelt.

The impacts of construction and operation of the immersed tunnel on hydrography are therefore considered small or non-existing.

**Transboundary impacts between Germany and Denmark**

The changes in other hydrographical parameters such as water levels, salinity, temperature and stratification have also been assessed to be negligible. It is assessed that the hydrographical changes in the Danish waters do not cause any subsequent changes in the German waters, and vice versa.

**Conclusion**

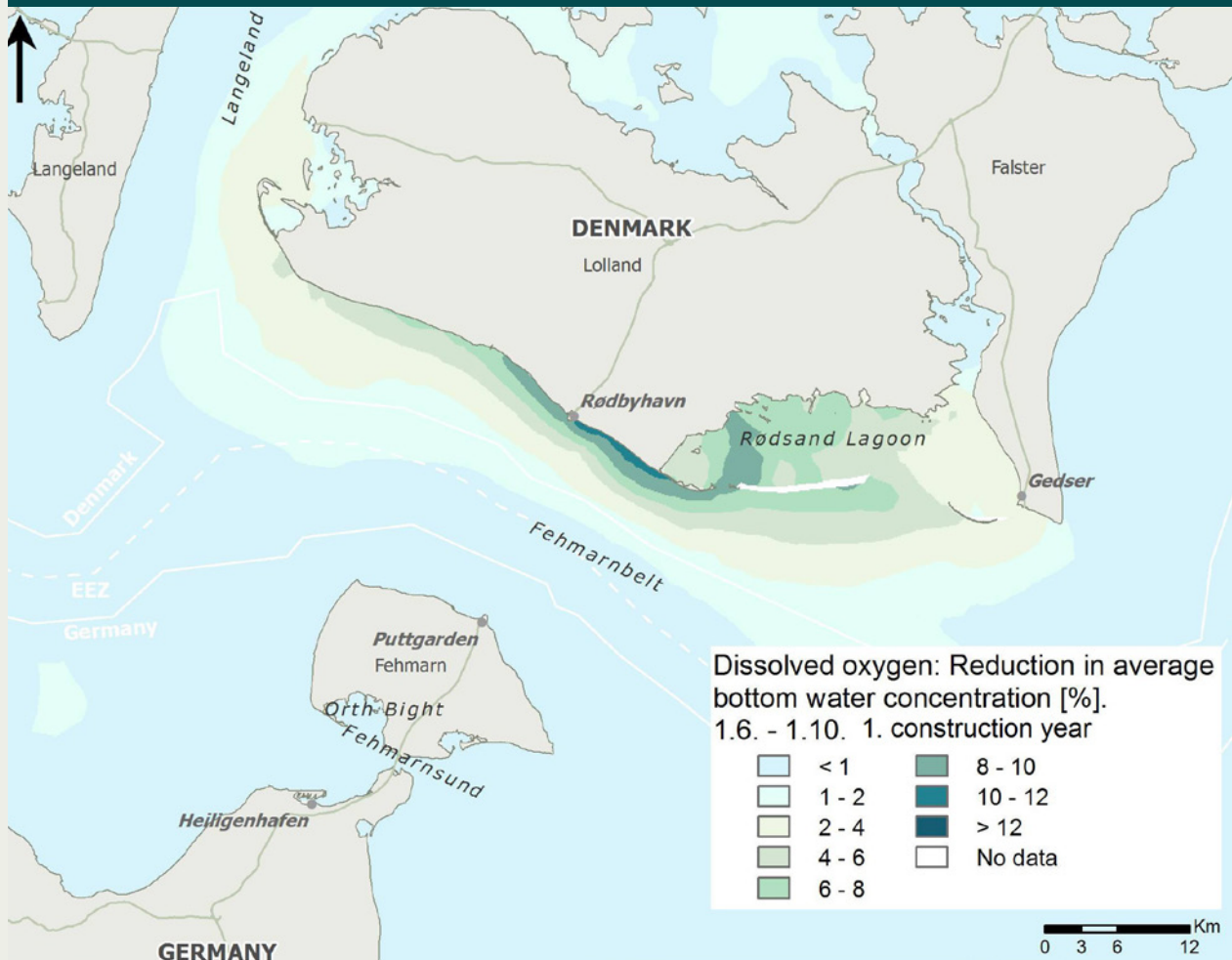
The investigations and assessment show that construction and operation of an immersed tunnel have an insignificant impact on the hydrography (water level, salinity/temperature and stratification) in the Baltic Sea and all transboundary territorial waters. For Norway, the investigations show that there are no impacts. Concerning water exchange at Dars Sill, there are no impacts in Norway, Germany or

Denmark, while the other countries around the Baltic face an insignificant impact.

It is assessed that the hydrographical changes in the Danish waters do not cause any subsequent changes in the German waters, and vice versa.



**FIGURE 6 Oxygen reduction in the bottom water (% , June – October of first construction year) in relation to an immersed tunnel**



## WATER QUALITY

The water quality is reflecting environmental quality in a broad sense and can be seen as the essential condition for the existence of aquatic organisms and for bathing water quality. The water quality is affected by natural conditions, such as hydrography, nutrients introduced from adjacent waters and land, as well as the exchange of substances with the seabed and the atmosphere.

The project pressures, which could affect the water quality parameters in the Fehmarn Belt and thereby potentially impact the transboundary territorial waters of the Baltic Sea, are:

- Discharges of wastewater
- Release of organic material, nutrients and contaminants from dredged materials

- Enhanced vertical mixing of the upper and lower layers of water in the Fehmarn Belt, which could change the stratification in the Baltic Sea and redistribute nutrients and dissolved oxygen
- Impacts on the bathing water quality

### Transboundary impacts

#### Discharges of wastewater

According to the conceptual design of the immersed tunnel the total discharge of waste-water from construction-related activities will not exceed 1 m<sup>3</sup>/s on average, and the specific outlets will be positioned offshore to ensure sufficient mixing and dilution within German and Danish territories. The investigations show that no transboundary impacts from wastewater are expected outside German and Danish territories. The effluents have been assessed to have no impacts

on the salinity and general hydrography close to the source, or on a larger scale, taking into account the normal variation in salinity in the affected areas (9 – 25 psu) and the efficient flow. The discharges could also include reject water from a desalination plant, if that solution is chosen as water supply for the construction. The reject water is very salty, but because the dilution is very large, it would not cause any adverse impacts if discharged into Fehmarn Belt. The results of the investigations indicate that the impacts will be very local and will not detecably spread to the central parts of Fehmarn Belt area or have any detecable transboundary impacts outside Danish and German territories.

#### Releases from dredged materials

**Organic material:** In areas with the largest reduction in oxygen concentration such as in Rødsand Lagoon (located east of the tunnel



on Danish territory) the concentration of oxygen does not decrease below 6 mg O<sub>2</sub>/l as a result of the release of organic material from the dredged materials. Hence, using a critical level of 4 mg O<sub>2</sub>/l, reduction in oxygen levels caused by dredging will not constitute an additional pressure on benthos; therefore, impairment of indirect oxygen reductions caused by release of organic material is considered to be insignificant. As there is only an insignificant impact on the oxygen concentration in local waters, it is assessed that the release of organic material from dredging will not affect the oxygen content of any transboundary waters outside Danish and German territories (see Figure 6).

*Nutrients (Nitrogen and phosphorus):* A daily demand for (and assimilation of) nitrogen and phosphorus by phytoplankton within a 100 m wide zone along the entire alignment can be calculated to 553 kg N and 35 kg P. For nitrogen, the daily uptake is 3 orders of magnitude higher than the estimated average release from dredged materials, while for phosphorus the demand is about 15 times higher than the average release and 7 times higher than the maximum release. Thus, the release rates are negligible compared with the natural demand and impacts from nutrient release can be ruled out. In conclusion, there will be no transboundary impacts of nutrients outside German and Danish waters from the release of nutrients during dredging operations.

*Heavy metals:* Regarding release of heavy metals during dredging of sediments, previous studies with sediment from the Fehmarnbelt have shown that release of heavy metals from sediments when suspended will typically be 1 % of the sediment concentration. Because of the very low concentrations of heavy metals in the sediment, it can therefore be concluded that the heavy metals released during dredging in the Fehmarnbelt will not affect benthic or pelagic organisms. Hence, there will be no transboundary impact outside German and Danish waters from the release of heavy metals during dredging operations.

*Persistent organic pollutants:* Except for one sample the concentration of PCB in surface sediments was well below the lower values of the Danish and German standards. It is therefore assessed that there will be no impacts related to the release of PCB during dredging and subsequent settling of PCB on the seabed. As with other recently introduced pollutants, DDT is confined to the upper 10 – 15 cm of sediment. Below 10 cm depth PAHs reach background concentrations which are on average 10 times lower than surface concentrations. Being a recently introduced pollutant, TBT reaches zero (background concentration) below 10 cm sediment depth. It is therefore concluded that there will be no impacts of persistent organic pollutants related to spill or disposal of dredged sediment.

*Enhanced vertical mixing:* The modelling studies showed that neither in the construction nor in the operation of the immersed tunnel the marine structures will have any significant impact on the stratification of the waters in the Fehmarnbelt or the Central Baltic Sea. Therefore it can be concluded that the impact of enhanced vertical mixing is negligible and will have no transboundary impact outside German and Danish territories.

*Impacts on bathing water quality:* Dredging, changed discharges and movements of the discharge points may potentially affect the transparency and numbers of faecal bacteria at the different beaches and result in deterioration of the bathing water quality.

The discharge will be done in such a manner and at such a distance from the coast that it meets the current requirements and compared with existing conditions, the Fixed Link project will only cause insignificant impacts on bathing water quality in the Fehmarnbelt area. However, during the construction phase the dredging and land reclamation activities might affect the quality of the transparency of the water along minor parts of the coast, which might affect the use of one of the beaches (Bredfjed on Lolland). All impacts will be local and will not cause transboundary impacts.



### **Transboundary impacts between Germany and Denmark**

The project pressures, which could affect the water quality parameters and thereby potentially impact the Danish and German territorial waters, are as mentioned above primarily local and only insignificant. The conclusion is that project pressures on water quality on the Danish side will only cause insignificant impacts on water quality on the German side, and vice versa.

### **Conclusion**

The investigations and assessments of water quality show that discharges of wastewater, releases from dredged materials, enhanced vertical mixing, sediment spill, and impacts on bathing water quality from construction and operation of an immersed tunnel will have no transboundary impacts on the water quality of the countries outside German and Danish territories.

Concerning transboundary impacts between Germany and Denmark the project pressures on water quality on the Danish side will only cause insignificant impacts on water quality on the German side, and vice versa.





## SEDIMENT AND SEABED FORMS

The project pressures on sediment and seabed forms related to an immersed tunnel are determined by:

- Permanent structures, which occupy a part of the seabed, such as land areas and the protection layer on top of the tunnel
- Dredging and backfilling of the tunnel trench, which result in removal of seabed forms, resuspension of sediments and sedimentation, as a result of spills from the dredging and filling works
- Dredging of access channels for production facilities on Lolland, which results in deepening of the seabed and dredging of natural seabed
- Construction of working harbours at Lolland and Fehmarn, which temporarily occupies/changes a part of the seabed
- Possible dredging at Kriegers Flak for sand for backfilling of the trench
- Possible dredging on Rønne Banke for sand for the concrete for the tunnel elements

The impacts caused by the pressures of the project can basically be divided in two types: impacts caused by the footprint and temporary structures with no potential for transboundary impacts, and another group of impacts related to the sediment spill caused by the dredging operations. Below, the different transboundary impacts are outlined.

## Transboundary Impacts

### *Impacts by the footprint and temporary structures*

The assessment of the impacts on the seabed morphology shows that the impacts will affect an area of 1,471 ha within the local zone. The impacts are partly the loss of an area of approximately 350 ha of "other seabed", meaning without special seabed forms, and partly temporary impairments of a total area of 1,115 ha with and without special current-dependent seabed forms. The permanent loss of seabed of approximately 350 ha corresponds to 0.9 % of the total seabed within the area 10 km from the alignment (near zone + local zone). The seabed within the lost area has no special importance for the seabed morphology in the Fehmarnbelt area, and the loss is assessed as being insignificant.

Likewise, the temporary impacts in the area without special seabed forms are assessed to be insignificant. The area corresponds to approximately 126 ha, which will be naturally re-established within 15 – 20 years after the construction period. Impacts will occur on 989 ha with special current dependent seabed forms, hereof 984 ha with crescent-shaped seabed forms and 5 ha with sand waves. Of these, the impacts on approximately 890 ha are assessed to be of small or medium scale.

The affected area collectively corresponds to 6.1 % of the area of the existing 16,293 ha with special seabed forms (sand waves, crescent-shaped seabed forms and other current related seabed forms) found at a distance of up to 10 km from the alignment. All the impacts on the seabed forms are temporary. Most of the changes (90 %) are solely related to a temporary change of the size of the seabed forms. In the remaining area (103 ha), corresponding to less than 1 % of the area with special seabed forms within 10 km from the alignment, the seabed forms will be temporarily eliminated. In most parts of this area, the seabed forms will be fully re-established within a maximum of 15 – 28 years.

In an area of 5 ha with sand waves, which earlier was used for sand extraction and deposition of dredged materials, the regeneration of the seabed forms takes longer time, up to approximately 30 – 40 years.

According to applied assessment criteria, temporary changes in the geometry of sea bed forms are assessed to be a small to medium impairment. Based on the relatively limited area of affected seabed forms within the Fehmarnbelt, and the character of the changes, the impacts on the seabed forms from construction and operation of an immersed tunnel are assessed to be insignificant for the seabed morphology.

All impacts are located within the local zone, and therefore no transboundary or regional impacts are expected.

#### **Impacts related to the sediment spill**

##### *Plume patterns from dredgings*

The sediment plumes from the marine works at the Fixed Link site are assessed to be local and have no transboundary impacts outside German and Danish territories. At Kriegers Flak and Rønne Banke, which are both located within Danish territorial waters, the visible plumes are located around the dredger and do not extend to transboundary waters. This is mainly due to the low fine sediment content of the sand deposits in both areas.

##### *Exceedence of sediment concentration*

The visible surface plumes will only be seen in German and Danish waters, and at any given time during the construction the suspended sediment concentration will not exceed the physical threshold value

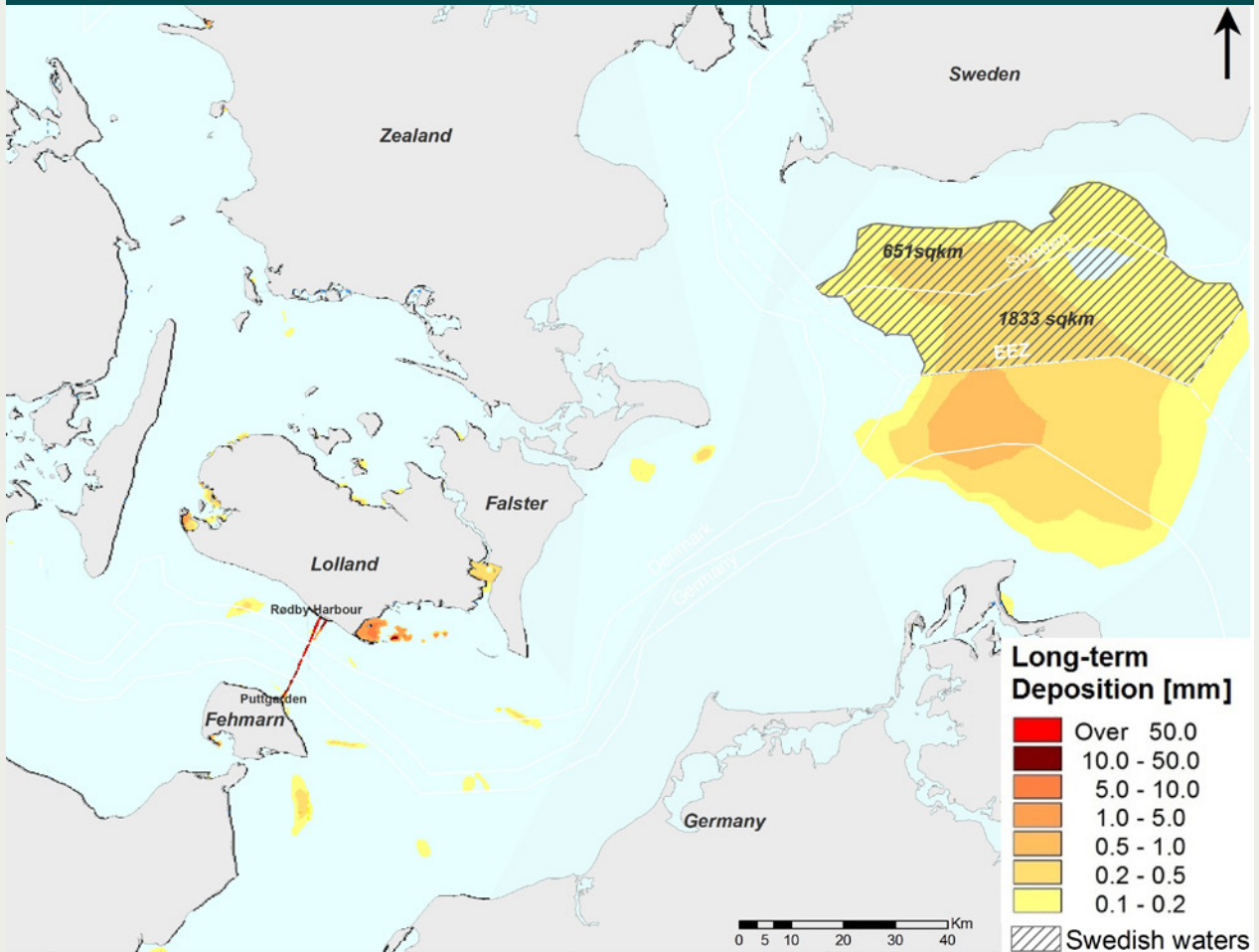
for visibility (2 mg/l) outside German and Danish territories. Similar results for Kriegers Flak and Rønne Banke can be found in the summer period, when the currents are less powerful, and the plume will not extend far away from the dredger. Transboundary territories outside Germany and Denmark will therefore not be affected by sediment spill at the extraction sites or the work areas.

#### **Deposition of spilled sediment**

The deposited sediment will be resuspended until final sedimentation in areas with the right physical conditions. The results of the modelling show that final resting places for the sediment spill are the Arkona Basin, the deeper waters in the Southern Lillebælt between Als and Ærø, Rødsand, and the edges of the Bay of Mecklenburg, where also natural deposition of fine-grained material takes place. Therefore, the deposition only occurs in the Danish, German and Swedish waters, and not into the rest of the transboundary territories (see Figure 7).

The deposits from the project in the Arkona Basin are less than 1 mm, which compared to the natural yearly deposition of approximately 10 mm, represents an excess deposition of 10 %. The sediment deposition from the project, which only takes place in natural deposition environments, is therefore assessed not to affect sand banks, sediment stability or sediment movements in Fehmarnbelt or in transboundary waters.

**FIGURE 7** Deposition of sediment spill from construction activities after the end of the construction period, excluding dredging at Kriegers Flak and Rønne Banke



At Rønne Banke and Kriegers Flak, which can be used for extraction of raw material, there will only be small areas with deposition of fine sediments of between 0.5 and 2 mm south and south-east of the dredging areas. The small deposition is due to the limited sand suction and the small content of fine sediments in the sand. All depositions from sand extraction at Rønne Banke and Kriegers Flak are assessed to occur only within German and Danish national waters and therefore have no transboundary impact.

The total deposition of fine sediments from the construction works in transboundary waters is less than 1 mm, which is less than 10 % of the natural annual deposition in the Arkona Basin, and the impact on deposition is therefore assessed to be insignificant.

#### Transboundary impacts between Germany and Denmark

Due to the highly variable hydrographical conditions in the Fehmarn-belt, smaller parts of the sediment spilled in Danish waters may spread to German waters and vice versa. However, the modelling does show that the areas potentially impacted by the suspended sediments are close to the coasts of Lolland and Fehmarn and are caused by the dredging activities near the coasts. It is therefore assessed that the sediment spill on the Danish side will only have a minor and insignificant impact on the seabed morphology on the German side and vice versa.

The possible sand extraction in the Danish part of Rønne Banke may give rise to a temporary and very small dispersal of spilled sediment into German waters. The effect is temporary and will not lead to significant impacts on the environment.

#### Conclusion

The investigations show that there will be no transboundary impacts outside German and Danish territories, except on Swedish waters, where there is expected to be insignificant transboundary impacts from sediment spill as a result of deposition of sediment from the dredging works of the construction of an immersed tunnel.



## COASTAL MORPHOLOGY

Coastal morphology concerns changes to a coastline and the adjacent seabed in terms of erosion and accretion. Such developments along a coast are caused primarily by the waves breaking at the coast.

Three pressures can affect the coastal morphology locally by:

- Reclamations at the coasts of Lolland and Fehmarn
- Protection reefs over the tunnel near the coasts
- The dredged approach channel for the work harbour on Lolland

The impacts on the coasts of Lolland and Fehmarn are caused by the reclamations, including new beaches occupying part of the original coastline and blocking the natural transport of sediment along the coast. The effect of these structures is to interrupt the natural transport of sand along the coasts – the so-called littoral drift. The littoral drift is predominantly a function of the wave climate which is a function of the wind conditions. The wind conditions are not affected by the project. The reclamations and protection reefs, but also the access channel to the production facilities on Lolland will cause changes to the near-shore wave field and thereby changes to the sediment transport along the coasts of Lolland and Fehmarn. However, no transboundary impacts are expected from this project pressure.

The only project activities which potentially could affect the coasts of transboundary waters, are the possible dredging at Kriegers Flak and Rønne Banke, where sand extraction is planned to take place during construction. The changes in water depths at the two sites could change the wave conditions, and if the wave changes reach the nearby coasts, there could be an impact on the coastal morphology.

### Transboundary Impacts

Sand extraction in the extraction area at Kriegers Flak will, on the average, lower the seabed by about 1 m, i.e. from a depth of about 20 to 23 m to about 21 to 24 m. This approximately 5 % increase in the water depth over the dredging area of 10 km<sup>2</sup> will have an insignificant impact on the wave conditions in the deepened area and absolutely no impact on the wave conditions at the nearest coasts, more than 20 km away from the sand extraction area. The wave conditions will therefore not be changed along the closest coasts of Møn, Rügen and southern Sweden; it can thus be concluded that the dredging at Kriegers Flak does not change the coastal morphology along these coasts. Therefore, there will be no transboundary impacts outside German and Danish territories from activities at Kriegers Flak.

Sand extraction in the extraction area at Rønne Banke will, on the average, lower the seabed by maximal 1 m (but will most likely be 0.5 m), i.e. from a depth of about 17 to 21 to about 18 to 22 m. The approximately 5 % increase in the water depth over the extraction area

at Rønne Banke of 9 km<sup>2</sup> will have an insignificant impact on the wave conditions in the deepened area and absolutely no impact on the wave conditions at the nearest coasts, 30 km away from the sand extraction area. Therefore, there will be no transboundary impacts outside German and Danish territories near Rønne Banke.

### Transboundary impacts between Germany and Denmark

The Lolland reclamation area has been assessed to cause significant erosion of the coastline to the east of the reclamation, and effective mitigation measures in the form of beach nourishment have been included in the project. The Fehmarn reclamation area may give rise to a small potential erosion of the coast south of Marienleuchte (Germany) and also here mitigation measures will be implemented. Under no circumstances will the reclamations on the Danish side cause changes to the coastal morphology on the German side, and vice versa.

### Conclusion

The investigations show that there is no impact from construction and operation of an immersed tunnel on coastal morphology in the transboundary region.

The land reclamations on the Danish side will cause no transboundary impacts on the German side, and vice versa.

The possible sand extraction at Kriegers Flak and Rønne Banke will have no impact on the coastal stability along any transboundary coasts.

## PLANKTON

Plankton populations are generally not considered sensitive to disturbances from construction activities in coastal areas, because of their short generation times, fast population changes in relation to environmental changes and the large exchange of water with adjacent areas. Nevertheless, phytoplankton and zooplankton serve as the base of the food chain, supporting fish, sea-floor life and other marine organisms. All fish and most invertebrates depend on plankton for food during their larval phases, and some species such as mussels continue to consume plankton their entire lives.

Four pressures are related to the construction and operation of an immersed tunnel in relation to plankton within transboundary waters:

- Suspended sediments
- Sedimentation
- Release of contaminants
- Loss of habitats

During construction, spill from dredging operations will influence light penetration and the transparency of sea water (measured as Secchi depth) that, in turn, affects primary production, phytoplankton biomass and composition, and

zooplankton production. Furthermore, suspended sediments can bury resting eggs of copepods and potentially affect recruitment of copepods, affecting the composition of the zooplankton community.

### Transboundary Impacts

#### ***Suspended sediment and sedimentation***

The modelled reductions of phytoplankton biomass correspond to a low and negligible degree of impairment, because reductions in waters of special importance for plankton (depths > 6m) are below 5 % in all years during construction. Direct impacts on zooplankton will be very low because the concentration of suspended sediment is low in those areas, where zooplankton biomass is high.

#### ***Release of contaminants***

Under maximum dredging intensity of one dredger (5000 m<sup>3</sup>/d) concentration of persistent organic pollutants (PCB, DDT, PAH, TBT) and heavy metals are not predicted to exceed the environmental quality standards set to protect the marine environment, not even in the sediment plume near the vessel. The impact of toxic substances released from the sediments is therefore assessed as insignificant for plankton living in transboundary waters.

#### ***Loss of habitats***

Permanent impacts of the immersed tunnel relate to loss of pelagic habitats for plankton. The volume lost constitutes approximately 0.03 % of the total pelagic volume (0 – 20 m) in the Fehmarnbelt and adjacent waters. Such low proportion, along with the fact that loss is mainly confined to waters where importance for plankton is low, leads to the conclusion that impairment caused by the loss of habitats is negligible. Overall, the assessment showed that minor impacts on plankton will only appear in German and Danish territories, and therefore no transboundary impacts are expected to occur for plankton organisms.

#### **Transboundary impacts between Germany and Denmark**

Concerning transboundary impacts between Germany and Denmark, there are no local impacts on phytoplankton or zooplankton in Danish waters from the project with a potential for having impacts in Germany and vice versa.

#### **Conclusion**

The investigations show that there will be no transboundary impacts outside German and Danish territories on plankton from construction and operation of an immersed tunnel.

There will be no transboundary impacts between Germany and Denmark.



## BENTHIC FLORA

Benthic vegetation is a valuable part of the coastal ecosystem due to its function as a three-dimensional habitat as well as a nursery, breeding and/or feeding ground for invertebrates and fish. The habitat function of vegetation is dependent on the complexity and longevity of their key species as well as the size and coverage of the habitat itself.

Eight project pressures have been determined to have a potential impact on the benthic flora in the Fehmarnbelt during construction and operation of the immersed tunnel, and some of them can also have impacts on the benthic flora in trans-boundary waters. The pressures are:

- Suspended sediments
- Sedimentation
- Release of contaminants

- Nutrients
- Construction vessels and imported material
- Additional solid substrate
- Land reclamation and tunnel footprint
- Drainage

### Transboundary Impacts

#### ***Suspended sediments and sedimentation***

During construction, an increased concentration of suspended sediment in the water reduce light availability for photosynthesis and growth of benthic flora, while sedimentation leads to physical stress as sediment reduces the active surface area for photosynthesis and nutrient uptake. The model simulations predict that the response of benthic

flora to increased concentrations of suspended sediment is highest in the first and second years of the construction phase of the immersed tunnel. During the following years, the benthic flora recovers to a state close to that for the reference situation with no sediment spill. The maximum thickness of sediment layers persisting > 10 days is 8 cm and occurs directly at the alignment area as well as in the Rødsand lagoon. Time series for the Rødsand Lagoon showed that the sediments are re-suspended from time to time, and that the overall thickness of deposited sediments will therefore be reduced.

#### ***Release of contaminants, nutrients, and introduction of non-indigenous species***

Furthermore, benthic flora can be influenced, if dredging activities are resulting in concentrations of contaminants in the water column exceeding environmental quality standards (EQS) for seawater, or





if the nutrient loading is increased. During construction increased ship traffic and imported material also increase the risk of an introduction of non-indigenous species. Impacts from these pressures are assessed to be non-existing, because of the low content of contaminants or nutrients in the dredged materials and the low risk of introducing non-indigenous species. Therefore the benthic flora in the transboundary region will not be affected during the construction phase or the operational phase of the immersed tunnel.

#### **Construction vessels and imported materials**

The additional ship traffic related to the construction works corresponds to a minor pressure compared with the very intense existing traffic through Fehmarnbelt, where approximately 38,000 ships from other water areas pass every year. Furthermore, the additional ships and the new materials are expected to come from areas with comparable

benthic flora, so there is only a negligible risk of introducing non-indigenous (invasive) species into Fehmarnbelt.

#### **Additional hard substrate with risk of introducing non-indigenous species, and footprint and land reclamation on top of existing macroalgae communities**

Other pressures of relevance during operation of an immersed tunnel are additional solid substrate, which can impact benthic flora communities in three ways:

- Introduction of hard-bottom macroalgae communities to areas previously dominated by soft-bottom communities
- Increased risk of introducing non-indigenous species
- Loss of seabed due to footprint and land reclamation on top of sites with existing macroalgae communities

Overall, an immersed tunnel affects 298 ha of benthic flora; 218 ha are affected by structure-related and 80 ha by construction-related impacts. Nearly all of the lost area occurs in Danish national waters and EEZ waters (298 ha). In German waters, 0.22 ha are lost: 0.22 ha in German national waters and none in EEZ waters.

Out of the eight identified macroalgae communities, only one community has been assessed to be affected significantly due to loss of habitat caused by the footprint of the immersed tunnel. However, the impact is only assessed to be significant for the hard bottom macro-algae *Furcellaria* community (Red Seaweed) along Lolland's coastline. The *Furcellaria* community is common in the whole Baltic Sea area and is dominant or occurring frequently from the Skagerrak to the Bothnian Sea. Therefore, the loss will not threaten the existence





or function of the community in the Baltic Sea and no transboundary impacts will occur. In all other benthic flora communities the impacts are assessed as insignificant and not transboundary.

#### **Drainage**

Freshwater outlets coming from the accumulation of water from the project structures during operation can result in an increased pressure on benthic flora. However, the additional discharge of rainwater runoff from structures of the immersed tunnel, water from cleaning and maintenance of the inside of the immersed tunnel, and possible fire fighting are not assessed to be more than 3,500 m<sup>3</sup> per year. The normal discharge from the wastewater treatment plant and dewatering by the pumping stations by the same water mains will ensure sufficient dilution, even before the mixing and dilution with the Fehmarnbelt water. No transboundary impacts are therefore

expected on the benthic flora as a result of freshwater discharges.

#### ***Benthic Flora at the extraction sites at Rønne Banke and Kriegers Flak***

The observations did not detect any macroalgae, seagrasses or visible concentrations of microalgae (at the seabed surface) in the affected area at the sampling stations at Rønne Banke; only very limited quantities of macroalgae were present in the affected area at Kriegers Flak or in the vicinity, and the impacts on macroalgae at the extraction sites are assessed to be negligible. The observed green thin layer, consisted most likely of deposited algae and benthic microalgae, and it will be lost, when the sand at the seabed is extracted. The growth rate of small microalgae is very fast (hours-days), and the algae will hence recolonize very fast after the extraction has ended. Hence, the impact on the microalgae is very

limited at Rønne Banke and Kriegers Flak.

#### **Transboundary impacts between Germany and Denmark**

Concerning transboundary impacts between Germany and Denmark, there are local impacts on the benthic flora in the Danish waters from the land reclamations, but they have no potential for having impacts in German waters and vice versa. The local impacts are anyway much larger in Denmark than in Germany.

#### **Conclusion**

The investigations show that there will be no transboundary impacts outside German and Danish territories on benthic flora from construction and operation of an immersed tunnel.

There will be no transboundary impacts between Germany and Denmark.

## BENTHIC FAUNA

The benthic fauna communities in the Fehmarnbelt are important components of the marine ecosystem, since benthic fauna functions as a key link between primary producers and the higher trophic levels, and many benthic fauna communities also contribute to the creation of the substrate that actively shapes their surroundings.

In the Fehmarnbelt and transboundary waters, only the following two pressures, out of eight identified, have been determined to have a potential impact on the benthic fauna, as these have magnitudes of pressure that may exceed natural levels. The pressures are:

- Suspended sediments
- Sedimentation

Increased ship traffic and import of new materials such as sand, gravel and stones that will be introduced to the area in the construction phase may increase the risk of introduction of non-indigenous species. However, this is perceived as a minimal pressure in relation to the benthic fauna, as the construction and filling materials are primarily introduced from adjacent sea areas, which means that no non-indigenous species will be introduced.

## Transboundary Impacts

### *Suspended sediment*

The modelling shows that approximately 57,942 ha of benthic fauna communities in the Fehmarnbelt will be affected by suspended sediment from the construction phase. Up to 99 % of the area shows a minor degree of impairment, while 1 % is impaired to a medium degree, mostly in the *Dendrodoa* community. The maximum decrease in mussel biomass is estimated to be 10 % within small local areas along the coasts of Lolland and Fehmarn. However, the impact of suspended sediment has no transboundary impact outside German and Danish territories on benthic fauna.

### *Sedimentation*

The impact from sedimentation is distributed across all fauna communities, but the *Arctica* community is affected most in terms of area (16 ha). The impact is located largely around the tunnel trench (within 500 m from the tunnel trench) and in the Rødsand Lagoon east of the tunnel trench. The maximum accumulation of sediment is modelled to 7 cm near the tunnel trench. In other areas, sedimentation rates are typically below 1 mm per day. However, the impact is local and therefore no transboundary impact on benthic fauna caused by sedimentation is expected outside German and Danish territories.

### *Benthic Fauna at the extraction sites at Rønne Banke and Kriegers Flak*

The impact from suspended sediment and sedimentation from dredging at Kriegers Flak and Rønne Banke is not considered to have an impact on the adjacent areas, since the deposits are very thin, less than 1 mm. In comparison the natural deposition in the Arkona basin is approximately 10 mm during the construction period, and thus the effect of the immersed tunnel represents an excess deposition of 10 %. The deposition in these areas therefore does not influence benthic fauna outside German and Danish territories.

### *Transboundary impacts between Germany and Denmark*

Regarding suspended sediment, approximately 60,000 ha of benthic fauna communities are affected from the construction phase. Up to 99 % of this area is affected to a minor degree, while 1 % is affected to a medium degree, mostly in the *Mytilus* community. Most of the impacts are observed in the shallow waters along the Lolland coast, while a smaller area is observed along the northern and eastern coast of Fehmarn. The degree of the impact is largely minor and not significant.





Concerning sedimentation, 11,871 ha of benthic fauna communities will be affected according to the analyses. In 85 % of this area there is no impact for the benthic fauna, nearly 15 % of the area is affected insignificantly and 16 ha are affected significantly. The impact is located largely around the tunnel trench (in the near zone) and in the Rødsand Lagoon.

A total of 584 ha of benthic fauna communities are affected by the footprint. Most of the impacts are from the permanent loss due to reclamation areas at Lolland and Fehmarn and from temporary loss due to the tunnel trench. All temporary impacts are expected to be recovered within 5 – 22 years, depending on the location and the affected community. The transboundary impact from temporary loss of area is assessed to be not significant.

Concerning additional solid substrate, 149 ha of solid substrate are added due to the structures of the immersed tunnel, mainly (85 %) due to the protection layer on top of the tunnel elements. Their transboundary impact is not significant.

The conclusion is that in the Fehmarnbelt itself the impacts are very local, and none of the impacts in Danish waters, which are graded overall as not significant, have any transboundary impacts on German territory, and vice versa.

### **Conclusion**

The investigations show that the impact from construction and operation of an immersed tunnel will have no transboundary impacts outside German and Danish territories on benthic fauna.

None of the impacts in Danish waters, which are overall assessed as being not significant, have any transboundary impacts on German territory and vice versa.

## FISH ECOLOGY

The Fehmarnbelt plays a key role in the water exchange system of the Baltic Sea and is an important passage for migrating cod, herring and silver eel, as well as a spawning area for a number of fish species, including cod and flatfish.

The following pressures were identified as relevant to fish, in relation to construction and operation of an immersed tunnel in the Fehmarnbelt.

- New land reclamations (permanent or temporary loss of habitats)
- Changes in the hydrographical regime
- Sediment spill
- Noise and vibrations
- Changes/impairments of fish habitats (indirect pressures)

### Transboundary Impacts

#### **Land reclamations**

The new land reclamations will affect the shallow part of the near zone, including the redlisted sea stickleback. The temporary seabed reclamation will, in addition, affect benthic species at greater depths, including the red listed snake blenny, along the tunnel trench. However, the new land reclamations and temporary seabed reclamation are very local and do not extend into transboundary areas outside German and Danish territories.

#### **Changes in the hydrographical regime**

No transboundary impacts are expected outside German and Danish territories on fish as a result of changes to the hydrographical regime caused by the construction and operation of an immersed tunnel.

#### **Sediment spill**

The possible direct transboundary effects are mainly caused by sediment plumes and re-suspension of sediment. Apart from the Fehmarnbelt the central areas of the Mecklenburg and Arkona Bight will be affected by sediment spill. A medium level of sedimentation is expected in these bights of maximum 0.5 mm of sediment deposition the first three years of the construction period. The Mecklenburg and Arkona Bight are important spawning areas for flatfish and particularly for cod. A temporary impairment of eggs and larvae of these species cannot be excluded, although the natural background level of suspended sediment is considered a much more severe pressure.

#### **Changes/impairments of fish habitats and noise/vibration**

During the construction phase a barrier effect caused by dredging of the tunnel trench and immersing the tunnel elements is expected for anadromous fish species that spend most of their adult lives at sea, but return to fresh water to spawn, and also for fish species with long term migrations (cod, whiting, herring and sprat). These species avoid areas with a high intensity of sediment plumes and noise/vibration.

Thus, the migratory fish species might not reach areas of importance (spawning and feeding areas) in adjacent waters.

Sediment spill and noise can cause a temporary local impact on the migration of the Rügen herring from the spawning grounds at Rügen to the feeding areas in the Skagerrak. This can potentially have a theoretical impact on the stock in Norwegian and Swedish waters. The construction of the immersed tunnel may also affect the spawning migration of cod and the survival of eggs and larvae locally, which might theoretically affect the cod recruitment in Swedish and Polish waters. Impacts on the migration of whiting from nursery areas in the Baltic, back to the North Sea, might affect the whiting stock outside the project area, while impacts on sprat migration only imply local impacts. The impacts are all temporary and generally of very low intensity, and therefore only insignificant transboundary indirect impacts are expected outside the German and Danish areas. There are no such impacts on the fish ecology in the operation of the immersed tunnel.

The impacts on sprat are only local.

#### **Fish Ecology near Rønne Banke and Kriegers Flak**

Due to the low intensity of direct impacts by sedimentation at Rønne Banke and Kriegers Flak the potential transboundary effects for these areas are classified as insignificant. The overall conclusion is that there will be no impact on fish within the extraction areas due to extraction of sand. Outside the mined areas,





the impact is very limited. Furthermore, the impacts in the extraction area are temporary and do not have significant impacts on the environment of the Baltic Sea region.

#### **Transboundary impacts between Germany and Denmark**

Overall only insignificant or minor impacts are expected outside the near zone. In the near zone most impacts are expected to be due to loss of seabed, where land reclamation in both German and Danish shallow waters reduces nursery areas/grounds for cod and flatfish and habitats of shallow-water species.

Transboundary effects between Germany and Denmark at the operational phase of the immersed tunnel are of minor importance and insignificant (noise emission, sediment spill and barrier effect).

Most impacts on all fish species are in the near zones in Germany and Denmark, thus having no transboundary impacts. Only fish species migrating to other waters will be affected, e.g. cod, whiting, and herring. The impacts on these species will be small and insignificant.

The conclusion is that project pressures on fish ecology on the Danish side will only cause insignificant impacts on fish ecology on the German side, and vice versa.

#### **Conclusion**

The investigations shows that there are insignificant transboundary impacts outside German and Danish territories on some fish species (cod, herring, whiting) as a result of the construction and operation of an immersed tunnel.

Project pressures on fish ecology on the Danish side will only cause insignificant impacts on fish ecology on the German side, and vice versa.

## COMMERCIAL FISHERY

An infrastructure project like the construction and operation of an immersed tunnel across the Fehmarnbelt might affect fish stocks and the access to fishing areas, which may have economic consequences for the commercial fishery.

The project pressures relevant to the commercial fisheries and their resources (commercial fish species) have been assessed to concern:

- Land reclamation
- Sediment spill
- Noise and vibration
- Changes in hydrographical regimes
- Other pressures potentially causing avoidance responses and loss of fish habitats

The magnitude of pressure derived from light, electro-magnetic fields and contaminants are assessed as insignificant

### Transboundary Impacts

A number of the commercial fish species present in the Fehmarnbelt migrate over large distances between spawning grounds, nursery areas and feeding grounds. During these migrations and residency periods, these commercial species pass through or reside in national waters of other countries and international waters and fishermen of other countries will fish for the same species. Thus, it is therefore recognised that the commercial fisheries in other

countries are indirectly impacted, if shared commercial fish stocks are affected by the establishment of the immersed tunnel.

### Land reclamation

Results of the investigation show that there will be no impacts on trawl fishing, gill net fishing or seine net fishing in the Fehmarnbelt during construction activities, operation, or due to reclamation of areas/footprints, as this type of fishing takes place in deeper waters. As the migration behaviour of fish (e.g. herring, cod and eel) is not affected, no impacts on distant subpopulations and on distant fishing of the fish species occurring in the Fehmarnbelt are foreseen. Thus, in the case of commercial fishing, no transboundary impacts outside German and Danish territories will occur.

### Sediment spill and noise/vibration

There are no impacts on pound net fishing in the Fehmarnbelt during construction or operation activities. Sediment plumes will be greatest along the coastal areas of Lolland and may have an impact in short time intervals, but the impact on pound net fishing is only relevant on a local scale, and there will be no restrictions on the fishing activities outside German and Danish territories. In general, the impacts from the tunnel pressures such as sediment spills, noise and vibrations are only minor or insignificant in all cases.

### Changes in the hydrographical regime and other pressures

Hydrographical changes such as land reclamations and construction at the seabed may have an impact

on the yield of the fishing, by causing avoidance reactions or changed distribution of commercial fish species. It can also be a consequence of e.g. changes of seabed substrates.

Impacts from the construction, operation and structures of the immersed tunnel were low to medium on all commercial fish stocks that have extended geographical distribution. Significant impacts were only registered in the near vicinity of the fixed link i.e. they are classified as local and can therefore be considered insignificant in relation to potentially affecting transboundary fish ecology.

### Commercial Fishery at Rønne Banke and Kriegers Flak

Impacts on commercial fishery from the dredging at Kriegers Flak and Rønne Banke (fishery here is only undertaken with trawl) are restricted to loss of fish within the dredged area, due to loss of food sources for the fish. This impact is only expected to occur within a 5 year period, hereafter a re-colonisation of the benthic infauna and epifauna is expected. Furthermore, the fishing can be affected due to fishery restrictions during dredging activities. However, the impact is low (days) and only temporary within dredging periods. The fish can also be re-distributed to other areas due to increased sediment deposition, and this will cause a low impact on the trawl fishery in the area. This impact is, however, temporary and will be negligible after a few months.





The impact on the trawl and net fishing at Kriegers Flak within the extraction period (days) is only minor, because fish move to other areas, from where they can be fished. An impact on the undertaking of fisheries is only short-term (during the extraction period). In connection with the sand extraction, the fishery will be affected during the sand extraction periods. Because of the risk of collision, there will be zones around the extraction sites, where fishery is not possible. This impact is only expected over a short time period (hours).

#### **Transboundary impacts between Germany and Denmark**

The fishing with trawl, gill nets, pound nets, and Danish seine nets will only be affected locally due to the construction and operation of an immersed tunnel. Apart from gill nets that locally will be affected

significantly, all other types of fishery will only be affected insignificantly.

There are no transboundary impacts on commercial fishery between Germany and Denmark as a result of the pressures from the construction and operation of an immersed tunnel.

#### **Conclusion**

The investigations show that the construction and operation of an immersed tunnel will have temporary impacts on commercial fishery in the construction phase, which do not reach beyond German and Danish territories.

At Rønne Banke and Kriegers Flak the impact on the fishery is negligible, since impact primarily occurs within the extraction area, where fishing cannot take place in shorter periods of time.

Overall, the investigations show that there will be no transboundary impacts outside German and Danish territories regarding commercial fishery from the construction and operation of an immersed tunnel.

The project pressures on commercial fishery on the Danish side will not cause any impacts on commercial fisheries on the German side, and vice versa.



## MARINE MAMMALS

In the Fehmarnbelt and the Baltic Sea three species of marine mammals, which are top predators of the food chain, occur regularly:

*The harbour porpoise*, a small cetacean, which is widely distributed in the western Baltic Sea and the North Sea

*The harbour seal*, with haul-out sites in the Rødsand lagoon, holding a substantial proportion of the small subpopulation in the western Baltic Sea

*The grey seal*, which has its only and most southern breeding site at Rødsand Lagoon

Five project pressures, which may impact marine mammals, have been identified from the construction and operation of an immersed tunnel:

- Noise from construction-related activities
- Habitat loss and change
- Contaminants
- Barrier effects
- Suspended sediment

### Transboundary Impacts

Of the three species of marine mammals occurring in the Fehmarnbelt, only the harbour porpoise may be directly affected by the project. The seals seldom forage in the near-zone of the planned alignment, and their haul-out places are located

at least 8.5 km from the alignment and therefore, they cannot be affected, except indirectly by barrier effects and suspended sediment.

### Noise

Investigation results show that only 3 – 7 individuals of porpoise are expected to be affected at a time by noise in winter and summer, disturbing a maximum of 0.45 % of the local Fehmarnbelt study area population and less than 0.1 % of the population of the Belt Sea and Western Baltic. The number of harbour porpoises, which maximally will be affected by under water noise are 3 from the dredging works and 4 from sheet piling. Therefore, the impact is insignificant at the population level (<1 % of both the Fehmarnbelt study area population and the Belt Sea and Western Baltic population) for the occurrence (staging) and nursery areas of harbour porpoise.

### Habitat loss and change

Investigation results show that in relation to habitat loss 1 – 2 porpoises are expected to be affected by construction works, with a maximum disturbance of 0.1 % of the local Fehmarnbelt study area population and less than 0.1 % of the estimated population in the Belt Sea and Western Baltic. Moreover, less than one porpoise is expected to be affected by habitat loss during the operation phase, with a maximum disturbance less than 0.1 % of the local Fehmarnbelt study area population. The impact is therefore insignificant for the population in the Belt Sea and Western Baltic Sea.

### Contaminants

The analyses of sediment samples for contaminants in the Fehmarnbelt study area show levels at or below the lowest sediment quality criteria (Action Level). It is therefore concluded that contaminants released as a result of the project will have no adverse impacts on marine mammals in the Fehmarnbelt area or for the populations in the Belt Sea and Western Baltic Sea, living in transboundary waters.

### Barrier effects

Given the fact that less than 30 % of the alignment across Fehmarnbelt will be affected by the project at the same time and thereby resulting in barrier effects during construction, it has been concluded that there will be no local impact from barrier effects during construction, as the animals will easily be able to move around each dredging section. It has therefore also been assessed that the populations of marine mammals in the Belt Sea and Western Baltic Sea will not be affected by this pressure. Likewise, there will be no impact of the immersed tunnel during operation, as animals will be able to pass over the top of the immersed tunnel, once it is constructed.

### Suspended sediment

The sediment spill from the dredging of the tunnel trench and the temporary working harbours will increase the amount of suspended matter in the water. Harbour porpoises, which orient themselves with the help of echolocation, are adapted to conditions with a high degree of turbidity, and seals locate prey using whiskers, vibrissae, and



thus to some extent do not depend on vision. Therefore, no impacts on marine mammals are expected as a result of construction-related sediment spill.

#### **Marine Mammals at the extraction sites at Rønne Banke and Kriegers Flak**

The planned sand extraction activities on Rønne Banke will have little impact on harbour porpoises and seals in the area. There are few animals in these areas, and the sound levels are not assumed to affect the animals except at very close range. The impact on marine mammals is assessed to be insignificant. Considering the results of the sediment spill modelling, sediment plumes are not expected to cause any direct impact on seals and porpoises near the sites. The impacts on availability of prey, especially juvenile fish are assessed as minor. However, since the affected areas are expected to be very small com-

pared to the total area available to the animals on Kriegers Flak and as the duration of the impact is short, no significant negative impact due to sediment dispersal are expected near the sites.

In summary, the impacts from raw material extraction at Kriegers Flak and Rønne Banke lead to mainly temporary impacts, which do not reach beyond the German and Danish territories, and thus do not pose an impact on marine mammals living in transboundary waters.

#### **Transboundary impacts between Germany and Denmark**

There are no significant impacts on harbour porpoise, but there will be a small area with noise levels from the construction work that might cause avoidance behaviour. In a worst-case scenario the dredging will cause a continuous noise barrier above 144 dB re 1µPa2s stretching about 5,3 km, which corresponds

to less than the 30 % of the total length of the alignment.

As described for the transboundary impacts, the severity of impairment from the sediment spill, footprint, change of habitat, and reduction in food availability are assessed as being negligible for the transboundary impacts between Denmark and Germany.

#### **Conclusion**

The investigations show that there will be no transboundary impacts outside German and Danish territories on marine mammal species from the construction and operation of an immersed tunnel.

The severity of impairment from the sediment spill, footprint, change of habitat, and reduction in food availability is assessed as being negligible for the transboundary impacts between Denmark and Germany.

## BIRDS

In the Fehmarnbelt the bird community is dominated by non-breeding water birds, which use the area for moulting, staging or wintering. In addition, a variety of bird species pass through the area on migration. More than 200 bird species have been assessed during the investigations of the potential impacts of an immersed tunnel on the environment. However, only those species where a potential transboundary impact might occur, are included in the assessment.

Four main pressures with respect to birds have been identified from the construction and operation of an immersed tunnel:

- Habitat loss and change
- Barrier effects and disturbance from construction vessels
- Reduced light conditions in the water column caused by sediment spill
- Collision risk with construction vessels

The project will have no impacts for birds during the operation phase.

### Transboundary Impacts

#### **Breeding water birds**

*Loss of habitat:* The overall assessment of the severity of habitat loss from the footprint of an immersed tunnel across the Fehmarnbelt has been assessed to be minor for all breeding waterbird species.

As such, the impact of the habitat loss by the tunnel footprint has been assessed to be only relevant for birds breeding in the northern part of Fehmarn, in the south of Lolland and partly for birds breeding in the western part of Rødsand Lagoon, which might commute between the impact zone and the breeding area. Cormorants breeding in the western part of Fehmarn and birds of other breeding colonies within the German Special Protection Areas (SPAs) are mostly expected to use marine areas close to their colonies and not regularly visit the affected project area.

Since the impact from habitat loss has been assessed to be insignificant for all breeding water birds on a local scale, there will be no transboundary impact for those living outside German and Danish territories.

#### **Non-breeding water birds**

*Sediment spill:* Based on model calculations it is estimated that there will be impacts on 8,300 – 8,800 Common Eider and 950 – 990 Red-breasted Merganser the first two winters of the construction period within the investigation area, due to sediment spill, which leads to reduced light in the water column. This impact is expected to cause a displacement of foraging areas. The food availability is not affected significantly.

In total, the resulting impact of the sediment spill is expected to be a reduction in the number of diving water birds in the affected areas within German and Danish territories. The impact is estimated to be

temporary and confined to the first two years of the construction phase. An increase in density of the Common Eider means a doubling of the mortality rate to 1,200 individuals. This extra mortality of 600 individuals corresponds to less than 0.1 % of the biogeographic population and is far below the natural variation in mortality (which is 17,500 p.a. equal to 7 % of the total bio-geographical population). Thus, there will be a theoretical transboundary impact, but the possible higher mortality will not be measurable in the breeding area of the Common Eider in the Eastern Baltic.

Redistribution of 950 – 990 Red-breasted Merganser the first two winters of the construction period, which equals approximately 0.6 % of the bio-geographical population is below the internationally recognized criteria of 1 %. The impact is therefore assessed as insignificant for the transboundary region, and as being local.

*Disturbances and barrier effects from vessel traffic:* It is estimated that 1,500 Eurasian Widgeon, 700 Pochard and 7,000 Tufted Duck will be displaced due to disturbances from service vessels and marine works during construction. In addition, calculations show that 4,100 Common Eiders will be displaced due to these pressures. This is less than 1 % of the bio-geographical population of all four species, and there are thus no transboundary impacts outside German and Danish territories on these species. Furthermore, the impact is temporary for those species since it will be confined to parts of the construction phase.



The impact on the above-mentioned bird species consists of a local displacement of sensitive water birds on the Danish and German territories, mostly on stretches along the Lolland coast which means that the impacts are local. A consequent redistribution of water birds within the Fehmarnbelt area leads to statistically minor increased mortality.

No transboundary impacts outside German and Danish territories are expected for non-breeding water birds due to disturbances and barrier effects from vessel traffic.

#### **Impacts on birds near Rønne Banke and Kriegers Flak**

The impacts (due to sediment spill and vessel traffic/light) from the extraction at Rønne Banke and Kriegers Flak on the non-breeding water birds and the migrating birds are assessed as being insignificant and with minor impact, respectively. There are no breeding birds at Rønne Banke or Kriegers Flak.

Despite the fact that the planned dredging site at Rønne Banke is located within 5 km distance from the SPA Pommeranian Bay holding the largest concentration of water birds in the German EEZ of the Baltic Sea, it is assessed with certainty that there cannot be any significant impacts on the conservation objectives of this Natura 2000 site or on the conservation objectives of any other Natura 2000 site.

All other potential impacts from habitat displacement, collision risks, and sediment dispersal impacting foraging conditions have been assessed to cause a minor impact

for birds in the extraction areas, and no transboundary impacts outside German and Danish territories are expected.

#### **Transboundary impacts between Germany and Denmark**

The indirect impact of sediment spill is among the highest pressures on birds within the German and Danish project area. The highest levels of impact are predicted to occur along the Lolland coast and within Rødsand Lagoon, which are both within Danish territory.

The indirect impacts from sediment spill will cause displacement of birds, which is significant to Eider ducks only. It is estimated, that on both sides of the German and Danish project area the reduction in the population of Eider ducks will be in the order of magnitude of 8,300 – 8,800 birds (corresponding to approx. 1.09 – 1.16 % of the bio-geographic population) in the first two winters during the construction phase, where the most intensive dredging works take place.

A reduction in the light conditions in the water column due to sediment spill has thus been assessed to have a large local impact on Common Eider and a medium local impact on Merganser. 1.2 % of the bio-geographic population of Common Eider is displaced during the construction period and 0.6 % of the bio-geographic population of Merganser is displaced, due to this indirect impact from the sediment spill.

Individual-based modelling on Common Eider duck shows that the impact from reduced light conditions in the water column does not reduce the food resources significantly. Hence, the mortality rate caused by the displacement is not expected to be significantly higher than under existing conditions, and the impact from the sediment spill is hence assessed as insignificant for Eider ducks.

The conclusion from the impacts on birds within the German and Danish project area are therefore assessed as minor for Common Eider and insignificant for Tufted Duck, Merganser, Pochard and Wigeon. Concerning transboundary impacts between Germany and Denmark, there are minor impacts on Common Eider. For other non-breeding water birds, breeding water birds, and migrating birds there are insignificant impacts.

#### **Conclusion**

The investigations show that there will be insignificant transboundary impacts on birds outside German and Danish territories from the construction and operation of an immersed tunnel.

Concerning transboundary impacts between Germany and Denmark, there are insignificant impacts on Common Eider. For other non-breeding water birds, there are also insignificant impacts across the border between Germany and Denmark.









## MIGRATING BATS

As part of the transition area between Scandinavia and the middle European mainland, the Fehmarnbelt (and the Belt Sea) is passed by migratory bats.

The main pressures during construction (temporary) and the potential impacts identified are:

- Working areas, equipment, facilities and physical structures of the fixed link including land approaches and work areas at sea
- Collision risk with construction vessels
- Barrier effects from construction vessels
- Habitat change at tunnel entrances/land approaches

Potential effects induced by the presence of the (permanent) physical structures and associated facilities of the fixed link or related to the operation of the fixed link:

- Habitat loss and/or change
- Traffic-related collision risks of bats
- Habitat change at tunnel entrances/land approaches

### Transboundary Impacts

Only three bat species (Soprano Pipistrelle, Nathusius' Pipistrelle, and Noctule) are assessed to be relevant for the EIA of the fixed link, because of their migratory behaviour.

Most of the potential pressures concerning bats were assessed to cause no impacts on the relevant bat species during their migration phase.

Therefore, these potential pressures were not assessed any further. Only the pressure 'Traffic-related collision risks for bats' was assessed to be relevant.

Traffic collisions at the tunnel entrances have been assessed as the only relevant pressures with an impact on bats. The collision risk for migrating bats is assessed to be medium for Soprano Pipistrelle and Nathusius' Pipistrelle and low for Noctule.

The overall degree of impact in the project area is assessed to be minor. A medium collision risk between bats and traffic is present at the tunnel entrances at Rødbyhavn and Puttgarden. Accordingly, the magnitude of impact on bat migration is insignificant in the Fehmarnbelt and no transboundary impacts are expected outside German and Danish territories.





### **Transboundary impacts between Germany and Denmark**

Only traffic related collision risk is assessed to be relevant for the impact assessment. Traffic-related collision risk is assessed as a medium impairment to migratory Pipistrelle species in the area of the tunnel entrances. Traffic collisions and the tunnel entrances have been assessed as the only relevant pressures. The estimated traffic volume with regard to operation of a fixed link was estimated to be between 8,000 and 9,450 vehicles on an average day. The collision risk of migrating bats near the tunnel entrances at Rødbyhavn and Puttgården is assessed to be medium for Soprano Pipistrelle and Nathu-

sus' Pipistrelle and low for Noctule. However, the impact is insignificant, even though these bat species are migrating. Therefore, transboundary impacts on migrating bats from Germany to Denmark are considered to be insignificant and vice versa.

### **Conclusion**

The investigations show that there are no transboundary impacts outside German and Danish territories on bats from the construction and operation of an immersed tunnel.

Transboundary impacts on migrating bats from Germany to Denmark are considered to be insignificant and vice versa.



## STRICTLY PROTECTED SPECIES

The construction and operation of the immersed tunnel will potentially impact strictly protected species (as defined by the Habitats Directive) on land and in the marine area.

Pressures as a result of construction and operation of an immersed tunnel are treated separately for each species and include the following pressures: Area occupation and loss of habitat, barrier effects, and kills by traffic.

Other pressures, such as lighting, noise, vibrations, ground water lowerings, nitrogen deposition and pressures resulting from exposure to contaminants are also included, when they are considered relevant.

The protected species which could potentially be impacted are: amphibians (on Lolland and Fehmarn), birds (Appendix I in the Bird Directive), bats, fish and marine mammals. Impacts on the different protected species are assessed in the chapters with the relevant environmental component.

### Conclusion

The investigations show that with the implementation of planned mitigation and compensation measures there will only be insignificant local impacts on amphibians and bats, and limited to Denmark and Germany.

Furthermore, it is assessed that a minor impact could occur on Common Eider in the transboundary

waters between Denmark and Germany because of displacement from construction vessels and sediment spill, but this impact is insignificant in other transboundary waters. No transboundary impacts are expected on the other protected bird species.

No significant impacts on marine mammals are expected either in Danish, German or transboundary waters.

Overall, the impact assessment shows that with the implementation of planned mitigation and compensation measures no significant transboundary impacts are expected on strictly protected species from the construction and operation of an immersed tunnel.



## NATURA 2000

For the project in Fehmarnbelt, the impact assessment of Natura 2000 is based on the screening report of 16 Natura 2000 areas, eight in Denmark and eight in Germany. Furthermore, in connection with the Natura 2000 assessments of the possible sand extraction at Krieger's Flak and Rønne Bank, a preliminary assessment (screening) has been made of the possible impacts by the extraction activities on additional three Natura 2000 sites in Denmark and five in Germany.

### Transboundary Impacts

The two Swedish marine Natura 2000 sites, which are the closest sites to the area, where final deposition takes place in the Arkona Basin, Falsterbo-Foteviken (SE0430002) and Falsterbohalvön (SE0430095), can be considered as potentially affected sites. However, both areas lie outside the deposition area (closest distance is 6.6 km) and neither direct, nor indirect impacts are expected for these sites.

Excess sediment concentrations in the water column as well as the expected amount of deposited sediment in Swedish waters are low compared to the natural background level in the Arkona Basin.

All other countries further east, i.e. Finland, Poland, Estonia, Latvia, Lithuania and Russia as well as Norway, and other sites in Sweden, will only receive non-measurable sediment deposition, and thus their Natura 2000 sites have not been included in the screening.

### Transboundary impacts between Germany and Denmark

For six out of the eight Natura 2000 sites in Denmark the conclusion from the screening phase shows that significant impacts with certainty are not present, and that an appropriate Natura 2000 assessment should not be conducted.

For the remaining two areas, "SCI 006X238 Hyllekrog-Rødsand" (Smålandsfarvandet North of Lolland, Guldborg Sund, Bøtø Nord and Hyllekrog-Rødsand) and "SPA DK 006X083 Coastal Zone Hyllekrog-Rødsand", the conclusion is different, however, as the screening indicates that an appropriate Natura 2000 assessment should be conducted for the immersed tunnel. Both areas lie within the Natura 2000 area nr. 173 (Smålandsfarvandet north of Lolland, Guldborgsund, Bøtø Nor and Hyllekrog-Rødsand). The rationale behind this judgment is, that it cannot be excluded that the expected amounts of sediment during the construction phase within the Rødsand Lagoon will affect benthic communities of habitat type 1160 (shallow bays and inlets), and 1170 (reefs) through light attenuation and sediment deposition. Sediment spill may also affect food resources and feeding possibilities of breeding and staging birds. The Natura 2000 assessment of area no. 173 concludes that the fixed link over Fehmarnbelt neither in the construction phase nor in the operation phase affects the nature types or species, which the area has been appointed to conserve, or is in conflict with the conservation objectives of the areas.

For five out of the eight Natura 2000 sites in Germany the conclusion from the screening shows that significant impacts on the designation basis of the sites and conservation objectives can be excluded, and that an appropriate Natura 2000 assessment should not be conducted.

For the remaining three areas, SCI DE-1332-301 "Fehmarnbelt", SPA DE 1631-392 "Meeresgebiet der östlichen Kieler Bucht", and SPA DE 1633-491 "Ostsee östlich von Wagrien" the screening indicates that a significant impact on the conservation objectives cannot be excluded. An appropriate Natura 2000 assessment is therefore required for these sites.

All potential impacts in the German Natura 2000 areas are related to the construction phase. Relevant pressures to be considered are related to construction of harbours and other dredging operations, with their resulting sediment spill and subsequent spreading of sediment over a large area.

The possible sand extraction activities on Krieger's Flak and Rønne Banke may by their sediment spill, noise and other disturbances during the extraction and transportation potentially affect Natura 2000 sites located in the influence area of the sand extraction sites.

Concerning the sand extraction at Krieger's Flak a preliminary Natura 2000 screening shows that for the two Natura 2000 sites, which by the nature and spread of the pressure could be affected ("Klinteskov og

Klinteskov Kalkgrund" on Møn (DK990000254) and the German site "Kadetrinne" (DE1339301)), it can be excluded that there should be any significant impact on the designation basis or conservation objectives.

Concerning the sand extraction at Rønne Banke the preliminary Natura 2000 screening shows that a significant impact can be excluded on the two Danish and the four German Natura 2000 sites. Both the sediment spill as well as the other pressures are considered to be negligible, and there will be no significant impacts in the Danish habitat sites "Adler Grund og Rønne Banke" (DK00VA261) and "Bakkebrædt og Bakkegrund" (DK00VA310), in the German habitat sites "Adlergrund" (DE1251301), "Westliche Rönnebank" (DE1249301) or "Pommersche Bucht mit Oderbank" (DE652302) or in the German bird protection site "Pommersche Bucht" (DE1552401).

### **Conclusion**

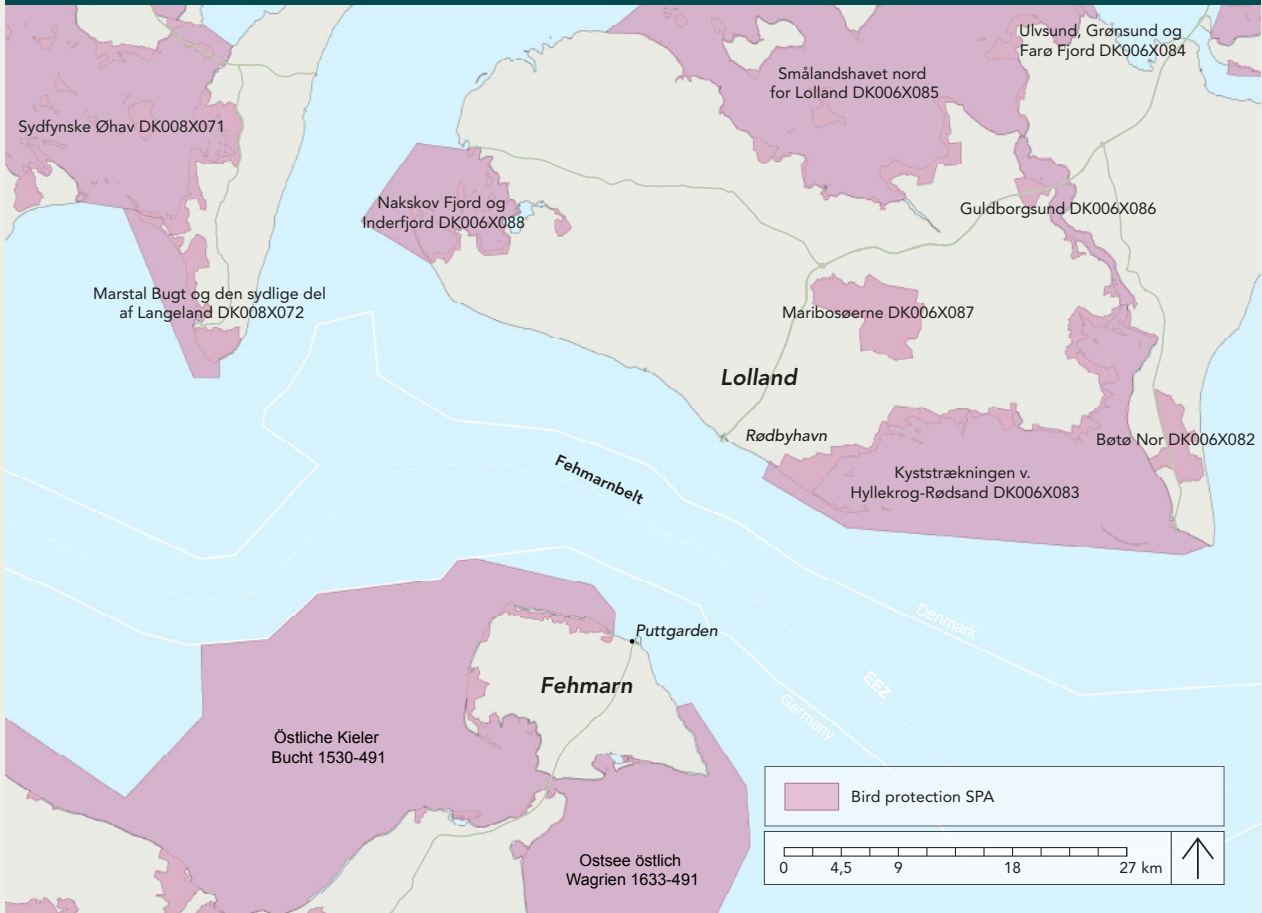
The appropriate assessment of the Danish Natura 2000 area no. 173 (Smålandsfarvandet north of Lolland, Guldborgsund, Bøtø Nor and Hyllekrog-Rødsand) concludes as mentioned that the Fehmanbelt Fixed Link will neither in the construction nor in the operation phase affect the species or habitats, which the area has been designated to conserve, nor is the project in conflict with the conservation objectives of the areas.

In Germany the appropriate assessment of the three relevant Natura 2000 areas SCI DE-1332-301 "Fehmarnbelt", SPA DE 1631-392 "Meeresgebiet der östlichen Kieler Bucht", and SPA DE 1633-491 "Ostsee östlich von Wagrien" concludes that the Fehmanbelt Fixed Link will neither in the construction nor in the operation phase affect the Natura 2000 areas, the nature types or species, which the areas have been designated to conserve, nor is the project in conflict with the conservation objectives of the areas.

In the Kattegat and further outside of the Baltic transition area, also including the possible sand extraction areas at Krieger's Flak and Rønne Banke, the impacts are assessed to be negligible, and the construction and operation of an immersed tunnel is therefore assessed to result in no impacts in the Kattegat and the Central Baltic Sea.

On the basis of the implemented Natura 2000 assessments, including both an assessment of the possible distribution of the overall pressures by the project, as well as a Natura 2000 screening of 24 Natura 2000 sites and an appropriate Natura 2000 assessment in two Danish and three German Natura 2000 sites it can be concluded that the project, including possible sand extractions on both Krieger's Flak and Rønne Banke, neither in the construction phase nor in the operation phase will affect any Natura 2000 sites.

**FIGURE 8 German and Danish Special Protection Areas SPA (top) and sites of Community Importance (SCI) in the region around the planned Fehmarnbelt Fixed Link (bottom)**



## CULTURAL HERITAGE AND MARINE ARCHAEOLOGY

It is possible to find ship wrecks from all historic periods in the Fehmarnbelt on both German and Danish marine territory. It is also possible to discover findings from habitations, fishing sites and minor findings of the way of life of prehistoric hunter-gatherer societies.

The following main pressures with respect to cultural heritage and archaeology have been identified from the construction of an immersed tunnel:

- Impacts from anchors, anchor wires and handling of anchors
- Erosion due to changing current conditions caused by the changing seabed after dredging and backfilling of the tunnel trench
- Changing seabed in the project area caused by e.g. sediment spill after dredging and backfilling of the tunnel trench, and establishment of the land reclamation (especially along the coast of Lolland)

### Transboundary Impacts

The location of the shipwrecks on Danish and German territory can potentially be affected by construction ships, anchor blocks and anchor wires during construction.

The project pressures identified for marine archaeology from the construction and operation of an immersed tunnel have no transboundary impacts outside the German-Danish EEZs. Therefore, no transboundary impacts on marine archaeology induced by project pressures are expected during construction and operation of an immersed tunnel.

### *Marine archaeology at Rønne Banke and Kriegers Flak*

As the baseline study did not observe any wrecks in the extraction area at Rønne Banke, no assessment has been found relevant for the site. Similarly, settlements have not been registered in the area.

Within the extraction area at Kriegers Flak, three ship-wrecks are registered in a database held by the Danish Heritage Agency. Actions should be taken to provide information of wreck positions to the captain of the dredger to avoid destruction due to dredging activities. However, all three wrecks are located outside the area recommended for extraction.

Ship wrecks outside the extraction area will not be affected by the project, as no activities influencing the seabed will take place here. Furthermore, settlements have not been registered, nor will they be at risk of being affected by the sand extraction due to the deep layer of sand, which has been deposited on the seabed. No impacts are therefore expected for marine archaeology in the extraction area.

### Transboundary impacts between Germany and Denmark

Because all impacts on marine archaeology are assessed to be local, no transboundary impacts are expected from project pressures in Denmark on marine archaeology in Germany, and vice versa.

### Conclusion

The investigations show that there are no transboundary impacts outside German and Danish territories on marine archaeology from the construction and operation of an immersed tunnel.

No transboundary impacts are expected from project pressures in Denmark on marine archaeology in Germany, and vice versa.



## RECREATION AND TOURISM

The tourism and recreation industries in the Baltic Sea area are likely to be dependent on the state of the marine environment. A fixed link between Germany and Denmark may have different impacts on the marine environment that can indirectly affect the tourism and recreational areas in the Fehmarnbelt area. Recreation activities include kite-surfing, water-skiing, kayaking, windsurfing, recreational fishery, and recreational boating.

The following project pressures, in relation to recreation and tourism on Fehmarn and Lolland, have been identified from the construction and operation of an immersed tunnel:

- Habitat loss and changes of recreational habitats also due to the new land reclamation (construction and operation)
- Physical and visual barrier effects of recreational areas and fragmentation of the landscape (construction and operation)
- Air, noise and light pollution of recreational areas (construction and operation)
- Sedimentation in the water column, which impacts the bathing water quality (construction)

## Transboundary Impacts

Tourists and other visitors may be temporarily affected by the construction works offshore and near-shore. This applies mainly to recreational boaters who pass the Fehmarnbelt area and for tourists visiting Lolland and Fehmarn. The possibility for practicing recreational activities offshore in the Fehmarnbelt area is assessed to be affected to a minor degree, as there are many places where such activities can take place without disturbances. As such, the offshore construction activities only occupy a minor area within the Fehmarnbelt near shore, and most of the recreational activities take place near shore.

The barrier effect caused by offshore construction works and an increased traffic intensity in the Fehmarnbelt will influence the area to a minor degree, but it is assumed that people using the Fehmarnbelt for recreational activities are already used to heavy ship traffic in the area, because there are 52 ferry passages between Rødby and Puttgarden per day.

Concerning transboundary impacts for recreation and tourism, all potential project pressures induced by the immersed tunnel are local, and hence there are no transboundary impacts.

## Transboundary impacts between Germany and Denmark

Concerning transboundary impacts for recreation and tourism, all potential project pressures induced by the immersed tunnel project are assessed to be non-existing, as they are all local. No transboundary impacts are expected from project pressures in Denmark on recreation and tourism in Germany, and vice versa.

## Conclusion

The investigations show that there are no transboundary impacts outside German and Danish territories on recreation and tourism from the construction and operation of an immersed tunnel.

No transboundary impacts are expected from project pressures in Denmark on recreation and tourism in Germany, and vice versa.



## **MATERIAL ASSETS**

The project pressures identified as relevant in relation to impacts on material assets from the construction and operation of an immersed tunnel are all related to the project area activities and material assets within or in the vicinity of the project area.

### **Transboundary Impacts**

There are no material assets at the extraction sites at Rønne Banke and Kriegers Flak. Therefore no transboundary impacts on material assets outside German and Danish territories are expected.

Project pressures that extend into transboundary areas i.e. more than 10 km from the alignment (such as sediment spill) during construction works offshore, are assessed not to affect planned or existing material assets.

### **Transboundary impacts between Germany and Denmark**

As mentioned, impacts on material assets from the construction and operation of an immersed tunnel are all related to the project area activities and material assets within or in the vicinity of the project area. Therefore, impacts on material assets in Denmark will only be of a local character and not affect German territory, and vice versa.

### **Conclusion**

The investigations show that there are no transboundary impacts on material assets outside German and Danish territories from the construction and operation of an immersed tunnel.

The project pressures on material assets on the Danish side will not cause any impacts on material assets on the German side, and vice versa.

## RAW MATERIALS AND WASTE

In this chapter the environmental impacts of raw material consumption and disposal of waste generated during construction and operation of the immersed tunnel are assessed separately.

### Raw materials

The main raw material consumption, i.e. concrete, steel and gravel have been calculated for the project including the tunnel, the land reclamation, and connecting railroad and highway.

Concerning import of raw materials, the dredged materials from the tunnel trench is planned to be used as filler in the land reclamations at Fehmarn (1 million m<sup>3</sup>) and Lolland (15 million m<sup>3</sup>). Thus, a maximum of 1 million m<sup>3</sup> of sediment will be imported from Danish territorial waters to Germany and up to 7.5 million m<sup>3</sup> of sediment will be imported from German territorial waters to Denmark. The total amount of dredged materials from the tunnel trench and cut-and-cover tunnel corresponds to 15 million m<sup>3</sup>.

### Transboundary Impacts of raw materials

Chemical analyses show that the hazardous substances are below national and international criteria, except for one sample. In this sample PCB exceeded the Danish LAC but not HAC. All contaminants are limited to the upper 10 cm

of the sediment. Therefore, no transboundary impacts from raw materials are foreseen.

The consumption of raw materials will only cause insignificant transboundary impacts on the environment. The majority of resources will potentially come from Kriegers Flak and Rønne Banke. The environmental assessment is integrated in this report.

Sediment from the Fehmarnbelt can be exported from Denmark to Germany and vice versa, as the sediment generally contains low background levels of contaminants.

### Waste

It is assumed that all waste from the project is handled and disposed of properly in accordance with applicable legislation. The total waste generation and the amount of potentially recyclable materials generated during the project are relatively small compared to waste generation at the national level.

Waste from the project will be handled in compliance with the Danish provisions of source separation, authorisation and review of construction and demolition waste. This will ensure that the vast majority of concrete, metal, sand/gravel and asphalt waste will be recycled. If the excavated volumes cannot be reused directly on site, the material will be sent to sorting facilities for reprocessing/recycling.

### Transboundary Impacts of waste

It is assessed that disposal of waste can be handled without problems in Germany and Denmark, and that there are no cross-border implications of waste.

### Transboundary impacts between Germany and Denmark

As indicated above, there will be no transboundary impacts due to consumption of raw materials or generation of waste, between Germany and Denmark during the construction or operation of an immersed tunnel. The potential import of sediment dredged from the tunnel trench from Germany to Denmark, or vice versa will not result in any transboundary impacts either.

### Conclusion

There are no transboundary environmental impacts identified by consumption of raw materials or generation of waste between Denmark and Germany and vice versa.





## AIR QUALITY AND CLIMATE

Construction of the immersed tunnel involves a number of activities on land and offshore, which will result in emissions of pollutants into the air.

The construction and operation of the immersed tunnel will also result in emission of greenhouse gasses (GHGs), either directly (such as exhaust from heavy equipment) or indirectly (such as electricity consumption and in the production of steel and cement used for the construction of the immersed tunnel). The greenhouse gasses will be released to the atmosphere and therefore add to the global emission of greenhouse gasses. The GHGs are irrelevant to air quality, but are relevant for climate change.

The emissions from marine activities, that is, from dredgers, tug boats and construction vessels, are considerable, and air quality will be locally affected. This is based on calculations of fuel consumption, and because for marine works there are fewer regulations for emissions from machines than on land. Since the activities will take place far away from residential areas and in a large area, where the air circulation is good, it is not expected that the threshold values for air quality inland will be exceeded during the construction phase.

With regard to PM<sub>10</sub> and NO<sub>2</sub> concentrations, calculations of dispersion show that on shore around the tunnel opening and up to approximately 200 m in the direction away from the tunnel opening there will be elevated

concentrations of these substances, exceeding current air quality threshold values for residential areas. However, there will be no permanent habitation in these areas, and the public will not have access to the areas, where the concentration is above the threshold values.

Project activities emitting GHGs during the construction and operation phases are:

- Construction of the fixed link, including production of tunnel elements and building materials, the main structures and construction works, temporary work sites and approach links for rail and road
- Operation of the link, excluding traffic
- Traffic

### **Transboundary Impacts**

Emissions of air pollutants from the marine activities are of a local character and are not expected to affect the air quality offshore. Likewise, the emissions of PM<sub>10</sub> and NO<sub>2</sub> inland are of a local character.

The assessment of calculated CO<sub>2</sub> emissions during construction of an immersed tunnel shows that CO<sub>2</sub> equivalent emissions of approximately 2.0 million t will be emitted compared with the situation of not establishing a fixed link across the Fehmarnbelt. Over the lifetime (120 years) of the immersed tunnel assuming the same emission and emission factors a total of 0.7 million t of CO<sub>2</sub> equivalents will be emitted during the operation.

The immersed tunnel will also result in savings of CO<sub>2</sub> emissions in the operation phase. The largest saving will be the result of the expected closure of the ferry line between Rødby and Puttgarden. In addition, there will also be a reduction of emissions from freight transport on road and rail. The reason for this is an expected transfer of road freight to rail and a decrease in travel distance for the rail freight. In its lifetime, the immersed tunnel will save over 22,000,000 t of CO<sub>2</sub> compared to a situation with continued ferry service, which is considered a positive impact for the climate.

The emission of GHGs from the construction and operation of the immersed tunnel is overall a small contribution compared to the national and global GHGs emission.

### **Transboundary impacts between Germany and Denmark**

Emissions from the marine activities are as mentioned of a local character and not expected to affect the transboundary air quality. Likewise, the emissions of PM<sub>10</sub> and NO<sub>2</sub> inland are of a local character, and emissions in Denmark will not affect the air quality in Germany and vice versa.

The emissions of GHGs are assessed as being of no relevance for the air quality on Lolland and Fehmarn.

### **Conclusion**

The Fixed Link project is assessed not to result in significant transboundary impacts outside German and Danish territories as a result of emissions from construction works and the operation of an immersed tunnel. However, over time there will be a minor positive impact from the expected closing of the ferry line between Puttgarden and Rødby and the expected transfer of freight from road to rail.

The conclusion regarding transboundary impacts between Germany and Denmark is that emissions on the Danish side from marine construction activities and emissions of PM<sub>10</sub> and NO<sub>2</sub> inland will not have impacts on air quality on the German side and vice versa.

## SHIP TRAFFIC AND NAVIGATION

Construction of an immersed tunnel involves a number of marine activities, which will affect the ship traffic in the Fehmarnbelt from adjacent areas.

The project pressures in relation to ship traffic are:

- The offshore construction works
- Exclusion zones
- Work areas offshore
- Barrier effects from construction works

The offshore construction related traffic is estimated to cause 130,000 movements in total during the four years it takes place (approximately 32,000 p.a. which corresponds to the present scenario of the movements of the ferries that sail between Puttgarden and Rødbyhavn). About half of those movements are bound to cross the international T-route in the Fehmarnbelt.

### Transboundary Impacts

#### ***The offshore construction works, exclusion zones and work areas offshore***

The majority of the dredging is related to dredging of a trench across the Fehmarnbelt where the immersed tunnel will be placed, but the works also include dredging for work harbours, access channels

to work harbours, and dredgings for portals and ramps near the coast associated with the construction of the immersed tunnel. The dredging is planned to be done by backhoe dredgers and trailing suction hopper dredgers, and the sediment will be transported to the reclamation areas with barges. Guard ships will be placed close to the dredging areas on both sides of the trench.

The tunnel elements will be towed from the work harbour to holding areas in the vicinity of the tunnel alignment by tug boats. The tunnel elements are stored in holding areas until they are moved into position and immersed.

#### ***Barrier effects from construction works***

There will be a barrier effect from the offshore construction works, but since all types of ship traffic can still pass the Fehmarnbelt during the construction phase, this is not assessed as a significant impact.

However, the impacts from construction of an immersed tunnel lead to mainly temporary local impacts, which do not extend beyond the German and Danish Exclusive Economic Zones (EEZ), and thus in the case of ship traffic, no significant transboundary impacts occur. This is mainly due to the effective mitigation measures such as the VTS system and the guard ships, as well as the WVC centre, which all will be in operation during the construction phase. A permanent VTS system has

already been put in place in Travemünde by the German authorities, which takes care of the German part of the T-route. These measures ensure that all types of traffic in the Fehmarnbelt can continue as usual during the construction phase. During operation there will be no impacts for ship traffic with an immersed tunnel.

#### ***Impacts on Ship traffic at Rønne Banke and Kriegers Flak***

Only a smaller amount of ship traffic (135 – 670 passages) passes Rønne Banke and Kriegers Flak (approximately 800 – 1,400 passages are expected during the construction phase). The extraction activities might cause the changing of sailing routes during the extraction period due to approximately 135 – 670 expected passages of construction-related traffic. The impact is regarded as minor.





### **Transboundary impacts between Germany and Denmark**

As mentioned, the impacts from construction and operation of an immersed tunnel is assessed to lead to temporary local impacts in the Fehmarnbelt, which do not extend beyond the German and Danish Exclusive Economic Zones (EEZ), and thus in the case of ship traffic and navigation, no significant transboundary impacts occur. There are also no transboundary impacts between Germany and Denmark, as all impacts are considered local and not significant.

### **Conclusion**

The investigations show that the impact from construction and operation of an immersed tunnel is assessed to have no significant impact on the ship traffic in the Fehmarnbelt, Rønne Banke or Kriegers Flak and the transboundary region. This is mainly, because the traffic is allowed to operate during the construction phase, and because the implementation of the different risk reduction measures (mitigation) continuously secures the on-going traffic.

The project pressures on ship traffic and navigation on the Danish side will not cause any impacts on ship traffic and navigation on the German side, and vice versa.

## CUMULATIVE IMPACTS

When several planned activities/projects within the same geographical area have an impact on environmental factors at the same time, cumulative impacts may occur.

The potential for transboundary cumulative impacts associated with an immersed tunnel in the Fehmarn-belt has thus been assessed. The assessment only includes planned offshore projects of the countries of origin (Germany and Denmark) of the immersed tunnel, as no planned offshore projects/activities of third parties have been identified.

### Transboundary impacts

The potential cumulative transboundary impacts have been assessed by analysing impacts from a number of projects, which are mostly offshore wind farms, as well as the replacement of a bridge across the Storstrøm in Denmark. All projects are either German or Danish owned, and they are all planned within German and Danish territories.

The assessment shows that the planned offshore wind farms Arkona-Becken Südost, EnBW wind farm Baltic 2, Wikinger wind farm and the planned wind farm at Kriegers Flak all lie more than 100 km from the project area of the immersed tunnel. Potential cumulative impacts in relation to these projects are sediment spill and displacement of habitat.

Regarding sediment spill, no cumulative impacts are expected to occur because of either the large distances, or – for the wind farm at Kriegers Flak – because the sedi-

ment spill from the dredging activities overlapping with the project area of the wind farm will consist only of fine sediments, which will be re-suspended and thereby will cause no significant cumulative impacts on the marine environment. Concerning habitat displacement, the immersed tunnel will theoretically affect a number of water birds within a two year period during the construction phase. Since all wind farms lie more than 100 km from the project area it is assessed that the construction of an immersed tunnel will not cause any transboundary cumulative impacts in relation to replacement of habitat.

Concerning the wind farm Rødsand II, a potential cumulative impact on the coastal morphology (erosion) may occur. Rødsand II has been incorporated in the hydrodynamic modelling, which forms the basis for the assessment of impacts on hydrography and coastal morphology from the immersed tunnel. Rødsand II has also been incorporated in the individual-based model (IBM) in relation to the assessment of impacts on Common Eider and other bird species. No significant cumulative impacts on birds in this respect are expected. Concerning cumulative impacts on coastal erosion, mitigation measures in the form of beach nourishment will prevent such impacts, and Rødsand II's contribution in relation to this pressure is assessed as insignificant.

Concerning the wind farm GEOFRéE, in order for any cumulative impact to occur, there will have to be an overlap between the dredging works of this project

and the two years during which the intensive dredging works of the construction phase of the immersed tunnel are taking place. This is not the case, as the timing of the two projects is different. Regarding displacement of habitat, an immersed tunnel causes a theoretical displacement of habitat for a number of water birds within a two year period. As a consequence of the distance between GEOFRéE and the project area, and this limited period of time, it has been assessed that there will be no cumulative impacts concerning displacement of habitat between these two projects.

Regarding extraction of raw materials at Kriegers Flak and Rønne Banke, the assessment concludes that given the very limited and local range of the sediment plumes near the extraction site and the distance of more than 130 km from these to the work areas where the construction of an immersed tunnel takes place, cumulative transboundary impacts are unlikely to occur. Only an assessment of potential cumulative impacts between the sand extraction at Kriegers Flak and the construction phase of the wind farm at Kriegers Flak is relevant, since the time schedule of these two projects are expected to overlap. However, since the exact timing of the work activities in relation to the construction of the wind farm is not known, it has not been possible to assess to what extent cumulative impacts may occur.



Concerning a planned new Storstrøm Bridge, it has not been possible to assess potential transboundary cumulative impacts, because the EIA for the Storstrøm project has not been completed yet. However, it has been assessed that disturbance and loss of habitat will only cause local impacts from the two projects, and no cumulative impacts are expected. Since the old Storstrøm bridge will be dismantled and replaced with a new bridge, no increased barrier effects are expected from the Fehmarn Belt Fixed Link, and no significant cumulative barrier effects are thus expected in regard to the replacement of the Storstrøm Bridge.

#### **Transboundary impacts between Germany and Denmark**

As can be concluded from the above, all planned offshore wind farms, and the replacement of the Storstrøm Bridge, are either German or Danish owned, and they are all

planned within German and Danish territories. No cumulative transboundary impacts are expected from Denmark to Germany or vice versa.

#### **Conclusion**

For the wind farms Arkona Becken Südost, EnBW Baltic 2, and Wikinger, no transboundary cumulative impacts have been identified. Concerning the Rødsand II and GEOFRéE wind farms, which both lie closer to the work areas of the immersed tunnel, no transboundary impacts have been identified either.

In relation to the planned wind farm at Kriegers Flak, no cumulative transboundary impacts are expected, even though the construction of the wind farm overlaps with the period of the extraction activities at the site. However, since the exact range and type of work activities in relation to the construction of the wind farm are not known,

it has not been possible to assess other potential cumulative impacts.

The construction and operation of a new Storstrøm bridge is not expected to have any significant transboundary cumulative impact.

Overall, no transboundary cumulative impacts have been identified in relation to the construction or operation of an immersed tunnel.



## SUMMARY

The investigations of the environmental impact assessment show that for two environmental components there will be a physical transboundary impact beyond the borders of Germany and Denmark.

Firstly, there will be a globally non-significant impact as a result of the emissions of greenhouse gases. Secondly, there will be deposition of suspended sediments from the sediment spill in the Arkona Basin as a result of the dredging activities of the Fehmarnbelt Fixed Link. Regarding the sediment spill, it is assessed that the amounts of deposited sediment on Swedish territory are very small and have a non-significant impact on the marine environment. Project-related transboundary impacts from temporarily increased concentrations of sediment and deposition rates on Swedish territory are very small and have insignificant impacts on the marine environment.

In addition to the mentioned physical impacts, there may be impacts on migratory bird and fish species. The impacts on fish take place in the near zone in Denmark or Germany without transboundary impacts. Only fish that migrate to other regional waters, such as cod, whiting and herring may theoretically be affected and only with an insignificant impact.

Similarly, there will in general be no transboundary impacts on birds, but there may be a theoretical impact on Common Eider in areas belonging to Sweden, Finland, Russia, Estonia, Latvia, Lithuania, and Poland, because of a temporary and impact on this bird species in the local area of the project.

Concerning ship traffic and navigation, the insignificant impact of national and international ship traffic in the Fehmarnbelt will be temporary and limited to a period of four years, which is the time, the offshore construction works have been estimated to last. Based on that it is assessed that there will be insignificant transboundary impacts on ship traffic and navigation.

# 7

## CONTROL AND MONITORING PROGRAMME

Femern A/S has decided to develop an inspection and monitoring programme for the construction and operation of the Fehmarnbelt Fixed Link. This is not a formal requirement from the EIA Executive Order, but customary practice if a project entails impacts, which impacts and development cannot be inspected or monitored solely on the basis of requirements and threshold values already prescribed by public authorities.

The purpose of the programme is:

- To verify that the project is compliant with prevailing standards, requirements and threshold values for construction and operation
- To monitor that any project pressures are as assumed in the environmental impact assessments
- To monitor that mitigation and compensation measures function as assumed
- To be able to implement corrective actions, if necessary

Therefore the programme will only be carried out for activities, where the impact is assessed as significant or insignificant in the EIA. For activities assessed as having no impact, or where the impact is so minor it is assessed as being of no consequence whatsoever, no inspection or monitoring will be carried out.

The monitoring programme will be based on self-regulation, where the requirements for the contractor's documentation of compliance with conditions, requirements, etc. will be set contractually.

The findings of the programme will be reported to the authorities at regular intervals, and interested groups, especially affected parties and the general public, will have access to monitoring data and results. The programme of parts hereof will be implemented at latest at the initiation of construction activities and is expected to be completed during the operation phase, depending on the type of parameter monitored.

The monitoring programme will be organised as part of an environmental management system, which will also set out guidelines and procedures indicating what is to be inspected and monitored, by whom, when and how.

The monitoring programme will be based on four main component packages:

1. Requirements for inspections at the construction site in compliance with statutory environmental requirements. This relates to e.g. emissions, handling of oil and chemicals, waste management, effluent discharge, raw materials consumption, etc.

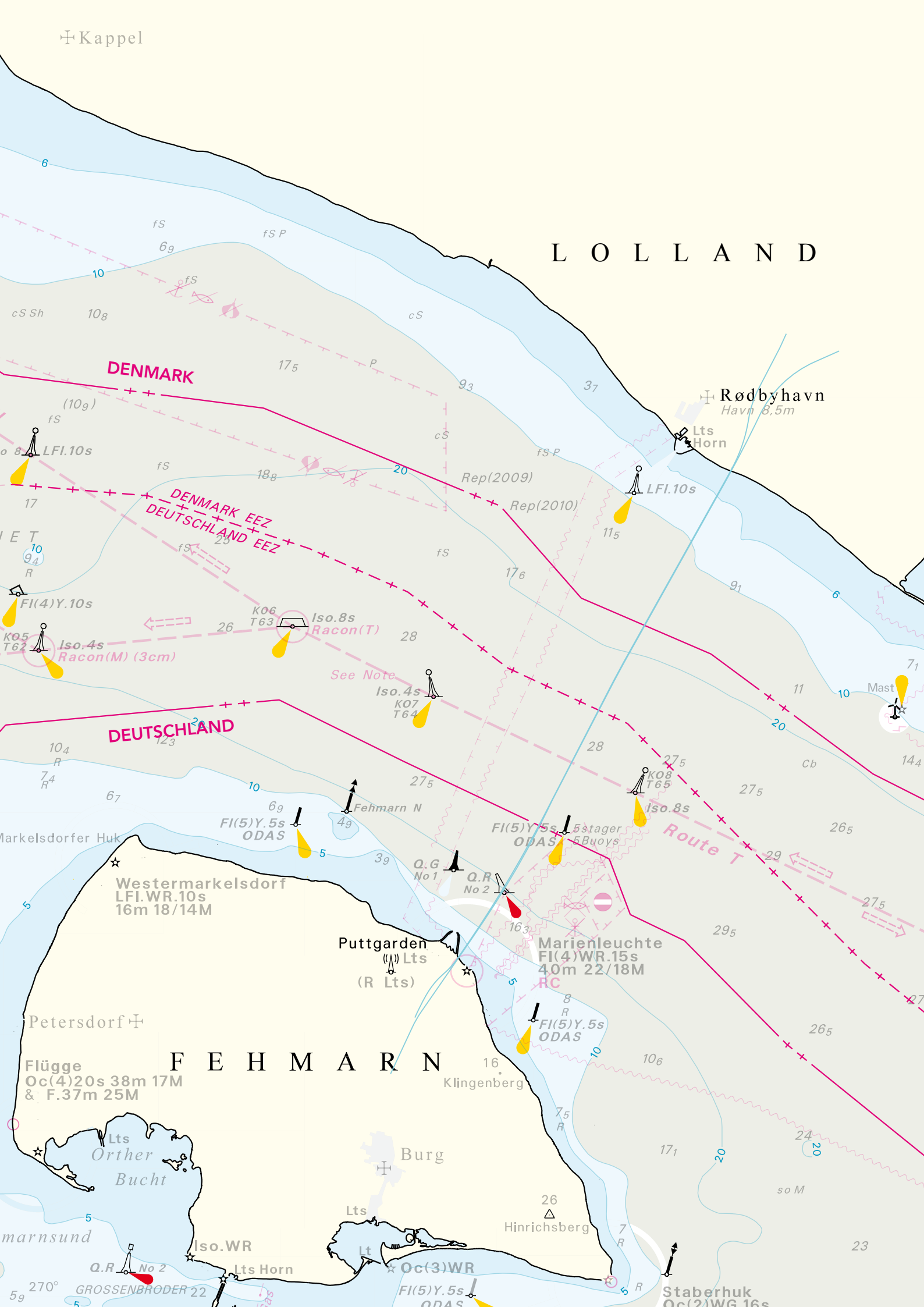
2. Requirements for spillage control of dredged sediment in compliance with contractually stipulated requirements. The contractor of marine construction works will be responsible for inspecting sediment spillage from all relevant sources at sea and for reporting to Femern A/S in compliance with the guidelines

3. Monitoring of implemented mitigation and compensation measures in order to ensure that the projected ecological functionality is achieved

4. Monitoring of selected biological/chemical components in order to verify basic model assumptions and to document the actual environmental status by means of selected parameters (e.g. Natura 2000 area designation basis and Marine Strategy Framework Directive's requirements for good qualitative status)

⊕ Kappel

# L O L L A N D



DENMARK

DEUTSCHLAND

# F E H M A R N

Rødbyhavn  
Havn 8,5m

Westermarkelsdorf  
LFI.WR.10s  
16m 18/14M

Marienleuchte  
FI(4)WR.15s  
40m 22/18M  
RC

Flügge  
Oc(4)20s 38m 17M  
& F.37m 25M

Staberhuk  
Oc(2)WG 16s

GROSSENBRÖDER 22



**Transboundary Environmental  
Impact Assessment  
Summary Report**

This publication has been prepared  
by Femern A/S

Femern A/S is responsible for planning  
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Femern A/S is responsible for the project planning which will result in the coast-coast link.

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