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# Annex 1 to the consultation paper pursuant to Articles 8 and 9a EIA Act (UVPG)

**Annex 1 – Summary for a General Audience in accordance with Article 6 para. 3 EIA Act – of Attachment 1 – explanatory report – of the application documents for the plan approval procedure**

**English version**

## Cover sheet, fully revised version, 03.06.2016

Prepared by:

Femern Sund≈Bælt

State Agency
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Schleswig-Holstein
Lübeck Office

Copenhagen, 03.06.2016
Femern A/S

Lübeck, 03.06.2016
LBV-SH Niederlassung Lübeck

signed by Claus Dynesen

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[1] The consulting consortia FEHY, FEMA, FEBI, FeBEC, FEMM, COWI and TGP were in place from September 2008 to November 2014 and are responsible for the documents up to the end of 2014. In 2014, two consulting agreements were put out to tender again for "Environment Advisors" and "Environment Consultants".

On 1 September 2014, the framework agreement with was signed with the new joint venture for the environment consultancy "FEIA" (Femern Environmental Inhouse Assistance).

On 28 November 2014, the framework agreement with was signed with the new consortium for environmental consultancy "FEMO" (Fehmarnbelt Environmental Monitoring and Consultancy).

(The plan amendment documents were put together with the assistance of the new joint venture and the FEIA and FEMO consortia.

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Maps:
Unless stated otherwise:
DTK5 and DTK25 © GeoBasis-DE/LVermGeo SH (www.LVermGeoSH.schleswig-holstein.de)
DDO Orthofoto: DDO®, © COWI
Geodatastyrelsen (previously Kort- og Matrikelstyrelsen), Kort10 and 25 Matrikelkort
GEUS (De Nationale Geologiske Undersøgelser for Danmark og Grønland)
HELCOM (Helsinki Commission – Baltic Marine Environment Protection Commission)

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# List of abbreviations

| | |
|---|---|
| abbr. | Abbreviation |
| AEG | Allgemeines Eisenbahngesetz (General Railway Act) |
| approx. | approximately |
| Art. | Article |
| ASB | Impact assessment of certain strictly protected species |
| BNatSchG | Bundesnaturschutzgesetz (Federal Nature Conservation Act) |
| BSG | Besonderes Schutzgebiet (Special Area of Conservation) |
| SWABG | Gesetz über den Ausbau der Schienenwege des Bundes (Law on the Expansion of Federal Rail Routes) |
| BVWP | Bundesverkehrswegeplan (National Transport Route Plan) |
| BWP | Bewirtschaftungsplan (Management Plan) |
| cf. | compare |
| DSchG | Denkmalschutzgesetz (Preservation of Historical Monuments Act) |
| DTV | Average daily traffic volume |
| DTVw | Average traffic, workdays |
| EEA | European Environment Agency |
| EEZ | Exclusive Economic Zone |
| e.g. | for example |
| EIA | Environmental Impact Assessment |
| etc. | et cetera |
| EU | European Union |
| FBFL | Fehmarnbelt Fixed Link |
| FGE | Flussgebietseinheit (River basin district, taken from the management plan in accordance with the Water Framework Directive) |
| FFH-VS | Fauna Flora Habitat Verträglichkeitsstudie (Impact Assessment) |

| | |
|---|---|
| FFH-VVP | Fuan Flora Habitat Vertraglichkeitsvorprüfung (Preliminary Impact Assessment) |
| FStrG | Bundesfernstraßengesetz (Federal Trunk Road Act) |
| GEUS | De Nationale Geologiske Undersøgelser for Danmark og Grønland |
| GGB | Gebiet von gemeinschaftlicher Bedeutung (Site of Community Importance) |
| Hbf. | Hauptbahnhof (Main train station) |
| i.e. | in other words |
| lat. | Latin |
| LBP | Landschaftspflegerischer Begleitplan (Landscape Conservation Plan – LCP) |
| LNatSchG | Landesnaturschutzgesetz (Nature Conservation Act for the State of Schleswig-Holstein) |
| LRP | Landscape Structure Plan |
| LVwG | Landesverwaltungsgesetz Schleswig-Holstein (State Administration Law of Schleswig-Holstein) |
| max. | maximum |
| MSFD | Marine Strategy Framework Directive |
| MTR | Migration Traffic Rate |
| MELUR | Ministerium für Energiewende, Landwirtschaft, Umwelt und ländliche Räume (Ministry for Energy, Agriculture, the Environment and Rural Areas) |
| LLUR | Landesamt für Landwirtschaft, Umwelt und ländliche Räume (State Agency for Agriculture, the Environment and Rural Areas) |
| NHN | Normalhöhennull (Standard Elevation Zero) |
| o.a. | as indicated above |
| o.g. | aforementioned |
| resp. | respectively |
| RL | Red list |
| ROV | Remotely operated vehicle |
| RUVS | Guideline for Preparing an Environmental Impact Statement in Road Construction |

| | |
|---|---|
| RWS | Spatial resistance analysis |
| s. | see |
| SGA | Summary for a general audience (Allgemeinverständliche Zusammenfassung AVZ) |
| SH | Schleswig-Holstein |
| TBM | Tunnel boring machine |
| TEN | Trans-European Transport Network |
| UVPG | UVPG Gesetz über die Umweltverträglichkeitsprüfung (Federal EIA Act) |
| VSchRL | Vogelschutzrichtlinie (Birds Directive) |
| WFD | EC Water Framework Directive |
| WHG | Wasserhaushaltsgesetz (German Federal Water Act) |

# 1. Initial situation/requirements

The detailed information on the initial situation and the project can be found in Attachment 18 of the plan approval documents (route determination report). The procedure to determine the environmental impacts of a Fehmarnbelt Fixed Link (FBFL) is described in detail in Attachment 15 of the plan approval documents (EIA report) and Attachment 12 of the plan approval documents (LCP).

## 1.1. Project description purpose

The Fehmarnbelt Fixed Link will cross the Baltic Sea with a, cross-border combined rail and motorway connection over 18 km in length between the Danish island of Lolland and the German island of Fehmarn. It will connect the metropolitan regions of Hamburg/Lübeck (with a connection to the rest of continental Europe) and Copenhagen/Malmö (with a connection to the rest of Scandinavia). Currently, the Fehmarnbelt can only be crossed by land-based transport (rail and road) via the Puttgarden (Germany) – Rødby (Denmark) ferry link. The planning for the Fehmarnbelt Fixed Link includes a double-track, electrified railway track and a four-lane highway designed as a combined railway and road tunnel and constructed as an immersed tunnel. The FBFL project is primarily concerned with the construction of the Trans-European Transport Network (TEN) and will complete the North-South axis between Scandinavia and Central Europe via the shortest route following the so-called "Bird migration route" between Denmark and Germany.

The basis for construction of the FBFL is the state treaty on the Fehmarnbelt Fixed Line, which was signed between the Federal Republic of Germany and the Kingdom of Denmark on 3 September 2008.

## 1.2. Project proponents

The state treaty signed between the Federal Republic of Germany and the Kingdom of Denmark on a Fehmarnbelt Fixed Link (hereinafter referred to as the state treaty) governs the planning- and construction-related tasks of the FBFL. According to article 3 of the state treaty, the Kingdom of Denmark is responsible for construction. This includes, in particular, preparatory measures, planning, tendering, awarding contracts and reviewing the implementation plans, obtaining all the necessary approvals, construction, sign-offs, invoicing, and monitoring and remedying faults.

Art. 4 of the State Treaty stipulates that the road section of the Fehmarnbelt Fixed Link on German sovereign territory shall be designated a federal motorway. The public authorities responsible for the road section are the Federal Republic of Germany, represented by the Lübeck Office of the State Agency for Road Construction and Transportation of Schleswig Holstein (LBV-SH). The construction, operation and maintenance for implementation of this section of road will be transferred by the public authorities to the Kingdom of Denmark.

According to Art. 6 of the State Treaty, a company formed by the Kingdom of Denmark is responsible for the tasks related to planning, design, obtaining approvals, contract award, constructing, financing, operating and maintaining the FBFL. The Danish company Fernern A/S shall carry out this task. The project proponent for the rail section located on the sovereign territory of the Federal Republic of Germany and the German EEZ is the Kingdom of Denmark, which is represented by the Company Fernern A/S.

This means that there are two project proponents for the part of the FBFL located on the sovereign territory of the Federal Republic of Germany: Femern A/S and the LBV-SH, Lübeck office.

## 1.3. Location of the planned project

The FBFL crosses the section of the Fehmarnbelt located in the Western Baltic Sea and connects the German island of Fehmarn to the Danish island of Lolland (see Figure 1 and attachment 2 of the plan approval documents). The FBFL begins on the German side to the south of Puttgarden with re-routing from the Lübeck Hbf - Puttgarden railway track operated by DB Netz AG and the realignment of the B 207/ E 47 (Heiligenhafen – Puttgarden). The route passes to the east of the Puttgarden ferry harbour and then runs as a combined rail and road tunnel straight to Lolland in the northeast direction. The tunnel reaches Lolland east of the Rødbyhavn ferry harbour. In the marine area, construction of the FBFL is planned as an immersed tunnel. The project will end to the north of Rødbyhavn with a connection to railway line 2 (Ringsted – Rødby Færge) located there and the E 47. Both routes lead to the Copenhagen/Malmö Øresund Region and beyond.


**Figure 1** **Investigation area related to the Fehmarnbelt Fixed Link project**

In Germany, the project is located in Kreis (district of) Ostholstein in the State of Schleswig-Holstein. This is located in the area comprising the Municipality of Fehmarn and the German maritime area of Puttgarden. The border between the German and Danish EEZ lies roughly in the centre of the Fehmarnbelt. On the Danish side, the construction project runs through the Lolland municipality in the district "Region Sjælland" (see Figure 1). The project generally avoids populated areas.

## 1.4. Legal basis

The construction of the Hamburg - Øresund Region rail link, which runs along the Fehmarnbelt, is mentioned in the current BVWP 2003 and BSWAG, specifically as point no. 1 concerning international projects. The project classification was confirmed by the review of the requirements plan which was concluded in November 2010. The fact that the project was named in the BSWAG underlies the fundamental importance of this project.

The importance of this route is also highlighted by the fact that it was included as project no. 20 in the TEN and as a section of the "Helsinki - Valletta" Core Corridor 5 of the EU-wide core regional transport network (see also Section 2.1).

A bilateral agreement was needed in order to carry out cross-border projects. This was achieved in the state treaty signed between Denmark and Germany on 3 September 2008, which was ratified by both countries in 2009 and which entered into force on 14 January 2010. This treaty concerned the construction of the Fehmarnbelt Fixed Link. According to the law governing this State Treaty, it constitutes the legal basis and the mandate for constructing the Fehmarnbelt Fixed Link. The main provisions, which are also important for the subsequent plan approval procedure, are listed as follows:

- The construction of a Fehmarnbelt Fixed Link between Puttgarden and Rødbyhavn takes the form of a combined road and rail link (art. 2, para. 1).
- The road connection will be constructed as a four-lane highway built to motorway standards (art. 2, para. 1).
- The railway line will be twin-tracked and electrified; the maximum speed will be at least 160 km/h for passenger trains and at least 120 km/h for freight trains (art. 2 para. 2).
- With regard to the technical dimensions and facilities, the FBFL will be constructed in a way which allows the road- and rail-based transport which currently use the trans-Øresund fixed link to continue to use the Fehmarnbelt Fixed Link in future (art. 2, para. 2).
- Approval for building the Fehmarnbelt Fixed Link must be applied for in accordance with the current legislation of the respective state (art. 2 para. 3).
- Denmark is specifically responsible for planning, obtaining all necessary approvals, construction, operation and maintenance of the Fehmarnbelt Fixed Link (art. 3) and will set up a separate company for this purpose (art. 6).
- Road construction on German sovereign territory shall remain the responsibility of the Federal Republic of Germany (Art. 4, Para. 1). The Federal Republic of Germany assigns completion of the following tasks to the Kingdom of Denmark: Construction, operation and financing.
- The FBFL shall be built in accordance with current Danish technical norms and provisions, unless the parties to the state treaty agree to the application of other European norms and provisions for individual construction elements (art. 13, para. 7).
- The required plan approval procedures for the section built on German sovereign territory shall be subject to German law and the section built on Danish sovereign territory shall be subject to Danish law (art. 13, para. 3). The law of the respective country shall apply in both countries' exclusive economic zones (art. 13, para. 4).
- In matters relating to public safety and order as well as management of emergencies on Danish sovereign territory and in the Danish EEZ, the Danish authorities shall be seen as competent. The German authorities shall be seen as competent in such matters where they relate to German sovereign territory and the German EEZ (art. 14, para. 1).

### Plan approval procedure (plan approval)

According to article 13 of the state agreement, the necessary plan approval procedure for the section of the Fehmarn Belt Fixed Link located on German sovereign territory and the section located on Danish sovereign territory shall be implemented in accordance with German and Danish law respectively.

The construction of the section of railway located on the sovereign territory and the EEZ of the Federal Republic of Germany is subject to plan approval according to § 18 AEG (General Railway Act.)

The construction of the road section located on the sovereign territory and the EEZ of the Federal Republic of Germany is subject to plan approval according to § 17 FStrG (Federal Trunk Road Act.) This road section of the Fehmarn Belt Fixed Link shall be designated as a federal highway up to the northern plan approval border with the designation "federal motorway".

Due to fact that the road and rail sections of the FBFL are closely-linked at a structural level, only a uniform decision pertaining to these is possible. As a result, there will be a joint plan approval procedure for the railway section and the road section of the FBFL in accordance with Article 145 of the LVwG (State Administration Law of Schleswig-Holstein).

The plan approval procedure will encompass the Environmental Impact Assessment (EIA). Cross-border participation of the authorities and the public will be carried out in accordance with §§ 8 and 9a of the Federal EIA Act (UVPG) in conjunction with the Espoo Convention as part of the EIA. The project will also be assessed on its compatibility with the conservation objectives of Natura 2000 sites, species protection requirements, water management and environmental goals (Water Framework Directive and the Marine Strategy Framework Directive) as well as the requirements of the nature conservation intervention regulation.

### Plan approval area

The section of the FBFL to be approved according to German law includes the section of the FBFL located on German territory and in the German Exclusive Economic Zone, i.e. the parts of the project located on the island of Fehmarn and in the Baltic Sea.

For the railway, this starts in the south at rail-km 85+497 (= chainage-km (rail) 7+400), approximately 350 m south of the current road bridge of the K 49 over the railway line. The section of road to be approved starts at the B 207 at road-km 18+032,201 (= chainage-km (road) 7+080), around 470 m north of the Bannesdorf - Hinrichsdorf municipal road.

The section to be approved ends in the north at the border between the German and Danish EEZ at chainage-km (rail) 20+000 and chainage-km (road) 20+000, roughly in the centre of the Fehmarnbelt. In total, therefore, the FBFL rail line is 12.6 km and the E 47 12.9 km long in the plan approval segment. Almost 9.5 km of this total runs through the tunnel.

The northern boundary of the section to be approved at the border between the German and Danish EEZ in the Fehmarnbelt is defined solely for reasons of territorial responsibility. The

FBFL is guaranteed to continue on through the territory of the Kingdom of Denmark. Route determination has only involved continuous, i.e. cross-border variants. The construction of a section limited to the territory of the Federal Republic of Germany without continuation to Denmark has been ruled out. Where necessary, the section of the project located on Danish territory is shown for information purposes in the plan approval document.

The new Puttgarden junction to be constructed is found in the plan approval area (intersection with K 49 at chainage-km (road) 8+060). As a result, the planning of the northern end section of the German road works will be modified. The plan approval procedure for these changes has already been initiated. The Puttgarden junction as well as the construction of the FBFL itself require changes in the secondary road network.

The construction of the new rail line and the E 47 requires the K 49 to be rerouted at the Puttgarden junction. Other roads and agricultural roads will also need to be re-routed or re-built.

In addition to the rail and road sections mentioned above, the following non-route-related measures, all of which are located in the State of Schleswig-Holstein also need to be approved:

- A radio mast west of Burg on Fehmarn (approximately 4 km south of the plan approval boundary above), for the purpose of rail transport safety, Location:
  District: Ostholstein
  Municipality: City of Fehmarn
- A system to detect overheated and derailed stock near Bannesdorf on Fehmarn (just 2 km south of the plan approval boundary above), for the purpose of rail transport safety, Location:
  District: Ostholstein
  Municipality: City of Fehmarn
- Nature and landscape conservation measures (nesting aid) for stock doves in the area of Blankenwisch on Fehmarn (see LCP, Attachment 12, Measure $9.1_{CEF}$; approx. 2.3 km northwest of the road route), Location:
  District: Ostholstein
  Municipality: City of Fehmarn
- Nature and landscape conservation measures for skylarks, ringed plovers, yellow wagtails and lapwings on the two surfaces to the northwest of Puttgarden on Fehmarn, Attachment 12, measure 9.4 $A_{CEF}$ and 9.5 $A_{CEF}$; ca. 2 km around 2 km northwest of the road, Location:
  District: Ostholstein
  Municipality: City of Fehmarn
- Nature and landscape conservation measure, compensation measure "Restoring a reef in the Sagas Bank area" which lies in the coastal waters of the Baltic Sea between Fehmarn and the Bay of Lübeck, Attachment 12, Measure 8.7 A: around 22 km south of the aforementioned process boundary, Location:
  Municipality: omitted (coastal waters not administered by a municipality)
  competent water authorities: Ministerium für Energiewende, Landwirtschaft, Umwelt

und ländliche Räume (Ministry for Energy, Agriculture, the Environment and Rural Areas)

- Nature and landscape conservation measures, "Johannisbek 2" alternative measure, Attachment 12, measure 11.5 E; approx. 36 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Lensahn (managing community: Municipality of Lensahn)
  Municipality: Municipality of Lensahn
- Nature and landscape conservation measures, eco account "Augustenhof I" alternative measure, Attachment 12, measure 11.17 E; approx. 26 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Oldenburg Land
  Municipality: Municipality of Heringsdorf
- Nature and landscape conservation measures, eco account "Augustenhof II" alternative measure, Attachment 12, measure 11.17 E; approx. 26 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Oldenburg Land
  Municipality: Municipality of Göhl
- Nature and landscape conservation measures, Barkau I" eco account, Attachment 12, measure 11.9 E; approx. 59 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): Municipality of Eutin
- Nature and landscape conservation measures, Bujendorf I" eco account, Attachment 12, measure 11.24 E; approx. 54 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin
- Nature and landscape conservation measures, Bujendorf II" eco account, Attachment 12, measure 11.25 E; approx. 54 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): Municipality of Eutin
- Nature and landscape conservation measures, Ehlerstorf" eco account, Attachment 12, measure 11.2 E; approx. 32 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Oldenburg Land
  Municipality: Municipality of Wangels

- Nature and landscape conservation measures, Gömnitz" eco account, Attachment 12, measure 11.13 E; approx. 53 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): Municipality of Eutin
- Nature and landscape conservation measures, "Gömnitz II (Schneckenkuhl)" eco account, Attachment 12, measure 11.6 E; approx. 53 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): Municipality of Eutin
- the nature and landscape conservation measures, "Gömnitzer Berg" eco account, Attachment 12, alternative and compensatory measures10.1 A/E; approx. 54 km southwest of the aforementioned process boundary,  Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin
- Nature and landscape conservation measures, "Gothendorf II" eco account, Attachment 12, measure 11.14 E; approx. 58 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin
- Nature and landscape conservation measures, "Gothendorf (Witt)" eco account, Attachment 12, measure 11.15 E; approx. 58 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin
- Nature and landscape conservation measures, Griebel I" eco account, Attachment 12, measure 11.16 E; approx. 51 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Ostholstein-Mitte
  Municipality: Municipality of Kasseedorf
- Nature and landscape conservation measures, "Grube I (Rosenhof)" alternative measure, Attachment 12, measure 11.23 E; approx. 29 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Grube
  Administration community (managing community): Municipality of Grömitz
- Nature and landscape conservation measures, "Grünland in Mühlenfeld" eco account, Attachment 12, measure 11.22 E; approx. 49 km southwest of the aforementioned process boundary, Location:

District: Plön
Sub-district: Amt Lütjenburg
Municipality: Municipality of Helmstorf

- Nature and landscape conservation measures, "Hassendorf I (Katzburg)" eco account, Attachment 12, measure 11.12 E; approx. 66 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Großer Plöner See (managing community: Municipality of Bosau)
  Municipality: Municipality of Bosau
- Nature and landscape conservation measures, "Krummsteert/Sulsdorfer Wiek" eco account, Attachment 12, measure 9.3 A; approx. 12 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: City of Fehmarn
- Nature and landscape conservation measures, "Lübbersdorf" eco account, Attachment 12, measure 11.18 E; approx. 33 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: City of Oldenburg in Holstein
- Nature and landscape conservation measures, "Organic farm areas in Hohwacht" eco account, Attachment 12, measure 11.21 E; approx. 42 km southwest of the aforementioned process boundary, Location:
  District: Kreis Plön
  Sub-district: Amt Lütjenburg
  Municipality: Municipality of Hohwacht (Baltic Sea)
- Nature and landscape conservation measures, "Oldenburger Graben – Plügger Wiesen" eco account, Attachment 12, measure 11.1 E; approx. 29 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Oldenburg Land
  Municipality: Municipality of Göhl
- Nature and landscape conservation measures, "Redingsdorfer Au 1" eco account, Attachment 12, measure 11.10 E; approx. 54 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin
- Nature and landscape conservation measures, "Redingsdorfer Au 2" eco account, Attachment 12, measure 11.11 E; approx. 54 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin

- Nature and landscape conservation measure, Riepsdorf I" eco account, Attachment 12, measure 11.4 E; approx. 34 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Lensahn (Managing community: Municipality of Lensahn)
  Municipality: Municipality of Riepsdorf
- Nature and landscape conservation measure, "Suksdorfer Wiesen" eco account, Attachment 12, measure 11.19 E; approx. 23 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Oldenburg Land
  Municipality: Municipality of Großenbrode
- Nature and landscape conservation measure, "Taarstedt – Loiter Au" eco account, Attachment 12, measure 11.3 E; approx. 104 km northwest of the aforementioned process boundary, Location:
  District: Kreis Schleswig-Flensburg
  Sub-district: Amt Südangeln
  Municipality: Municipality of Taarstedt
- The Nature and landscape conservation measure, "Wasbuck" eco account, Attachment 12, measure 11.20 E; approx. 38 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Sub-district: Amt Oldenburg Land
  Municipality: Municipality of Wangels
- Nature and landscape conservation measure, Woltersteich I" eco account, Attachment 12, measure 11.7 E; approx. 59 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): City of Eutin
- Nature and landscape conservation measure, "Woltersteich II" eco account, Attachment 12, measure 11.8 E; approx. 59 km southwest of the aforementioned process boundary, Location:
  District: Ostholstein
  Municipality: Municipality of Süsel
  Administration community (managing community): Municipality of Eutin,

The boundaries of the plan approval area are shown in Attachment 3 of the plan approval documents (overview plans) and Attachment 7.1 of the plan approval documents (site plan).

The FBFL project to be approved can also be carried out without upgrading the landworks. The FBFL will be connected to the respective railway and road landworks in Germany and in Denmark, both of which are due to be upgraded. If necessary, however, e.g. if the landworks are not completed or not completed on schedule, the FBFL will be connected to the existing rail and road network.

## Legal basis

According to the Federal EIA Act (UVPG), an Environmental Impact Assessment (EIA) must be carried out for the section of the Fehmarnbelt Fixed Link located on German territory and in the German Exclusive Economic Zone. Accordingly, an EIA is required for the construction of a railway line (§ 3 para 1, point 1 of the EIA Act in conjunction with Appendix 1 no. 14.7) and the construction of a federal motorway or a new four- or multi-lane highway (§ 3, para 1, point 1 of the EIA Act in conjunction with Annex 1 no. 14.3 and 14.4).

In addition to the national laws mentioned above, article 13 para. 1 of the State Treaty stipulates that: "The decision on the choice of the technical solution for the Fehmarnbelt Fixed Link shall be made, among other things, on the basis of an Environmental Impact Assessment (EIA) in accordance with applicable EU law." The State Treaty refers in this respect to the Environmental Impact Assessment (EIA) Directive (2011/92/EU) of the European Parliament and the Council, which also stipulates an EIA requirement for the construction of long-distance railway lines, motorways, highways and new four- or multi-lane roads (article 4 in conjunction with Annex I, no. 7).

The Environmental Impact Assessment includes the identification, description and evaluation of the direct and indirect impacts of a project on human beings, including human health, fauna, flora and biodiversity, soil, water, air, climate and landscape, cultural heritage and other material assets as well as the interactions between the factors mentioned (§ 2, para. 1 of the EIA Act).

The EIA is a non-autonomous part of the administrative decision-making process on project approval (§ 2, para. 1 of the EIA Act). The project proponent must present the documents on the project's environmental impacts relevant to the decision-making process to the competent authorities at the beginning of the environmental impact assessment process (§ 6 para. 1 of the EIA Act). The project proponent's documents are – inter alia – the basis for the summary of the environmental impacts (§ 11 of the EIA Act) and their assessment (§ 12 of the EIA Act) by the approval authority. The result of the EIA does not affect the approval decision from a legal standpoint. The plan approval authority must, however, take the Environmental Impact Assessment into account in the decision to approve the project with respect to effective environmental protection (§ 12 of the EIA Act).

The EIA for the Fehmarnbelt Fixed Link project will be conducted as part of the plan approval procedure for the Fehmarnbelt Fixed Link. With the EIA report provided (Attachment 15), the project proponents are providing the documents on environmental impacts relevant to the decision-making process in the German plan approval procedure as required by § 6 of the EIA Act.

The legal requirements for conducting the EIA and the relevant documents to be provided by the project proponent are specifically stipulated in the EIA Act and the EIA Directive. In addition, the requirements of the relevant laws, particularly national and international environmental laws, form the legal framework for the EIA report.

- At the national level, these include, in particular, the regulations of the Federal Nature Conservation Act (BNatSchG) on intervention regulation (§§ 13 et seq.), habitat and bird protection (§§ 31 et seq.) and species protection (§§ 37 et seq.). The key national legal regulations for the evaluations carried out under the scope of the EIA report are listed in detail in the respective evaluation sections and in the methodology sections for the baseline evaluation by environmental factor and subject area (cf. EIA report, Attachment 15, Annex B, Section 0.2 et seq.).
- The EU Flora and Fauna Habitat Directive (Habitats Directive, Directive 92/43/EEC) serves as the framework for European law. The Directive aims to preserve and protect wild flora and fauna, their habitats and the Europe-wide network of these habitats. The FFH protection areas, together with the special protection areas and the Birds Directive (Directive 2009/147/EWG), form the coherent Natura 2000 network. Plans or projects which could have a significant impact on one of these Natura 2000 areas require an appropriate assessment with the conservation objectives defined for said area (to consult the results of the Natura 2000 studies, see Section 9 and Attachment 19 of the plan approval documents). The specifications of the Habitats Directive and the Birds Directive were transposed into German law in the BNatSchG.
- A comprehensive European legal framework was also created for the marine area, which mainly consists of the EU Water Framework Directive (WFD, Directive 2000/60/EC). The WFD creates a legal framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. By 22.12.2027, it aims, inter alia, including deadline extensions, to improve the ecological state of surface waters through programmes of initiatives. The EU Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) establishes a framework within which all EU Member States will take the necessary measures to achieve or maintain "good environmental status" in all marine environments by 2020. Both directives were transposed into German law in the German Federal Water Act (WHG). Further details can be found in the landscape conservation plan (LCP, Attachment 12 of the plan approval documents.

The EIA report takes account of this legal framework and the requirements arising therefrom.

*Danish legal basis (for information only)*

The EIA requirement for the part of the project located on Danish territory and in the Danish Exclusive Economic Zone is stipulated in § 4 of the Danish Planning Act.

The key legal regulations and regulatory provisions for the Danish VVM (EIA report) are as follows:

- Lov om projektering af fast forbindelse over Femern Bælt med tilhørende landanlæg i Danmark (act on the planning of a Fehmarnbelt Fixed Link with the landworks in Denmark), "The Planning Act". Act no. 285 of 15 April 2009.

- Bekendtgørelse om vurdering af visse offentlige og private anlægs virkning på miljøet (VVM) i medfør af lov om planlægning, BEK no. 1510 of 15 December 2010 (EIA ordinance resulting from the Planning Act).
- Vejledning om VVM i planloven (EIA Guidance in accordance with the Danish Planning Act – Directive no. 9339 of 12 February 2009).
- Vejledning om inddæmming og opfyldning på søterritoriet (Guidance on land reclamation and marine sediment deposits – Directive no. 6 of 23 January 2002).

### Basis of the Landscape Conservation Plan (LCP)

As the project is a combined rail and road project, the following in particular were used as the methodological basis for developing the LCP:

- Environmental guidelines for planning and plan approval under railway law and for magnetic suspension railways, part III of the Environmental Impact Assessment, conservation law intervention regulation. Federal Railway Authority, as of August 2014.
- Information on the environmental impact forecast in the EIA, LCP and Natura 2000 impact assessments for upgrades and new construction measures for federal railways. Federal Railway Authority, as of March 2004.
- Orientation framework for the baseline definition, evaluation and identification of the compensation measures under the Landscape Conservation Plan for road construction projects (jointly enacted by the Ministry for Economic Affairs, Employment and Transport of the State of Schleswig-Holstein and the Ministry for the Environment, Conservation and Forestry of the State of Schleswig-Holstein, 2004).
- Observing the European Species Conservation Law during the plan approval stage (State Agency for Road Construction and Transportation, Schleswig-Holstein in Kiel) the authority for Energy Plan Approval, as of February 2016).

The procedure introduced for road construction in Schleswig-Holstein (see above for the orientation framework) will be used to determine impairment and compensation/replacement in the German project area. Because the orientation framework is only related to the land area, it will be further developed to determine the interventions in the marine habitats of the German coastal waters and the Exclusive Economic Zone. Details of how the orientation framework will be applied and further developed are addressed in the LCP, Attachment 12 of the application material, articles 6 and 11.

## 1.5. Evidence of the need for this project

### Importance for regional planning and transport

The need for a Fehmarnbelt Fixed Link is derived from the requirement to improve the inadequate transport conditions between Scandinavia and continental Europe based on the regional planning and transport policies of the European Union, the Federal Republic of Germany and the Kingdom of Denmark. Only the FBFL can eliminate the existing bottlenecks in rail and road connections with the Nordic countries. It will eliminate the physical barrier of the Baltic Sea.

The project will therefore help the European internal market function smoothly and contribute to economic, social and territorial cohesion as well as improved accessibility of all regions in the EU.

These considerations are also reflected in the fact that the FBFL has been included in the priority trans-European transport network (TEN-T) and in the State Treaty concluded between Germany and Denmark. The development plan for the State of Schleswig-Holstein, which also sets the FBFL as a binding goal for the region, also refers to the State Treaty.

In transport terms, the FBFL will result in much shorter travel and transport times and increased road and rail capacities. The amount of time gained over the ferry service will be at least 45 minutes, and during peak travel times considerably more. The time gains for passengers travelling by train are greater than those travelling by car. This strengthens the incentive to travel by train as a more environmentally friendly means of transport.

It is not just the reductions in travelling time that are important, however; the provision and assurance of sufficient capacities for handling future increases in freight and passenger transport are also vital. The ferry service is currently limiting capacity. It is often already inadequate during the summer months and cannot be freely expanded to meet requirements. The FBFL will eliminate this bottleneck and ensure sufficient capacities over the long run. In addition, only the FBFL will guarantee free and unhindered access at any time to the transport routes independently of ferry schedules.

There are also advantages arising from the resumption of rail freight transport along the "bird migration route", which was suspended in 1998. Compared to the rail freight route in use over the Great Belt today, the route will be shortened by around 160 km using the bird migration route, resulting in noticeably shorter transport times. As a result, the resumed rail freight connection will also be interesting for establishing new ties between Denmark/Sweden and continental Europe.

Structural reasons for the project result from the improved integration of the Hamburg and Copenhagen/Malmö metropolitan regions together with the expanded Øresund region. Through its contribution to strengthening cross-border integration in science, the economy and culture, the project will encourage further cohesion in Europe. A new, more competitive large-scale region will be created – the Fehmarnbelt region. The improved connection will also stimulate the economy and tourism in the border area between Germany and Denmark.

The FBFL has a key role to play in achieving these transport and structural goals. Only this project will be able to provide sufficient capacities and unhindered access for motorised personal and rail transport over the long term.

## 1.6. Procedure

Both Germany and Denmark are responsible for carrying out the approval procedure in accordance with their national law in force at the time. An Environmental Impact Assessment is required for the project as part of the application documents in accordance with the EIA Directive of the EU and the two national laws on Environmental Impact Assessments (Federal EIA Act – UVPG, Bekendtgørelse om vurdering af visse offentlige og private anlægs virkning på miljøet – VVM).

Within the framework of the Fehmarnbelt Fixed Link project, a "vurdering af virkninger på miljøet" (VVM) will thus be created for the Danish procedure and an Environmental Impact Assessment report (EIA report) for the German procedure. The following section deals with the basic methodological procedures for the German Environmental Impact Assessment report with cross-references to the Danish procedure.

In Germany, the decision-making process for the future route is shown in detail in the EIA report and the plan approval documents. All environmental concerns pertaining to the decision-making process have been factored in, taking into account the relevant laws, stipulations, regulatory provisions and directives as interpreted in legislation (in particular, those of the European Court of Justice), etc. The alignment of the Fehmarnbelt Fixed Link in Denmark also takes into account the result of the VVM (EIA report).

The results of the Danish VVM (EIA report) for Danish territory will be included in the German EIA report for informational purposes. The content of the German EIA report will also be incorporated into the Danish VVM.

### Baseline definition and evaluation

The baseline is defined and evaluated separately broken down by environmental factor. An initial overview of the structure of the Danish and German environmental investigations in the land and marine areas is provided in Figure 2 and Figure 3.

With regard to the Baseline investigation and evaluation, it should generally be noted that, when addressing the environmental factors in Denmark and Germany, particular attention is paid to the national legal and material specifications and practices – in addition to European law. As a consequence, the onshore results on Lolland and Fehmarn in particular reflect the national standards and thus are not (always) comparable. Even though the evaluation in the marine area is primarily based on the EU Directives (incl. the Habitats Directive, Birds Directive, Water Framework Directive and the Marine Strategy Framework Directive) and the overall ecological context of the Baltic Sea, national standards, however, also have to be taken into account on a case-by-case basis in Danish and German waters (e.g. marine biotopes protected under German nature conservation legislation).

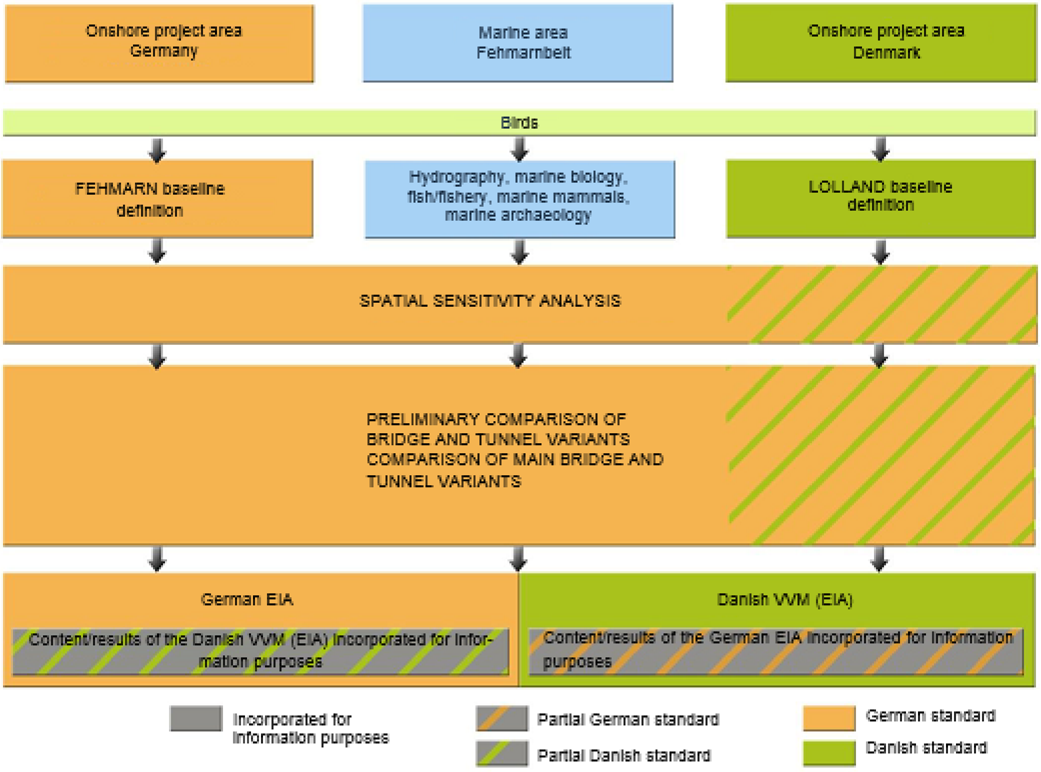



**Figure 2** **Overview of the structure of the Danish and German environmental investigations**

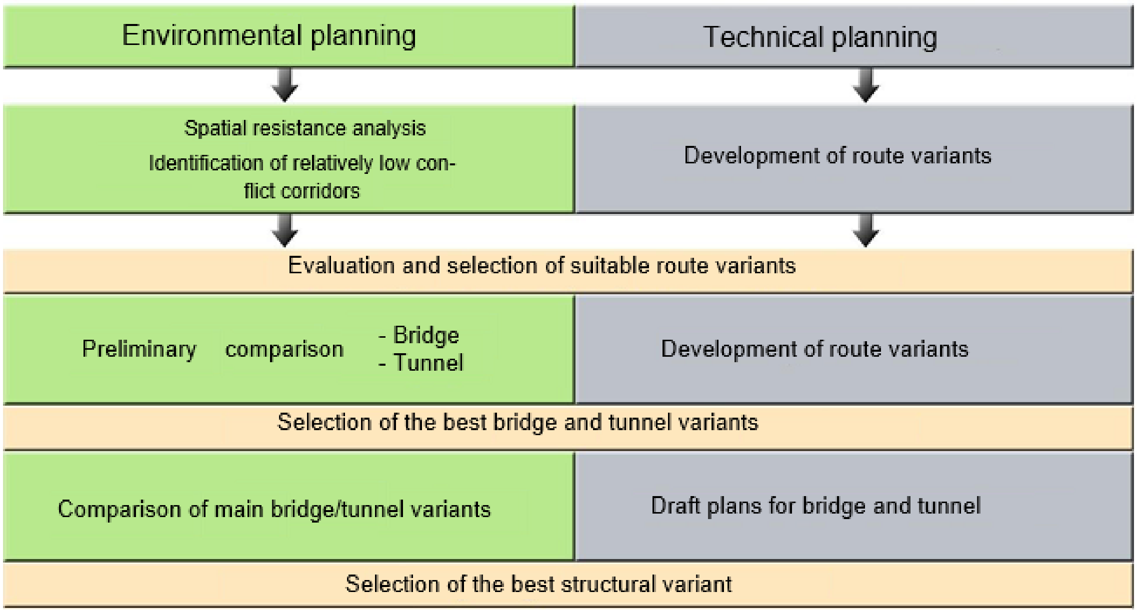



**Figure 3** **Overview of the process of environmental investigations in conjunction with technical planning**

### Spatial resistance analysis (SRA)

The first step in the preparation and development of the Environmental Impact Assessment report was to create a spatial resistance analysis (SRA) which aimed to identify the most environmentally friendly alignment in terms of optimisation and prevention very early on in planning, i.e. to identify "relatively low conflict corridors" for possible route variants. The analysis includes the entire onshore and offshore project areas of the Fehmarnbelt in both countries. The onshore part spans an area west of the ferry harbours of Puttgarden and Rødbyhavn to an area east of these harbours. The spatial sensitivity analysis analyses the environmental factors in relation to the project on the basis of existing information and data. The key findings and content of the SRA are described in section 2.2 .

### Impact forecast and comparison of variants of the Environmental Impact Assessment report (EIA report)

Within the relatively low conflict corridors identified, the technical partners developed various route variants, including those that connect points west of Puttgarden and west of Rødbyhavn (west-west) and east of Puttgarden and east of Rødbyhavn (east-east) as well as other variants, e.g. diagonally from east to west, etc. These route variants were then evaluated and optimised with regard to environmental concerns but also in relation to traffic aspects and impacts on the existing infrastructure, shipping safety and road traffic, profitability and construction logistics and with respect to conflicts with local and state development plans.

Route variants comprising bridge and tunnel solutions that were not practical from a technical point of view or for other reasons consistent with the project goals were eliminated in advance and reasons provided. This is described in detail in Section 5.1 of the EIA report (Attachment 15 of the plan approval documentsVolume III).

The preferred bridge and tunnel variants (cable-stayed bridge and immersed tunnel) are identified as part of route determination (see Attachment 18 of the plan approval documents) taking into account all assessment criteria including the environmental concerns from the preliminary comparison of variants (see below). In the following comparison of main variants, structural solutions are evaluated and compared with one another taking all environmental factors into account.

### Preliminary EIA report comparison of variants (individual comparison of tunnel solutions and bridge solutions)

In the preliminary comparison of variants, the preferred variant from an environmental point of view is identified both for the remaining immersed tunnel variants and for the cable-stayed bridge variants. In this step, practical tunnel and bridge variants in corridors that are as ‘low-conflict’ as possible are compared to one another from a technical (transport) point of view (i.e. tunnel with tunnel variants and bridge with bridge variants). The result of this preliminary comparison shows which tunnel and bridge variants are preferable from an environmental point of view. As part of an overall assessment, the preferred tunnel and bridge variants to be further developed are identified in a second evaluation step on the basis of all assessment criteria.

In line with the planning carried out at this level, the route variants and projected impacts are described in less detail in the preliminary comparison of variants than in the main comparison.

The details of the methodology used in the preliminary comparison of variants are described in Section 0.3.5 of the EIA report (Attachment 15, Annex B). The specific preliminary comparison of bridge variants is given in Section 6 and the preliminary comparison of tunnel variants in Section 7 of the EIA report (Attachment 15 of the plan approval documents Volume IV A).

**EIA report comparison of main variants (comparison of the structural variants)**

The comparison of main variants focuses on the three structural variants. The preferred immersed tunnel variant, the preferred bridge variant and the bored tunnel variant, are compared with one another here. The comparison of main variants aims to project the impacts of the three main structural variants and to identify the best structural variant (immersed tunnel, bored tunnel or bridge) from an environmental point of view.

The tunnel and bridge variants are described in more detail in the comparison of main variants than in the preliminary comparison. The comparison of main variants includes the variant gradients (contours of the route) and any (absolutely necessary) minimising measures (e.g. noise protection measures), and is carried out with a project boundary defined by the construction and installation of each variant (footprint determined by the construction and installation) and all assessment criteria to project the impacts.

The details of the methodology used in the comparison of main variants are described in Section 0.3.5 of the EIA report (Attachment 15, Annex B). The actual comparison of main variants is carried out in Section 8 of the EIA report (Attachment 15, Volume IV B & C).

The EIA report investigates the main variants: immersed tunnel, cable-stayed bridge and bored tunnel. The zero variant, i.e. environmental changes if the project is not carried out, was not investigated because the project goals cannot be met with the zero variant (see explanatory report Attachment 1, Section 3.4.1). It is only used as a comparison for the concrete planning solutions (see Federal Ministry for Transport, Building and Urban Development 2008).

**EIA Annex C**

In the current plan approval procedure on the Fehmarnbelt Fixed Link, in the course of the objection process, from the results of hearings and the duration of the current procedure, the need has arisen to implement a plan alteration procedure.

The need to implement a plan alteration procedure stems from commitments made in the framework of the objection process and the hearings which will lead to alterations to the proposal for a plan approval. Furthermore, based on the duration of the current procedure, the data gathered from basic evaluations on protected and partially-protected assets in accordance with the UVPG are more than five years old which means an up-to-date study is required. Additionally, changes resulting from guidelines referring to a level higher than this project e.g. an updated Plan for Federal Traffic Routes with an updated traffic forecast.

When seen from a specialist environmental perspective, the Environmental Impact Statement needs to undergo a current status check covering all aspects affected by planning alterations. The results of this current status check are shown in Appendix C on the Environmental Impact Statement. Appendix C has been newly inserted into the application material and supplements the previous Environmental Impact Statement with regard to various aspects of its currency as to the planning alteration procedure.

At the centre of this current status check lies the question of whether the results of the current Environmental Impact Statement are valid and correct as before with regard to the necessary planning alterations, particularly as concerns the results of the main variant comparison and the derivation of alternatives seen as preferable from an environmental perspective.

Thus, the basis for this study is the alterations to technical planning as well as the consideration of newly-obtained data and the evaluation of existing third-party data with regard to its currency.

In addition to Appendix C, Annex 30, "Background Reports", has been added to the application material. Attachment 30 contains, inter alia, the reports on the results of the update mappings carried out (Attachment 30.2 of the plan approval documents), the assessment of third-party data pertaining to the marine study area (Attachment 30.1 of the plan approval documents) as well as the modelling of the open tunnel trench (Attachment 30.3 of the plan approval documents). The extensive issues presented in the background reports are pooled together in Annex C, Attachment 15 of the plan approval documents and this is referenced in the background reports themselves. By using this additional data, the currency and plausibility of the inventory data and the conclusions drawn from the same for which the impact assessments underpinning the main variant comparison must be studied.

### Landscape Conservation Plan (LCP)

The preferred solution derived from the overall assessment in the planning approval process is used as the basis for the information in the LCP (Attachment 12 of the plan approval documents)

The Landscape Conservation Plan (LCP) addresses the impairment regulation under the Federal Nature Conservation Act (BNatSchG) and the Nature Conservation Act of the State of Schleswig-Holstein (LNatSchG) and the impact assessment of certain strictly protected species (ASB) with any measures necessary under species protection laws. The LCP is also the continuation of the Environmental Impact Assessment report (EIA report) which was already completed at plan approval level and implements any necessary measures arising from the Natura 2000 impact assessments to limit damage or coherence measures on German territory. Like the other plan approval documents, the LCP relates to the plan approval section of the project in the land and marine area.

The construction of the FBFL is associated with negative impacts on the ecosystem and the landscape. According to Article 14 BNatSchG, the impairments caused by the construction project are to be viewed as changes that could significantly impair the ecosystem and the landscape. They are therefore to be viewed as impairments to nature and the landscape. According to § 15 BNatSchG in conjunction with § 9 LNatSchG, the party responsible for impairment must keep the impairments to a minimum and initiate compensation and/or replacement measures.

§ 17 para. 4 BNatSchG stipulates the requirement to create an LCP. The LCP must provide all information necessary to assess the impairment in text and maps. The LCP must include the following in particular:

- Definition and evaluation of the baseline situation prior to the impairment and description of the project
- Review and definition of measures to prevent and minimise impairments
- Identification and evaluation of unavoidable impairments
- Description of the type and scope of preventative, compensation and replacement measures

# 2. Environmental Impact Assessment Report for the Fehmarnbelt Fixed Link

The descriptions below were taken from the route determination report (Attachment 18 of the plan approval documents) in conjunction with the EIA report (Attachment 15 of the plan approval documents).

The central land transport axis between continental Europe and the Nordic countries runs along what is known as the "bird migration route" (Danish: "Fugleflugtslinien") and connects the Hamburg/Lübeck metropolitan regions (with a link to the rest of continental Europe) and Copenhagen/Malmö (with a link to the rest of Scandinavia). It crosses the Fehmarnbelt, a heavily trafficked waterway approximately 19 km wide between the German island of Fehmarn and the Danish island of Lolland. Currently, the Fehmarnbelt can only be crossed by land-based transport (rail and road) via the Puttgarden (Germany) – Rødby (Denmark) ferry link. The railway line of the Fehmarn Fixed Line will be constructed as a twin-tracked, electrified line. The planned maximum speed is 200 km/h for passenger trains and 140 km/h for freight trains. The road connection will be constructed as a dual carriageway with a four-lane vehicle road. The planning and construction of the German landworks, i.e. the continuation of the Fehmarnbelt Fixed Link to the south, ends at the Puttgarden junction. The project ends north of Rødbyhavn on Lolland where it is integrated into railway line 2 (Ringsted – Rødby Færge) and the E 47.

Taking into account these and other conditions for the construction of a Fehmarnbelt Fixed Link (see route determination report, Attachment 18 of the plan approval documents), e.g. environmental results of the spatial resistance analysis (see. 2.2) or residential or technical constraints on Fehmarn, in the marine area or on Lolland, the alignments of potential tunnel and bridge solutions are analysed in a first step (see 2.1 or 2.1.1). The structural variants immersed tunnel, bored tunnel and cable-stayed bridge are then described for the selected routes (see Section 2.4). These main variants are subject to an environmental comparison (see Section 2.3) in the EIA report (Attachment 15 of the plan approval documents, Volume IV B & C, Section 8), taking into account the evaluated, environmental factor-related baseline (see Section 2.4). The preferred variants (see Section 2.5) are ultimately derived on the basis of the three main variants given in the route determination report (Attachment 18, Section 6 of the plan approval documents). This is achieved by weighing the advantages and disadvantages of the three main variants in the seven assessment areas below:

- Environment
- Regional planning
- Transport
- Urban development
- Agricultural structure
- Construction procedure
- Profitability/investment costs

## 2.1. Description of the basic variants

### 2.1.1. Alignments of tunnel and bridge variants

The following section first describes the potential alignments developed for a Fehmarnbelt Fixed Link and then the alignments that were eliminated for various reasons. Finally, the alignments selected for the tunnel and bridge solutions will be given.

#### 2.1.1.1. Alignments for a Fehmarnbelt Fixed Link

**Relatively low conflict corridors (see Section 2.2) and landing points as pre-requisites**

When developing alignments, the general goal is to prevent environmental conflicts/impairments as much as possible. This requirement is best fulfilled when the alignments to be developed are situated within the low conflict corridors identified in the spatial resistance analysis (see 2.2). The corridors therefore form an important basis for developing alignments. Alignments have been developed within these corridors in accordance with the design-related limitations and constraints.

The spatial resistance analysis shows that the western corridors on both Fehmarn and Lolland are less suitable than the eastern corridors (see Section 2.2.5). Routes through the western corridors are nevertheless examined as part of the route determination process. This procedure is consistent with the project goals because all landing points in Lolland are generally accessible from every landing point on Fehmarn. Unfavourable constraints and/or impacts in one sub-section can be offset by more favourable constraints/impacts in other sub-sections. This ensures that all potential alignments are included in the assessment and that aspects not included in the spatial resistance analysis, such as lengths of new structures, design-related advantages and disadvantages of alignments, costs and traffic-related effects, are incorporated into the assessment.

Landing points designate the locations in the coastal area where the potential Fehmarnbelt Fixed Link alignments reach the Fehmarn or Lolland mainland. They also represent nodes from which various alignments can begin in the marine area. The onshore corridors are mostly narrow and, in part due to the constraints on land, do not allow for any feasible route variations. As a result, only one alignment – which is identical for all routes in the marine area – is considered for the onshore area. One exception is the much wider "Eastern corridor" on Lolland (L-E), which has two landing points and two onshore alignments. The potential alignments can vary slightly in the direct vicinity of the landing points, depending on whether the FBFL is designed as a bridge, immersed or bored tunnel. These variations mainly relate to the gradients. They do not, however, affect the selected route in the onshore corridors. In addition, alignments have been considered which lie partially outside the corridors identified in the spatial resistance analysis (see 2.2). This involves landing points located within the harbour. These are included because the direct connection between them is the shortest distance across the Fehmarnbelt.

The landing points under consideration on Lolland (Lolland-West L-W, approximately 1 km northwest of the Rødbyhavn harbour, Lolland-Harbour L-H, directly in the Rødbyhavn ferry harbour, Lolland-Mideast L-ME, approximately 750 m east of the eastern harbour breakwater, Lolland-East L-E, approximately 500 m further east than L-ME) and the landing points under consideration on Fehmarn (Fehmarn-West F-W, approximately 2 km west of the B 207/E 47 transport axis and just 500 m east of the "Grüner Brink" nature reserves, Fehmarn-Nearwest F-NW, next to the western harbour breakwater, Fehmarn-Harbour F-H, directly in the Puttgarden ferry harbour and Fehmarn-East F-E, next to the eastern harbour breakwater) are shown in Figures Figure 4 and Figure 5.

### Potential alignments for bridge or tunnel solutions

Only a single basic route is created within the onshore corridors for every landing point (see above). Smaller differences in alignments in the direct vicinity of the landing point that depend on whether the FBFL is constructed as a bridge or tunnel are initially not considered. As there is only one alignment that connects to every landing point onshore, there are 16 continuous routes (variants) for bridge and tunnel solutions. As there is only one alignment that connects to every landing point, there are 16 potential alignments (variants) for bridge and tunnel solutions.

The variants are listed with their designations in Table 1. The variant designation is comprised of the code for the bridge or tunnel solution (B or T) and the abbreviations for the landing points located on Fehmarn and Lolland.

**Table 1 Potential alignments for bridge or tunnel solutions**

| | | Landing points on Fehmarn | | | |
|---|---|---|---|---|---|
| | | **F-W** | **F-NW** | **F-H** | **F-E** |
| **Landing points on Lolland** | **L-W** | B-W-W<br>T-W-W | B-NW-W<br>T-NW-W | B-H-W<br>T-H-W | B-E-W<br>T-E-W |
| | **L-H** | B-W-H<br>T-W-H | B-NW-H<br>T-NW-H | B-H-H<br>T-H-H | B-E-H<br>T-E-H |
| | **L-ME** | B-W-ME<br>T-W-ME | B-NW-ME<br>T-NW-ME | B-H-ME<br>T-H-ME | B-E-ME<br>T-E-ME |
| | **L-E** | B-W-E<br>T-W-E | B-NW-E<br>T-NW-E | B-H-E<br>T-H-E | B-E-E<br>T-E-E |

Not all potential alignments run exclusively within the relatively low conflict corridors. All variants for a landing point in the Puttgarden and/or Rødbyhavn harbours and all variants that cross or touch the undersea cable line run partially outside the relatively low conflict corridors. These alignments are still included in the assessment because, when assessing/choosing the most suitable variant, there are aspects that play a role that were not considered, or only considered in part, when deriving the relatively low conflict corridors.

Diagrams of the bridge solutions are shown schematically in Figure 4 and the tunnel solutions in Figure 5.

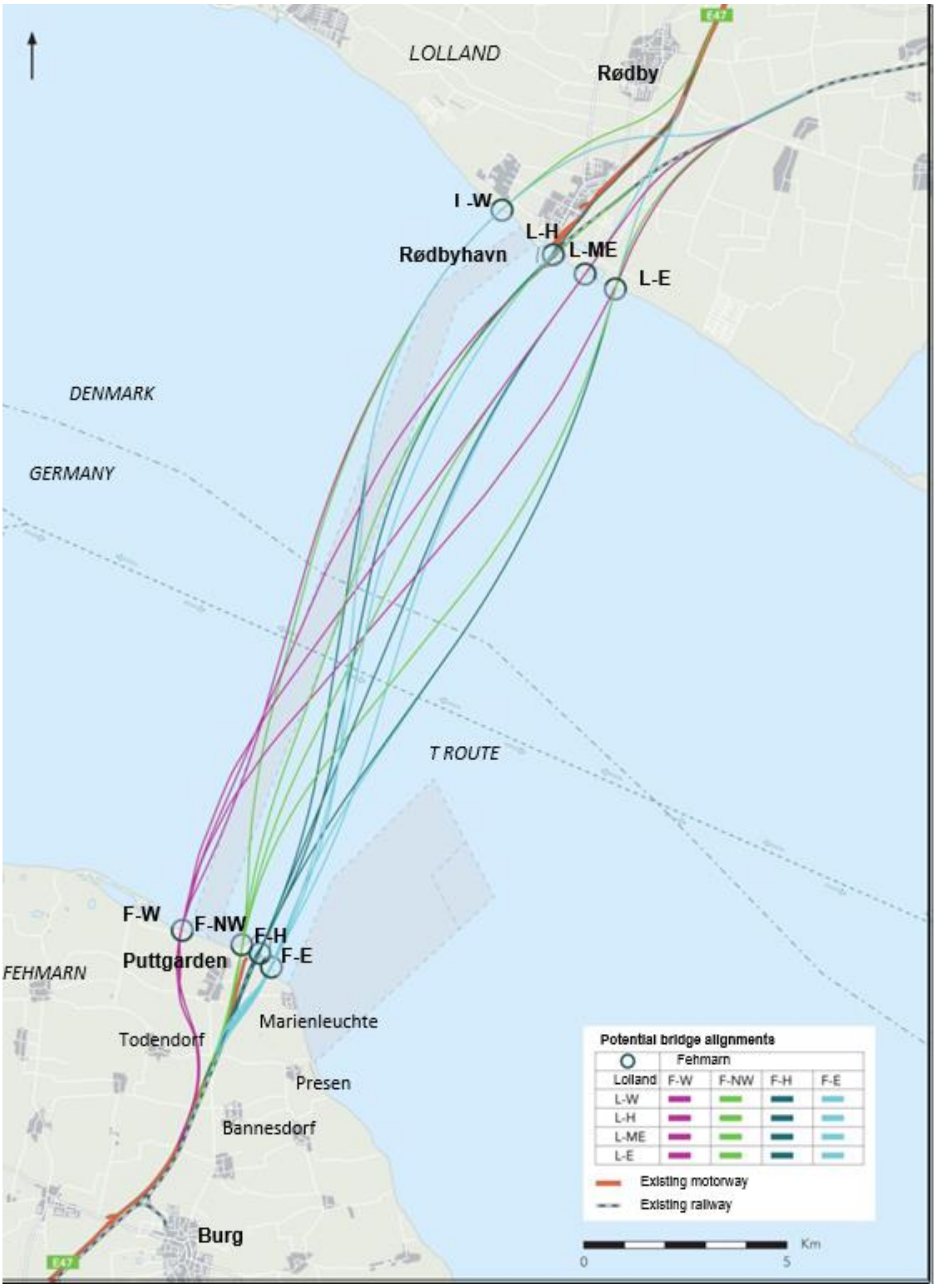



**Figure 4 Potential alignments for bridge solutions**

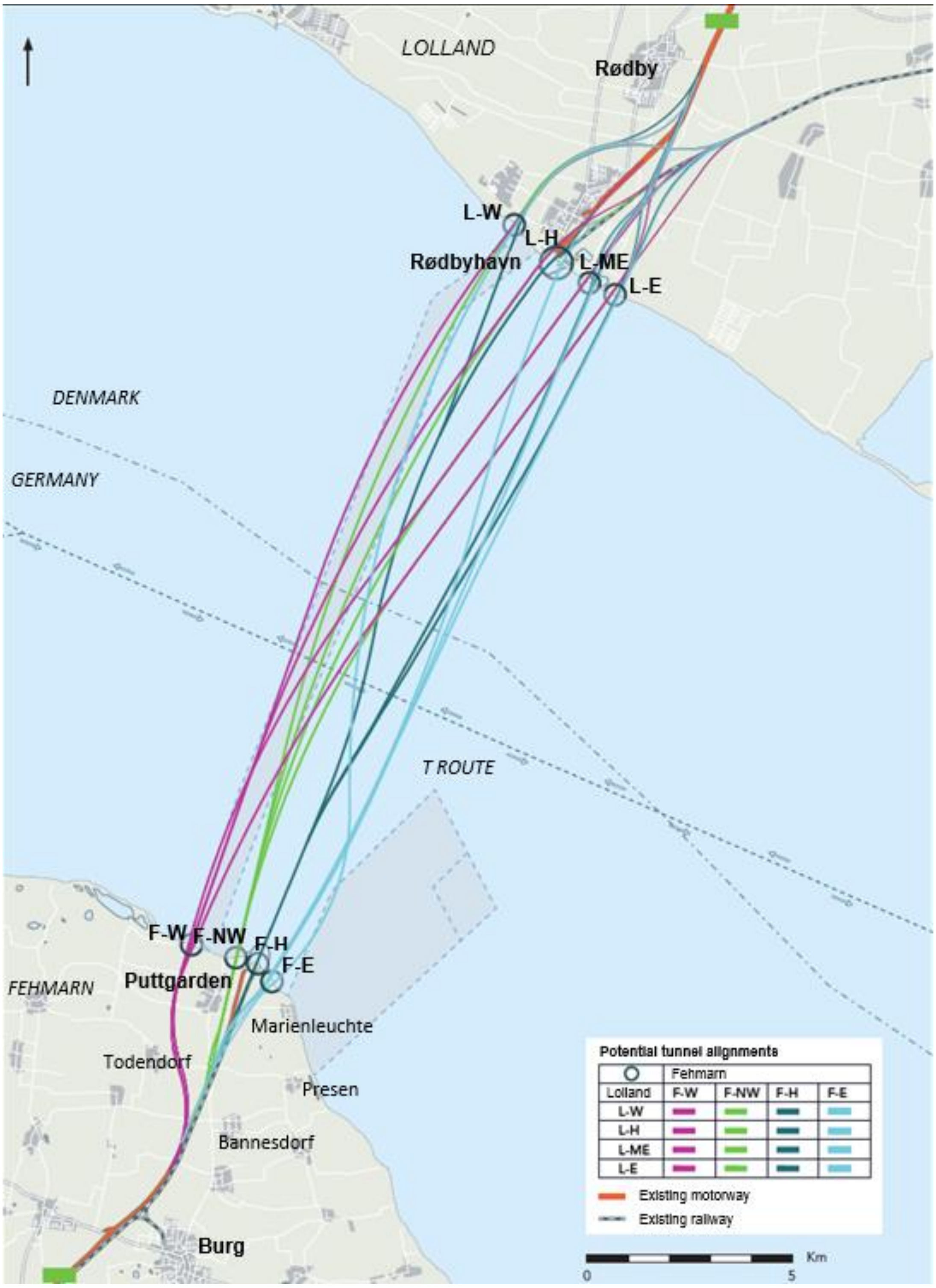



**Figure 5	Potential alignments for tunnel solutions**

### 2.1.1.2. Alignments eliminated in advance of the study

The following sections provide summaries of Sections 5.2.1 and 5.2.2 as well as Section 4.4 of the route determination report (Attachment 18 of the plan approval documents). Reference is made to further details in these sections.

#### Zero variant

The zero variant is defined as the upgrade of the transport network to complete the Fehmarnbelt Fixed Link, but excluding the FBFL itself. In this case, the zero variant generally means preserving the ferry crossing over the Fehmarnbelt and continuing to route rail freight along the circuitous route via Jutland and the Great Belt. The zero variant should always be included in the analysis if it represents an alternative for achieving the transport and structural objectives associated with the project.

The main weaknesses of the current transport infrastructure are the interruption of the land transport axis by the Fehmarnbelt resulting in the need for the ferry service and the inadequate capacities of the transport infrastructure. The ferry service in particular limits the capacity and the desired quality of the transport network. Cross-border transport of rail freight which, due to the dimensions of the ferries, has to be divided up into several sections and then reattached upon arrival in the other country, is specifically affected. This takes so much time and costs so much money that it is more cost-effective to use a detour approximately 160 km in length across the Great Belt and Jutland instead of following the bird migration route. The cross-border transport of rail freight along the bird migration route was therefore discontinued.

However, the main reason for eliminating the zero variant is that a possible improvement in the ferry service does not remove the crucial weakness. As long as the ferry service is the only transport system across the Fehmarnbelt, it forces a system change from road or rail to ferry which leads to the serious disadvantages described above. The transport-related, structural and EU-wide objectives mentioned above would therefore not be met. The zero variant is not an alternative that will achieve the intended objectives.

Pursuing one or both variants is therefore not consistent with the objectives and would also contradict the goal of constructing an FBFL, as agreed in the State Treaty. The zero variant will not be pursued further.

#### Combinations of bridge and tunnel

Between 1995 and 1996 numerous variants of basic possible solutions for an FBFL were investigated from a geological, technical and environmental standpoint. The basic solutions included four tunnel solutions (bored and immersed tunnels) with and without a ventilation island, a bridge solution and two solutions consisting of combined bridge and tunnel structures.

*Combined solution 1* consists of a railway tunnel and a road bridge independent of this tunnel. This solution allows for the greatest flexibility in alignments. From an environmental standpoint, however, two structures produce greater impairments than only one structure, even if the latter is larger. A much narrower cross section would be sufficient for a pure railway tunnel than for a combined road-railway tunnel. However, even if an immersed tunnel with a smaller cross section were built, it would still impair the seabed, e.g. sedimentation, almost as much as a tunnel with a larger cross section. The dimensions of a pure road bridge are only marginally smaller than for the combined solution which is currently under consideration because the cross section design is largely determined by the span, i.e. optimisation of the number of pier shafts. The dimensions of the main bridge are primarily based on shipping requirements (spans, heights, ship impact protection). The differences between a pure road bridge and a combined bridge are only minor. It should also be kept in mind that the effort required to build two structures with different technical requirements and incompatible construction processes is much greater and therefore more expensive than a structure involving only one construction procedure. Combined solution 1 "railway tunnel and road bridge" combined solution is eliminated primarily due to the considerable environmental impact and the financial and technical reasons.

*Combined solution 2* consists of an immersed tunnel used by both modes of transport that merges into a bridge on an artificial island in the Fehmarnbelt which is also used by both modes of transport. T route, the primary shipping route in the Fehmarnbelt, runs along the southern half of the Fehmarnbelt and is thus closer to the German coast than the Danish coast. To permanently prevent interference with shipping in the Fehmarnbelt, a tunnel will be constructed under this section. The tunnel starts on Fehmarn, then rises after crossing the T route by passing over an artificial island and then continues to Lolland via a ramp bridge. This type of solution is only possible using an immersed tunnel. As the floor of the Baltic Sea is 25 to 30 m deep and the tunnel itself lies around 10 m beneath the seabed in the area of T route, a height difference of approximately 40 m must be overcome in order to reach the surface of the water. Taking into account the maximum longitudinal gradient of the railway, the tunnel would have to cover a distance of approximately 3,200 m before “surfacing”. due to the ramps leading to the bridge which are planned there, the island must be approximately 10 m high and between 800 to 1000 m in length. Even at the steepest gradient of 1:2, the artificial island would have a large underwater footprint (approximately 50 ha) and corresponding impacts on the marine environment. It would also considerably impede the exchange of water with the salty North Sea water, which is extremely important for the Baltic Sea. In addition, it is much more difficult to protect a tunnel which rises up from the sea against external influences (dropped anchors, shipping accidents, etc.) than one located on the seabed. From an overall perspective, combined solution 2 is not practical for technical and financial reasons or an environmental point of view.

*Conclusion*

Both combined solutions are associated with so many obvious disadvantages from an environmental, technical, economic and operational point of view that they cannot be justified. These two solutions will therefore not be pursued further.

Therefore, the remaining realistic solutions are the continuous tunnel and bridge solutions. The restriction here, however, is that continuous tunnel solutions with a ventilation island have such impairments on the environment and water exchange (see above) that they will not be further pursued, particularly because there are other variants with fewer impairments. Further assessment thus only looks at continuous bridge and continuous tunnel solutions without ventilation islands between Fehmarn and Lolland.

### Structural variants for bridge solutions: A main bridge as a cable-stayed bridge or suspension bridge

A distinction must be made between the main bridge and the ramp bridges for bridge solutions. The main bridge spans the shipping path of T route. The ramp bridges connect the main bridge with Fehmarn and Lolland. The building principle adopted in the construction of the main bridge depends on the span. If there were to be only one bridge opening, the large span of at least 1,200 m would require a suspension bridge construction. If the main bridge had two openings, a cable-stayed bridge design would also be possible. The ramp bridges would be supported by pier shafts. This design principle holds true regardless of whether the main bridge were designed as a suspension or cable-stayed bridge.

Whether or not the two design principles cable-stayed (see Figure 6) and suspension bridge (see Figure 7) are suitable and advisable as a main bridge is assessed – taking into account the aspects of shipping ease and safety, deformation properties, construction time, aerodynamic stability, technical feasibility, aesthetics and environment – in the route determination report (Attachment 18, Section 4.4.4).

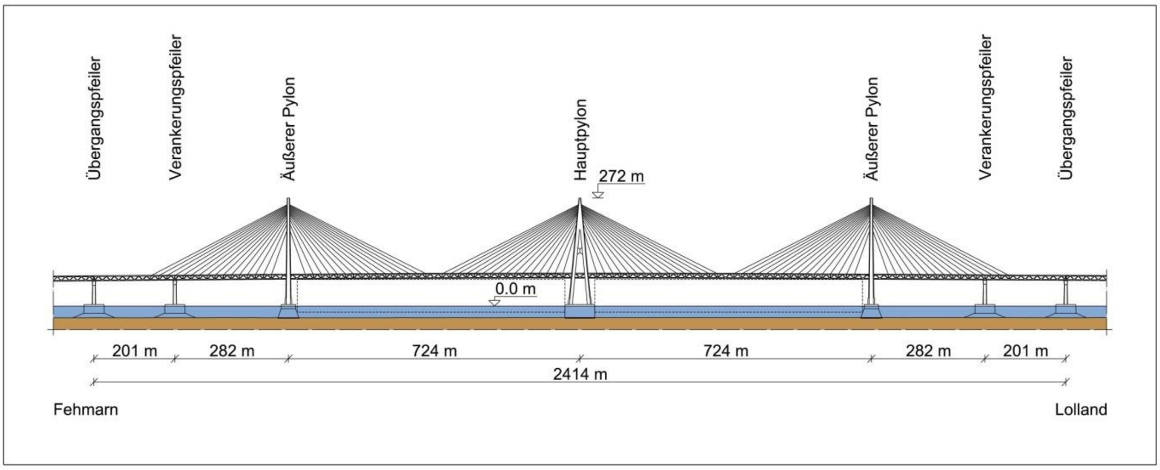



**Figure 6 View of cable-stayed bridge**

| | |
|---|---|
| Übergangspfeiler | Transition pier shaft |
| Verankerungspfeiler | Bracing pier shaft |
| Äußerer Pylon | Outer pylon |
| Hauptpylon | Main pylon |
| Äußerer Pylon | Outer pylon |
| Verankerungspfeiler | Bracing pier shaft |
| Übergangspfeiler | Transition pier shaft |

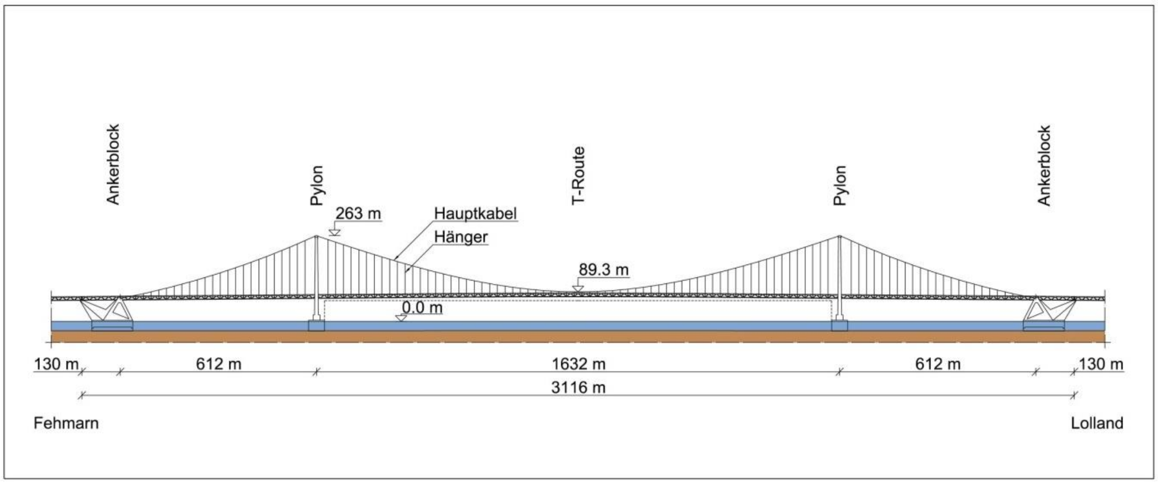



**Figure 7 View of suspension bridge**

| | |
|---|---|
| Ankerblock | Anchoring block |
| Pylon | Pylon |
| Hauptkabel | Main cable |
| Hänger | Suspension |
| T-Route | T route |
| Pylon | Pylon |
| Ankerblock | Anchoring block |

The advantages of the cable-stayed bridge lie in its better deformation properties, higher aerodynamic stability, shorter construction time and lower construction costs. The deformation properties are very significant in terms of railway operations. The two solutions are equivalent in relation to the other aspects mentioned above. For these reasons, the main bridge will be designed as a cable-stayed bridge.

### 2.1.1.3. Alignments eliminated in advance of more in-depth investigations

The following sections provide summaries from Section 5.3 of the route determination report (Attachment 18 of the plan approval documents). Reference is made to further details in these sections.

#### Alignments through the ferry harbours of Puttgarden and/or Rødbyhavn

The direct link between the harbours in Puttgarden and Rødbyhavn is the shortest connection between Fehmarn and Lolland. The harbours are thus considered potential landing points of an FBFL.

The alignments running through the landing points in the harbour would interfere to varying degrees with the harbour operations on Fehmarn and Lolland and in some cases would hinder or even prevent ongoing ferry operations. For the construction and subsequent operation of the FBFL, however, access to and functionality of both ferry harbours must be ensured. As a result, replacement measures (relocations) would be required for the FBFL's footprint in the harbour areas. This would not just affect the harbour facilities but also the incoming and outgoing roads and railway lines. These measures would have to be completed and the new harbours fully operational before construction of the FBFL could begin.

The advantage of routes with landing points in the Puttgarden and/or Rødbyhavn harbours is that they are shorter. However, a route across the harbours would only shorten the distance by approximately 100 to 200 m, which represents only 1% of the length across the Fehmarnbelt.

This slight advantage stands in contrast to the disadvantages of the necessary relocation measures. The costs for constructing new harbours, railway lines and roads far exceed the cost savings of the shorter FBFL route. Alignments through the harbours do not therefore offer a financial advantage. A particularly negative factor is that the completion date would be postponed by several years as a result of new and/or more extensive approval procedures and the extended construction time for relocation measures.

Because the alignments via the F-H and L-H landing points lie outside of the low conflict corridors, have larger footprints, would take much longer to construct and do not offer any financial advantages, they will not be pursued further – especially given the fact that alternative alignments are possible. This eliminates 14 potential alignments.

**Bridge alignments crossed by ferries**

Alignments from the F-W and F-NW landing points on Fehmarn to the L-ME and L-E landing points on Lolland and from the F-E to the L-W landing points cross the ferry routes between Puttgarden and Rødby. Bridge variants that have to be crossed by the ferries create serious disadvantages for shipping.

Alignments in which the ferries have to pass under the bridge run at a slight diagonal across the Fehmarnbelt and thus have a longer overall bridge structure (ramp and main bridges). The link, for example, between the F-E and L-W landing points is 19.8 km long. In contrast, the link between the F-E and L-E landing points is 1 km shorter at 18.8 km (5%; both specifications relate to the current coastline).

The potential risks related to ferries passing under the bridge and encountering ships on T route with right-of-way (limits potential alternatives), the longer travel times (waiting times in the event of such an encounter, the risk of schedule delays) and higher construction and maintenance costs could be avoided if the FBFL alignments consistently ran to the west or east of the ferry routes, thus eliminating the need for the ferries to pass under the bridge. For this reason and because "non-intersecting" solutions are possible, the bridge variants that cross the ferry lines will not be pursued further. This eliminates five potential alignments for bridge solutions (B-E-W, B-W-ME, B-W-E, B-NW-ME, B-NW-E; see Table 2).

The passage of ferries causes no problems for tunnel solutions. As a result, no potential tunnel alignments are eliminated for this reason.

### Tunnel alignments in the area of the undersea cable line

On account of their depth, alignments of bored tunnel solutions do not interfere with the undersea cable line and will therefore be pursued further.

Alignments of immersed tunnels via one or both landing points F-W and L-W would cross the undersea cable line at a glancing intersection or even run within the undersea cable line over longer distances. In the best case, intersections would be approximately 1 km long and in the worst case, the tunnel variant (T-NW-W) would run over a distance of 11 km within the undersea cable line (see Figure 5).

Even though it would be feasible to cross the undersea cable line, it would require enormous effort in areas away from the coast[2]. It would be very difficult to protect the undersea cables during construction of the immersed tunnel because they could not remain in the construction field during excavation work and immersion of the tunnel elements. It would therefore be necessary to relocate the undersea cables in advance. From an engineering standpoint, however, this would be associated with considerable difficulties and risks. As a result of this and the unavoidable protection measures required to relocate the undersea cables, new interventions with a negative environmental impact would be necessary. In addition, the cost of relocating the cables would be prohibitive.

All of the immersed tunnel variants via the F-W and L-W landing points (see Figure 5) cross the undersea cable line away from the coast. For these reasons, they are considered extremely problematic but cannot generally be ruled out at the current time. Despite their obvious disadvantages, they are still included in the assessment because the suitability of the routes via the other landing points has not yet been conclusively determined (T-W-W, T-W-ME, T-W-E, T-NW-W, T-E-W, see Table 3). Tunnel variants that cross the undersea cable line close to the cut-and-cover structure are less problematic because safety measures would be easier to implement. These variants will therefore be considered further.

Bridge solutions that touch or cross the undersea cable line are also problematic but easier to compensate for due to the scattered pier shaft positions. For this reason, potential bridge variants that cross the undersea cable line will continue to be considered if there is otherwise no other reason to eliminate them.

[2] In this context, “away from the coast” means tunnel locations that could no longer be constructed with a cut-and-cover design, i.e. the prefabricated tunnel elements would be floated to the location and laid in a prepared trench.

### Alignments in the western corridors, particularly in the F-W corridor

Route variants in the F-W corridor on Fehmarn run very far to the west and require the existing B 207/E 47 transport axis on Fehmarn to be exited at an early stage. This results in the corresponding construction of new onshore rail lines. The road link on Fehmarn is more than twice as long and the rail link almost twice as long in the western corridor as they are in the eastern corridor. The distance between the F-W and L-W landing points is the longest of all of the remaining alignments. The western landing point on Lolland would also require the most new construction to build a wide detour around Rødby in the west.

The longer sections in the western corridors increase the construction costs. Construction costs (onshore) are expected to be 50% higher for routes via the F-W – L-W landing points and approximately 25% higher for routes via F- NW – L-W than in the eastern corridors.

The spatial resistance analysis (see Section 2.2) shows that the F-W corridor is much less advantageous than the F-NW and F-E corridors in all factors with the exception of the environmental factor climate/air. The environmental factor climate/air is not relevant to the decision because the impacts in all corridors are similar. Clear advantages are also evident for the eastern corridor in the marine area. In the marine area, the impacts of the environmental factors water, climate/air and landscape are independent of the corridor; for all other environmental factors, the advantages clearly lie with the MA-E corridor. The environmental differences between the L-W and L-E corridors are less distinct on Lolland than on Fehmarn; the advantages here, however, also lie in the eastern corridor. They are primarily a result of the lower impact on the environmental factors human beings and landscape.

In the section-by-section assessment (Fehmarn – Fehmarnbelt marine area – Lolland), the western corridors prove less suitable than the eastern corridors with respect to the environment. Consequently, the continuous route in the western corridor as a whole is also not suitable. Alignments in the western corridors are therefore classified as unsuitable. This assessment is also underscored by the need for longer new sections in the western corridor. Fragmentation and impairments of the environmental factors are also unavoidable with alignments in the F-NW and F-E corridors but the overall impact is much less significant due to the bundling with the existing B 207/E 47 – railway transport axis.

A route in the F-W corridor would also negatively impact the development of Puttgarden. In this case, Puttgarden would then be surrounded by two transport routes.

The structural, financial and structural aspects above as well as the environmental effects make it clear that alignments in the western corridors are significantly less suitable than routes in the eastern corridors. They are therefore not being pursued further. The impairments in the western corridors are independent of whether the solution is a bridge or a tunnel.

As a result, the only remaining bridge solutions are routes via the F-E landing point to the two eastern landing points on Lolland (see Table 2).

**Table 2 Alignments eliminated for bridge solutions**

| . | | Landing points on Fehmarn | | | |
|---|---|---|---|---|---|
| | | F-W | F-NW | F-H | F-E |
| Landing points on Lolland | L-W | 3 | 3 | 1 + 3 | 2 + 3 |
| | L-H | 1 + 3 | 1 | 1 | 1 |
| | L-ME | 2 + 3 | 2 | 1 | B-E-ME |
| | L-E | 2 + 3 | 2 | 1 | B-E-E |

Reasons for elimination:
1 = already eliminated due to routing through the harbours
2 = eliminated due to intersection with ferry route
3 = eliminated because it runs through the western corridors

Another serious negative aspect of the immersed tunnel solutions in the western corridors is that all alignments have to touch or cross the undersea cable line. As previously mentioned, this would be associated with considerable structural difficulties and financial expenses, which the project proponent cannot be expected to accept/pay because other alignments are cheaper. However, the F-NW landing point remains a possibility for the tunnel solutions because the ferries would not be hindered by the immersed tunnel. Ultimately, the four tunnel variants shown in Table 3 will be pursued further.

**Table 3 Alignments eliminated for tunnel solutions**

| . | | Landing points on Fehmarn | | | |
|---|---|---|---|---|---|
| | | F-W | F-NW | F-H | F-E |
| Landing points on Lolland | L-W | 3 + 4 | 3 + 4 | 1 + 3 + 4 | 3 + 4 |
| | L-H | 1 + 3 | 1 | 1 | 1 |
| | L-ME | 3 + 4 | T-NW-ME | 1 | T-E-ME |
| | L-E | 3 + 4 | T-NW-E | 1 | T-E-E |

Reasons for elimination:
1 = already eliminated due to routing through the harbours
3 = eliminated because it runs through the western corridors
4 = contact/intersection with the undersea cable line

## Alignments in the F-NW and F-E corridors with tunnel solutions

Two alignments of the non-eliminated tunnel solutions run through the F-NW corridor and two through the F-E corridor. The following assessment of the suitability of the F-NW and F-E corridors therefore only involves the tunnel solutions.

When comparing the F-NW and F-E corridors, the following picture emerges: The dense alignment on Puttgarden, with its effects on people and partial effects on living and recreation in the F-NW corridor caused by both the immersed tunnel and bored tunnel, is a far greater cause for concern than an F-E corridor routing, both to Puttgarden and Marienleuchte. This also applies to the sustained transport impairments. The impact on construction time is similar in both corridors; however, fewer people are affected in the F-E corridor and the area is less important as a tourist destination. The other environmental factors are similarly affected overall in both corridors so that alignments in the F-E corridor are more suitable from an environmental standpoint than routes in the F-NW corridor. This assessment is reinforced by the fact that the F-E corridor offers economic advantages. Alignments in the F-NW corridor will therefore not be pursued further. The tunnel solutions in the F-E corridor (immersed and bored tunnel) can either be routed via the L-ME landing point or the L-E landing point to Lolland (see Table 4).

**Table 4 Alignments eliminated for tunnel solutions**

| . | | Landing points on Fehmarn | | | |
|---|---|---|---|---|---|
| | | F-W | F-NW | F-H | F-E |
| Landing points on Lolland | L-W | 3 + 4 | 3 + 4 | 3 + 4 | 3 + 4 |
| | L-H | 1 + 3 | 1 | 1 | 1 |
| | L-ME | 3 + 4 | 5 | 3 + 4 | T-E-ME |
| | L-E | 3 + 4 | 5 | 1 | T-E-E |

Reasons for elimination:
1 = already eliminated due to routing through the harbours
3 = eliminated due to contact/intersection with the undersea cable line
4 = contact/intersection with the undersea cable line
5 = eliminated due to the less suitable F-NW corridor

### 2.1.1.4. Selected alignments for bridge and tunnel solutions

The result of the assessment of the possible bridge and tunnel alignments is that the only solutions that remain are in what is known as the "eastern corridor", i.e. solutions that are situated on Fehmarn and Lolland with landing points to the east of the respective ferry harbours and whose rail and road connections run to the east of the existing transport infrastructure lines (see Section 2.1.1.3).

### 2.1.1.5. Derivation of the main variants

There are two main alignments remaining for bridge and tunnel solutions for the FBFL.

- T-E-ME and T-E-E
- B-E-ME and B-E-E

#### Main variant bridge

The routes for the B-E-ME and B-E-E bridge solutions on Fehmarn in the F-E corridor use the same landing point. This produces identical alignments and footprints; overall, there are no major differences in individual environmental factors on Fehmarn relevant to the decision from an environmental perspective (see Section 6.2.2 EIA report, Attachment 15, Volume IV A). In summary, it can therefore be deduced that neither of the variants presents a clear and relevant advantage to Lolland from an environmental perspective (see Section 6.2.3 EIA report, Attachment 15, Volume IV A) The location of the alignments varies only slightly in the marine area. Overall, the B-E-ME variant has slight advantages in the marine area in the environmental (sub-) factors human beings/human health, benthic flora and fauna. For the environmental factor landscape, the B-E-E variant has a slight advantage, meaning that the B-E-ME variant in the marine area also has a slight advantage from an environmental perspective (see Section 6.2.1 EIA report, Attachment 15, Volume IV A).

To sum up, there are no crucial differences in terms of the factors agricultural structure and regional planning or urban development between the B-E-E and B-E-ME alignments. Overall, the B-E-ME variant has slight advantages in the environmental area. When it comes to bridge variants, the B-E-E alignment is more advantageous in terms of transport/shipping and routing. Overall, these advantages outweigh the slight advantage of the B-E-ME alignment in environmental terms.

The B-E-E alignment is therefore selected as the main variant for a bridge solution.

**Main variant tunnel**

The remaining options for the tunnel solution were the T-E-ME and T-E-E alignments. The T-E-ME and T-E-E alignments on Fehmarn in the F-E corridor use the same landing point. The result is near identical alignments, footprints and effects which, from an environmental standpoint, show no relevant disparities (see Section 7.2.2 EIA report in the plan approval documents, Attachment 15 of the plan approval documents, Volume IV A). In summary, it can therefore be deduced that neither of the variants presents a clear and relevant advantage to Lolland from an environmental perspective (see Section 7.2.3 EIA report, Attachment 15 of the plan approval documents, Volume IV A)

Even in the marine area, the location of the alignments varies only slightly. Only a few (partial) factors here present even slight advantages for one variant or another. When making an overall ranking of the marine area, the T-E-E variant presents three slight advantages which are based on temporary impairments/losses and the T-E-ME variant presents two slight advantages which are based on permanent losses with small areas. Bearing in mind that the permanent environmental losses outweigh the impairments/losses caused during the construction phase, the slight advantages cancel each other out (see Section 7.2.1 EIA report, Attachment 15, Volume IV A).

Overall, there are no clear differences between the T-E-E and T-E-ME alignments in the areas of the environment, agricultural structure, transport/ shipping and regional planning/ urban development. Here, there are only slight advantages for one or the other variant in a small number of environmental (sub-) factors.

Therefore, the T-E-ME alignment is selected as the main variant for the tunnel solution.

### 2.1.2. Description of the main variants of a Fehmarnbelt fixed link (immersed tunnel, bored tunnel, bridge)

#### 2.1.2.1. Immersed tunnel

**Alignment, gradients, connections, technical facilities**

- Basic alignment: T-E-ME (see Section 2.1.1.5).
- Landing points/reclamation areas: The tunnel portal is located at around the same height as the current coast on Fehmarn. A section of the current coastline around 300 m wide will be shifted approximately 350 m to the north in connection with the

immersed tunnel (reclamation area).
On Lolland, a section of the coastline approximately 3 km wide will be shifted into the Fehmarnbelt and will then lie around 500 m south of the current coast (reclamation area). The tunnel ends roughly 100 m north of the new coastline.

- Length of the line: The railway line is of 26.7 km long in total. Of that, around 3.4 km consists of the onshore connection on Fehmarn, 18.1 km of the tunnel structure and 5.2 km of the onshore connection on Lolland. The total length of the road construction project is 28.1 km, of which around 3.7 km consists of the connection on Fehmarn, 18.1 km of the tunnel structure and 6.3 km of the onshore connection on Lolland.
- Gradients: At the beginning of the planned section to be approved, the railway line is located in the cut, then reaches ground level and, north of the agricultural road between Marienleuchte and Marienleuchter Weg, goes back into the cut which is maintained until the beginning of the tunnel. The gradient of the road is close to ground level or slightly raised until south of the Drohn trench and then goes into an embankment to cross the access track to the Puttgarden train station. The gradient, which then slopes downward, only reaches the same gradient as the railway at the tunnel portal. The shared gradient of the railway and road follows the progression of the seabed in the Fehmarnbelt. It rises up steadily to the Danish coast starting at a location close to the border between the German and Danish EEZ. The E 47 already reaches the flood-proof height on Lolland immediately after passing the current coastline, while the railway does so approximately 400 m north of the current coastline. The lines are virtually at ground level until they connect to the existing route.
- Required junctions and intersections, adaptation to the existing road network and walkways: On Fehmarn, construction of a junction to the Puttgarden train station (railway), construction of the Puttgarden junction with the new overpass to the existing K 49, "service exit" to the western carriageway (direction of Heiligenhafen) to the north as a service entrance to the harbour site and the immersed tunnel, access to the agricultural land, relocation of the connection of the municipal roads to Todendorf and Presen, new access road to the ferry harbour, relocation of the Marienleuchter Weg, new roads or adjustments to existing roads as service entrances (road). On Lolland, construction of a junction where the existing E 47 resumes with connection to the E 47 and the Ottelundevej in the east as a connection to the ferry harbour and to Rødbyhavn, new structures and changes in the secondary road network and the walkways (particularly in the area of the junction and the toll/customs station).
- Other technical details: On Fehmarn, auxiliary areas for FBFL operation, maintenance and emergencies on both sides of the E 47, five bridge structures, large-scale tunnel portal on Fehmarn with flood protection (crest level 6.35 m above sea level) to protect against storm surges. On Lolland, toll and customs station and four bridge structures.

### Tunnel cross section

The tunnel of the Fehmarnbelt Fixed Link is comprised of 79 standard elements. All standard elements have the same geometric form. The two road tubes in the standard elements are each approximately 11 m wide and are located on the west side of the tunnel. Between the two road tubes, there is a central gallery approximately 2 m in width, sub-divided into three levels:

- Lower level: Lower level: pipes for the drainage shafts and water supply lines for hydrants and the fire protection system
- Middle level: located at road level, is used by maintenance staff and serves as temporary safety area in the event of an evacuation from one road tube to the other
- Upper level: supply channel

The two rail tubes, each of which is approximately 6 m in width, are located on the eastern side of the tunnel. Each tube provides space for what is known as a slab track. Escape routes are planned on both sides of the track.

A total of 10 special elements (see Figure 8) are arranged along the length of the immersed tunnel. They provide space for the mechanical and electrical equipment of the tunnel's operating systems. The special elements have individual specifications and cannot be exchanged with other elements. The special elements are lower than the standard elements in order to offer space on a different level for equipment rooms below the road and railway level, e.g. for transformers. The lower level can be accessed from the western road tube.

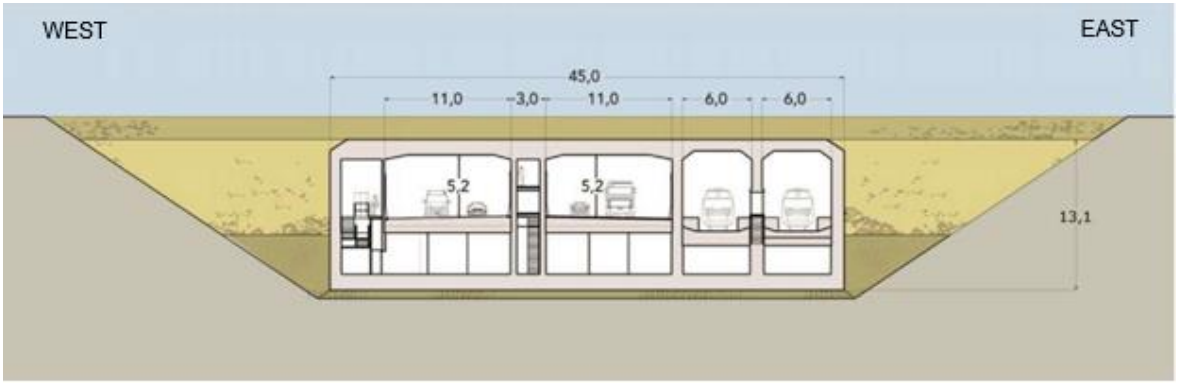



**Figure 8 Cross section immersed tunnel - special element (dimensions in m)**

### Construction procedure

The immersed tunnel is made of prefabricated standard and special elements in a production site located on Lolland. The finished tunnel elements are floated to their installation location and immersed in an excavated trench below the original seabed. The immersed elements are then connected to the previous elements. The tunnel has a cut-and-cover design in the area where the land transitions to the sea and the water depth is inadequate to float the elements.

Most of the excavation work for the immersed tunnel will be carried out by backhoe dredgers and grab dredgers. Backhoe dredgers will likely excavate all the material down to 25m below sea level, while grab dredgers will excavate most of the seabed below this level. In some places where the seabed is deeper, a trailing suction hopper dredger will be used first to break up the hard layers of soil. Subsequently, this soil can be mechanically excavated using grab dredgers. In total, 19.338 million m³ of excavated material is produced, which is then transported to the reclamation areas on the coasts of Fehmarn and Lolland using cargo barges. The reclamation areas are located to the east of the Puttgarden harbour on the German side. On the Danish side, two areas are planned to the east and west of the Rødbyhavn harbour. A plan is also in place to use part of the material excavated from the tunnel trench for the land set aside for the portal and ramp area.

The temporarily stored sediment will be removed from the trench before the tunnel elements are immersed. This sediment has a very low density and is hydraulically transported (suctioned) and drained to sedimentation basins on Lolland located in the reclamation areas.

After the tunnel trench has been dredged and cleared of sediment, an initial underlay composed of gravel is introduced into the trench. This underlay forms the foundation for the tunnel elements. A combination of locking fill (gravel) and normal fill (sand) is used to refill the areas along the sides of the immersed elements. The locking fill secures the position of the tunnel element in the trench and prevents movements caused by hydraulic loads or adding normal fill. A protection layer made of larger stones is added on top of and to the side of the elements. Generally, this is approximately 1.2 m thick and protects the element from any sinking ships or ship anchors that are dragged across the seabed.
The depth of the tunnel was selected to ensure that, with the exception of the areas directly in front of the coasts of Fehmarn and Lolland, the stone protection layer is always located beneath the level of the existing seabed.

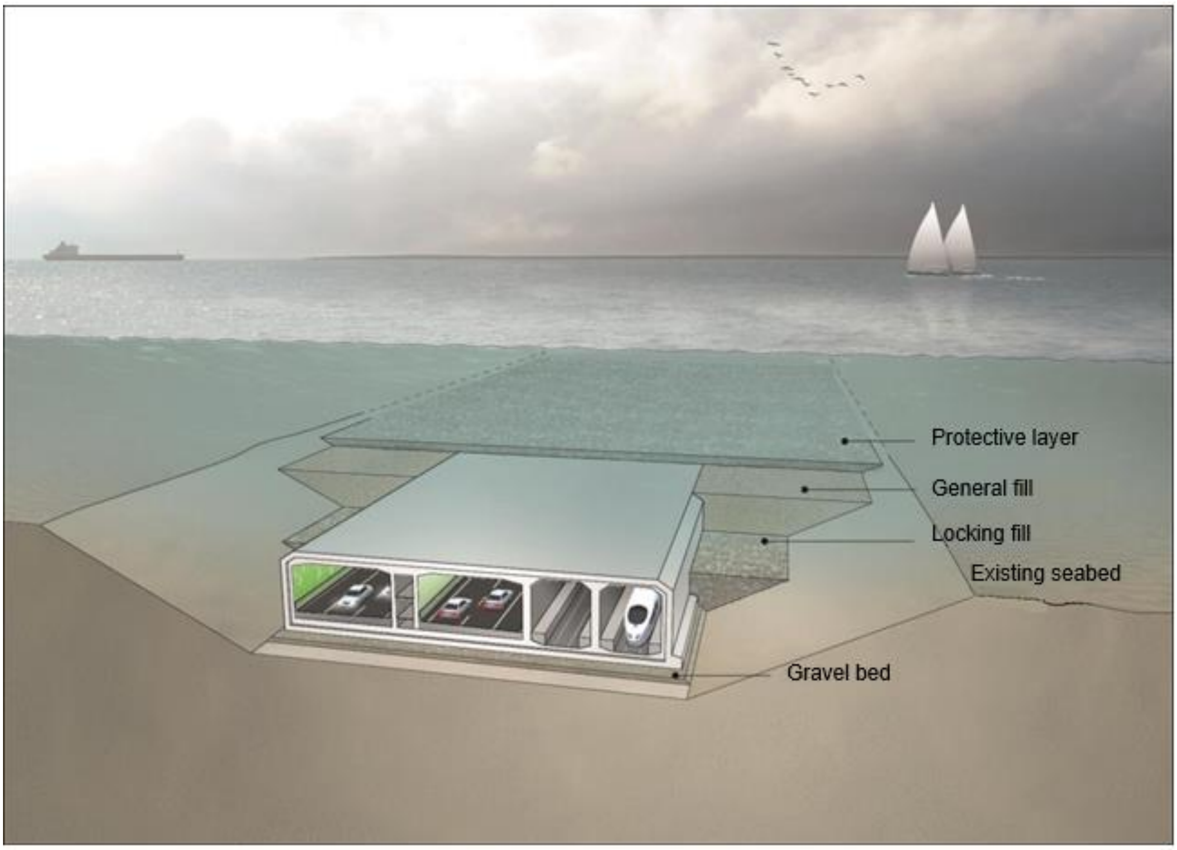



**Figure 9 Perspective view of the immersed tunnel trench with tunnel element and fill**

### Site establishment, working harbours and production site

Several independent sites must be established on Fehmarn to create the immersed tunnel. These sites will be used partly to supply the sea-based works and tunnel facilities through the portals as well as the onshore construction activities. The land used for the temporary construction site areas will be restored after construction work is completed and the original use resumed.

To build the immersed tunnel, two temporary working harbours are planned: one on the German side at Puttgarden and one on the Danish side at Rødbyhavn.

The working harbour on Fehmarn is partly inside but mostly outside the reclamation area located directly between the existing ferry harbour and the tunnel portal building.

The Danish working harbour on Lolland will be located to the east of the landing point of the immersed tunnel and integrated into the production site to produce the tunnel elements.

Both harbours will be integrated into the planned reclamation areas. The plan is to dismantle the working harbours after the tunnel construction work has been completed. The working harbour on Lolland will be filled and become part of the planned permanent reclamation areas.

The working harbours will serve as safe harbours for the various vehicles used by the building contractors for transporting personnel and for supplying, storing, loading and unloading material and equipment. Most building materials will be delivered by sea.

The tunnel elements will be manufactured at a production site established for this purpose to the east of the Rødbyhavn harbour. The production site will be located partly on land and partly off the current coast in the reclamation area.

Situated directly in front of the plant's production building is an adjoining flotation basin, which is partly shallow and partly deep and from which there is access to the Fehmarnbelt via a floating gate.

Each element will be concreted in short sections, referred to as segments. Once all the segments of a tunnel element have been manufactured, they are joined together using tendons to form a complete tunnel element. The completed tunnel elements are pushed to the shallow part of the flotation basin where they are equipped and fitted with ballast tanks, and provided with a watertight bulkhead at each end. To transfer the elements to the sea, the basin will be separated from the production area by a sliding gate and from the sea by a floating gate. The flotation basin will then be flooded with water in a controlled process until the tunnel elements float and can be pulled to the deep part of the basin and moored. The water will then be pumped out of the basin to reduce the water level back down to the level of the Fehmarnbelt. The sliding gate and floating gate can then be opened. Now the upper shallow basin will once again be dry and will be ready for the next tunnel elements.

From the deep basin, the elements will be towed to a predetermined holding area near the tunnel trench in the Fehmarnbelt, to be kept ready for immersion in the tunnel trench. When the element reaches the holding area, it is connected with the pontoons necessary for the immersion process.

#### 2.1.2.2. Bored tunnel

In Attachment 18 of the application material, Section 4.5.3, a total of 12 different bored tunnel variants are described and their cross sections have been evaluated with regard to "technical feasibility" and "cost effectiveness". After a qualifying round, the following bored tunnel solutions were investigated further:

**Table 5 Bored tunnel variants for further investigation**

| Variant | | Road type designation | Rail type designation |
|---|---|---|---|
| **A** | 2-tube solution | Combi_2b | |
| | | Internal Ø of each tube = 16.66 m<br>TBM Ø = 18.86 m<br>Cross sectional area = 2 x 279 $m^2$<br>Tunnel length = 23,600m | |
| **B** | 3-tube solution | Vehicle_3 | Type 4a |
| | | Internal Ø of each tube = 14.20 m<br>TBM Ø = 16.20 m<br>Cross sectional area = 2 x 204 $m^2$<br>Tunnel length = 19,600m | Internal Ø = 15.20 m<br>TBM Ø = 17.20 m<br>Cross sectional area = 232 $m^2$<br>Tunnel length = 21,200m |

The weighting is based on the assessment areas, which were also used in the main variant comparison (c.f. plan approval documents, Attachment 18, Section 6.1). These are:

- Environmental impact
- Regional planning
- Transport
- Urban development
- Agricultural structure
- Construction procedure
- Profitability/investment costs

The assessment summary Table 6 shows the following:

**Table 6 Tabular summary of comparison between variant A and variant B**

| Assessment criterion | Variant A Combi_2b solution | | Variant B 3-tube solution | |
|---|---|---|---|---|
| Environmental impact | the small relevant difference in impact on the mainland is a result of the somewhat larger footprint | | the small relevant difference in impact on the mainland is a result of the somewhat smaller footprint | |
| | slight disadvantage | −/0 | Slight advantage | 0/+ |
| Regional planning | no relevant difference in impact as a result of alignment and links | | no relevant difference in impact as a result of alignment and links | |
| | Equivalent | 0 | Equivalent | 0 |
| Transport | no relevant difference in impact as a result of alignment and links | | no relevant difference in impact as a result of alignment and links | |
| | Equivalent | 0 | Equivalent | 0 |
| Urban development | no relevant difference in impact as a result of alignment and links | | no relevant difference in impact as a result of alignment and links | |
| | Equivalent | 0 | Equivalent | 0 |
| Agricultural structure | the small relevant difference in impact on the mainland is a result of the somewhat larger footprint | | the small relevant difference in impact on the mainland is a result of the somewhat smaller footprint | |

| | | | | |
|---|---|---|---|---|
| | slight disadvantage | −/0 | Slight advantage | 0/+ |
| Construction procedure | high and incalculable risk arising from very large TBM, which is under development, and lack of construction experience | | high risk, calculable due to use of currently common TBM technology | |
| | large disadvantage | −− | | ++ |
| Profitability/ investment costs | no relevant difference in impact as the whole project is at the same level | | no relevant difference in impact as the whole project is at the same level | |
| | Equivalent | 0 | Equivalent | 0 |

*Summary conclusion*

The double-deck Combi_2b solution (variant A) requires a deeper railway gradient relative to the 3-tube solution (variant B), because the railway is arranged beneath the roads and the gradients of both cross sections must lie somewhat deeper than with variant B as a result of the larger tunnel diameter. Lowering the gradients leads to altered boundary conditions where the railway is concerned. Markedly longer approach areas (ramps and cut-and-cover areas) result, since the permissible longitudinal inclination of the railway is limited to 1.25%. This also requires a location slightly further south of the Puttgarden connection than variant B.

The effects caused by these variants in the assessment areas of regional planning, transport, urban development and investment costs/profitability differ either slightly or not at all. As a result, these assessment areas are not relevant to the assessment. In the assessment areas of environment and agricultural structure, variant B offers slight advantages. There are clear differences between the two variants in the area of construction techniques. For reasons of tunnelling length and complex geology alone, excavating a bored tunnel under the Fehmarnbelt presents a very demanding project with high attendant technical risk. Implementing the Combi_2b solution would significantly increase that risk, since tunnel boring machines of this magnitude have never before been deployed for such long distances. Variant B avoids this extreme risk which ultimately leads to variant A being excluded.

Consequently, the 3-tube solution (variant B) proves to be the most favourable option overall. Therefore, it will be further pursued when comparing principal variants for a bored tunnel solution.

### Alignment, gradients, connections and technical facilities of the selected bored tunnel variant

- Basic alignment: T-E-ME (see Section 2.1.1.5).
- Landing points/reclamation areas: The actual tunnel portal for the railway tunnel located approximately 1,000 m south of Fehmarn's current coastline. The bored road tunnel begins around 450 m south of the current coastline. A section of the coastline around 300 m wide will be shifted approximately 550 m to the north in connection with the tunnel (reclamation area).
  On Lolland, a section of the coastline approximately 3 km wide will be shifted into the Fehmarnbelt along with seabed material from the bored tunnel and will then be

located around 500 m south of the current coastline (reclamation area). The railway tunnel will end north of the Faergevej, while the road tunnel will end approximately on a level with Østersøvej.

- Length of the line: The total length of the railway line is 28.6 km, of which around 3.1 km is attributed to the onshore connection on Fehmarn, 21.2 km to the tunnel structure and 4.3 km to the onshore connection on Lolland. The total length of the road construction project is 28.1 km, of which around 2.9 km consists of the connection on Fehmarn, 19.6 km of the tunnel structure and 5.6 km of the onshore connection on Lolland.
- Gradients: The railway line is located in the cut at the beginning of the section to be approved. To the north of the K 49 motorway, the gradient begins to slope downwards at the maximum permissible longitudinal gradient of 12.5‰, which is maintained into the Fehmarnbelt. The line is approximately 13 m below sea level at the beginning of the tunnel and approximately 25 m below sea level when the current coastline is reached. The gradient then levels off and follows the seabed. At its deepest point, the line is up to 58 m below sea level. The gradient begins to rise again close to the border between the German and Danish EEZ and follows the seabed. On Lolland, the railway line reaches ground level around 1,200 m north of the current coastline.
  In the case of the E 47 motorway, the gradient south of the Drohn trench is close to ground level
  or slightly raised. The E 47 then goes into an embankment in order to cross the access track to the Puttgarden train station. To the east of the track and after the Marienleuchter Weg underpass, the line of the E 47 slopes downward and then reaches ground level, with the downward slope being maintained. It is approximately 5 m below sea level at the beginning of the tunnel and approximately 24 m below sea level when today's coastline is reached. On the Fehmarnbelt, the gradient of the road tube follows the progression of the seabed. It rises steadily up to the Danish coast starting at a location close to the border between the German and Danish EEZ. The E 47 reaches ground level around 500 m north of the current coastline on Lolland and maintains this level until it connects to the existing E 47.
- Required junctions and intersections, adaptation to the existing road network and walkways: The junctions and intersections to be newly constructed and the necessary changes in the road network and walkways are basically the same as those of the immersed tunnel (with the exception of Marienleuchter Weg on Fehmarn with a different road route).
- Other technical facilities: On Fehmarn, auxiliary areas for FBFL operation, maintenance and emergencies on both sides of the E 47, three bridge structures, large-scale tunnel portal on Fehmarn with flood protection (crest level 6.35 m above sea level) to protect against storm surges. On Lolland, toll and customs station and four bridge structures.

### Tunnel cross section

Bored tunnels will be bored with tunnel boring machines (TBM) and, for structural reasons, will have a circular cross section. A separate tunnel tube is required for car traffic in each direction. The internal diameter of each tube is 14.20 m. One track is sufficient for each direction in the railway tunnel. As a result, both directions can be located in a single tunnel tube. At 15.20 m, the internal diameter of the railway tunnel, is slightly larger than that of the road tunnel. The three tunnels run parallel to one another, and the distance between the tubes is practically the same as the tube diameter (see Figure 10). Otherwise, each tube is an independent structure. The tubes are not connected to one another in the Fehmarnbelt, which means that each must be equipped with all of the necessary safety and utility facilities.

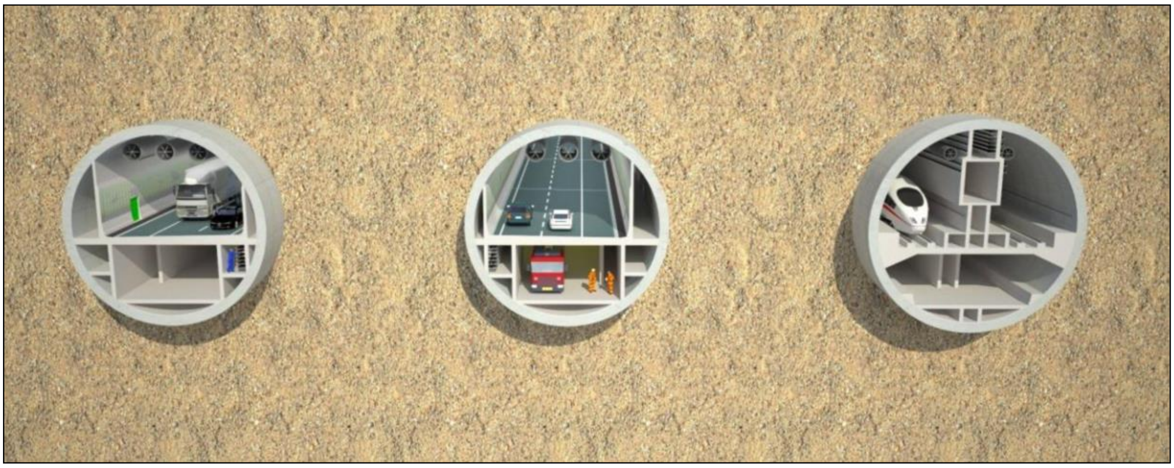


**Figure 10 Location of the three bored tunnels, facing north**

### Construction procedure

Each tunnel tube is bored using two tunnel boring machines (TBM). These start from Lolland and from Fehmarn and meet in the middle under the Fehmarnbelt. A total of six TBMs are required to bore the three tubes. This method makes it possible to construct the tunnel structure under the seabed without requiring any access point other than the start shaft.

During drilling, the earth in front of the tunnel boring machine is loosened using various cutting discs and scrapers. The excavated soil passes into the excavation chamber through openings in the cutting wheel and is then pumped using water and a suspension containing bentonite via pipes to the mainland, which is 10 km away. Only the amount of seabed material necessary to install the cement lining (external tunnel wall) made of prefabricated cement parts (called "tubings") will be loosened and removed at any one time. The tunnel wall is made of prefabricated cement parts (one closed ring each consisting of 11 tubings).

For structural reasons, bored tunnels require a cover that is at least the same size as their diameter, meaning that the top edge of the tunnel must be at least 14 m to 15 m below sea level. This means that the bottom of the tunnel is roughly 30 m below sea level in the coastal area. At its deepest point in the Fehmarnbelt, the bottom of the tunnel reaches around 60 m below sea level.

In total, approximately 18.50 million m³ of material will accumulate, which has to be loosened from the tunnel face and pumped to the sites of the portals so that it can be separated from the suspension. It can then be transported by lorry or ship to its respective destination.

The material excavated from the bored tunnels, portal and ramp areas and the working harbour must be reused. Bentonite and as much water as possible will be separated out of the excavated material from the bored tunnels to increase the stability of the material to be reused. The degree of dehydration and separation depends on the capability of the separation plants to separate out fine-grained soil from liquid. The separation process separates the soil into different fractions by particle size.

Because there are more reclamation areas planned on the Danish coast, a large quantity of excavated material has to be brought from Germany to the Danish coast. This requires the excavated material to be processed before being transported to Denmark.

However, from a technical perspective it must be assumed that it will be possible to reuse all of the excavated material.

**Construction site establishment, working harbours and production site**

With the exception of the new reclamation areas, the temporary working harbours and production sites that are needed to construct the bored tunnel and portal building have the largest footprint in the project.

The following activities will take place at the construction sites on Lolland and Fehmarn:

- Tubing plant
- Temporary storage area for the prefabricated tubing
- Separation system to process the excavated soil (three each on Fehmarn and Lolland) and storage of the associated piles of excavated material;
- A system used to produce suspension for the individual tunnel boring machines;
- Office and workshop equipment;

The direct fresh water supply is not sufficient for the construction site; as a result, the supply of fresh water will most likely have to be supplied by tankers.

Generally, as much soil as possible should be reused for the cut-and-cover section, additional protection and landscaping. The remaining soil will be used for the reclamation areas.

To build the bored tunnel, three temporary working harbours are planned: one on the German side at Puttgarden and two on the Danish side located east and west of Rødbyhavn.

The working harbour on Fehmarn is located to the east of the reclamation area and will be dismantled after construction work is complete. The working harbours on Lolland will be subsequently integrated into the planned reclamation areas. The plan is to dismantle the working harbours after the tunnel construction work has been completed. The working harbours will be filled and will become part of the planned permanent reclamation areas.

### 2.1.2.3. Cable-stayed bridge

**Figure 11 View of the cable-stayed bridge**

The most important features of the cable-stayed bridge include:

- A twin-tracked railway line and a four-lane motorway; two-level bridge girders with the road on the upper level and the railway line on the lower level;
- A main bridge with six bridge spans and a total length of 2,414 m;
- Two main navigational spans each with a span of 724 m and a minimum vertical clearance above sea level of at least 66.2 m;
- Two approach bridges to connect the main bridge with the coasts, with a length of 5,748 m on the German side and 9,412 m on the Danish side; the bridge spans of the approach bridges are generally 200 m in length;
- Two artificial peninsulas with bridge abutments on the coast sides of Fehmarn and Lolland up to water depths of 5 to 6 m connect the approach bridges to the coasts;
- Onshore structures integrate the road and railway connection into the existing transport infrastructure;
- A toll station on the Danish side.

#### Alignment, gradients, connections, technical facilities

- Basic alignment: B-E-E (see Section 2.1.1.5).

- Location: The railway line on Fehmarn follows the existing tracks for approximately 400 m, before curving slightly to the east and then running straight in a north-easterly direction and reaching the German coast after a turning line.
  The road route initially curves left to the west on Fehmarn to gain enough land for the eastern parallel ramps of the Puttgarden junctions. Right around the existing road connecting Todendorf to the K 49, the E 47 curves to the right and then continues in to the northeast. The E 47 crosses the access track to the Puttgarden train station at a glancing intersection to the south of the shunting yard and continues in this direction. The current coast will be shifted by a peninsula in the area of the line by approximately 550 m to the northeast. In the marine section of the bridge, the railway and road routes initially curve slightly to the left, before running in a straight line in the area of the Exclusive Economic Zone and subsequently curving slightly to the right. The route meets Lolland on a level with the abandoned fish farm (approximately 1,500 m to the east of the Rødbyhavn ferry harbour). On the Danish side, the coastline is shifted by a peninsula into the Fehmarnbelt and is then located approximately 400 m south of the current coastline. The bridge ends roughly on a level with the current coastline.
- Length of the line: The total length of the railway line is 26.94 km, of which around 4.2 km is attributed to the onshore connection on Fehmarn, 17.6 km to the bridge structure (without peninsulas) and approximately 5.1 km to the onshore connection on Lolland. The total length of the road construction project is 26.9 km, of which around 4.2 km is attributed to the connection on Fehmarn, 17.6 km to the bridge structure (without peninsulas) and approximately 5.1 km to the onshore connection on Lolland.
- Gradients: The railway gradient is mainly at ground level on Fehmarn, with slight indentations resulting from the typography. Around 200 m south of the current coastline, the gradient starts to slope upwards at the maximum permissible incline of 12.5‰ and reaches a height of almost 15 m above sea level at the southern abutment. Until south of the Drohn trench, the gradient of the E 47 motorway route is close to ground level or slightly raised. The E 47 then slopes upward (embankment) to cross the access track to the Puttgarden train station. To the east of the track and after passing under Marienleuchter Weg, the E 47 gradient slopes downward and reaches ground level on a level with the intersection of the former Rethen road. The gradient then rises to reach the required height difference of approximately 10 m to the railway. The abutment of the road bridge is located south of the current coastline. After the gradient rises, the highest point of the gradients of the routes in the marine area is at the height of the centre pylon at a good 72 m above sea level. The gradient then slopes downward at 5.9‰ and maintains this incline until Lolland. The railway gradient is around 11 m above sea level at the northern bridge abutment. On Lolland, the railway line runs at ground level. The ground level of the road line on Lolland is reached around 400 m north of the current coastline and maintained until it connects to the existing E 47.
- Required junctions and intersections, adaptation to the existing road network and walkways: The junctions and intersections to be newly constructed correspond to those of the immersed tunnel. The junction for the bridge solution will be connected

via a new road to the former E 47 in the west and to the Darketvej in the east. With the exception of the road to Marienleuchte, the necessary changes to the road network and walkways correspond to those for the immersed tunnel. In future, Marienleuchte will be accessed via a new road from the road to Presen.

- Other technical facilities: On Fehmarn, there are auxiliary areas for FBFL operation and maintenance on both sides of the E 47 as well as four bridge structures for emergencies. On Lolland, toll and customs station, two bridge structures, relocation of the Østersøvej and several new connections.

### Bridge cross section

The bridge cross section is designed with a construction height of approximately 12.90 m. This results in 28 pier locations for the Fehmarn ramp bridge as well as 46 pier locations for the Lolland ramp bridge along the total length of the ramp bridges.

### Construction procedure

Before the main work on bridge construction can begin, measures are required to improve the soil conditions on the German side for the foundations of the main bridge and the foundations of the approach bridge. Soil without load-bearing capacity will be reinforced with bored piles made of concrete.

The next steps in the construction procedure are as follows:

- Construction of the main bridge substructure:
  The pylon caissons will be prefabricated in existing dry docks at the Odense/Lindø production site and completed at an interim construction site. They will then be towed to their final installation location in the Fehmarnbelt and immersed using water ballast to the three already constructed installation surfaces. The systems used for on-site concrete production and other construction systems will be provided on pontoons that are connected to the caissons. The offshore construction sites will continue to be supplied by the temporary working harbours on Fehmarn or Lolland. The pylon legs will be simultaneously concreted on-site in girder formwork in sections with a height of approximately 4 m. While the pylons are being constructed, the caissons will be used as construction site areas. Pontoons will also be used to provide additional workspace and house the floating concrete factory, for example. The retaining rings of the concrete bracing pier shafts and transition pier shafts will most likely be prefabricated on land, possibly in the same production site in Odense/Lindø where the caissons for the shafts are also made for the approach bridges.

- Production of the bridge superstructure:
  The steel constructions for the main bridge will also be manufactured in the Odense/Lindø shipyard production site. The girders of the main bridge are made of segments approximately 20 m in length. The finished bridge girder segments are loaded and transported using hydraulic vehicles. The girder segments will then be

loaded onto barges and transported to the respective assembly location of the main bridge.
The bridge girders will be constructed using the free cantilever method. Using a jib crane, these 20 m long girder segments are then lifted onto the bridge deck of the transport pontoon. Hydraulic vehicles will be used to load and transport the finished bridge girder segments. The girder segments will then be loaded onto barges and transported to the respective assembly location of the main bridge. After the girder segments have been assembled, the corresponding stay cables are assembled and stressed.

- Constructing the substructure of the approach bridge:
  The substructure of the bracing and transition pier shafts are erected using the same procedure as the substructure of the approach bridges.
  The caissons for the approach bridges are manufactured at the Rødbyhavn production site and also include the lower part of the pier shaft that protrudes over the surface of the water. After completion, the caissons are either lifted by a floating crane or slid onto a barge and then taken over by two floating cranes at the installation location. The caissons are then transported the short distance to their final installation location and lowered to the concrete bed that has already been constructed.
  The pier shafts, which are also manufactured in the Rødbyhavn production site are, when completed, also either lifted by a floating crane at the production site or slid onto a barge and placed on caissons by two floating cranes at the installation location.

- Construction of the superstructure of the approach bridges:
  The superstructure of the approach bridge consists of 47 bridge spans on the Danish side and 29 bridge spans on the German side. The steel constructions for the approach bridges are manufactured in the Odense/Lindø shipyard production site. The completed girders are then transported to the bridge by pontoons.
  The bridge girders are generally assembled from the onshore abutment up to the main bridge. The peninsulas on Lolland (approximately 400 m long) and Fehmarn (approximately 550 m long) must be erected as early as possible because the access for constructing the abutment and the superstructure of the approach bridges is only possible via the peninsulas and the embankment. The plan is to create the peninsulas as follows:
  - Dredge the construction area
  - Fill the dredged area from both sides with rubble from land and ship
  - Construct the island reinforcement with water modules on both sides
  - Fill the embankment core with sand to the height required for constructing the gallery

- Key construction work on Fehmarn:

The gallery, with a length of approximately 320 m, separates the road and railway line. The upper part continues to run slightly to the west in the 25,000 m radius while the tracks follow a curve with a radius of 5,000 m to the east.
For the E 47, a viaduct approximately 500 m in length that serves as a ramp is planned to connect the gallery and the motorway embankment. It will be constructed using reinforced concrete pier shafts and a superstructure made of post-tensioned concrete with spans approximately 40 m in length. The viaduct connects to an embankment approximately 490m in length, which slopes down to the height of the natural terrain.
The railway line runs from the peninsula to the connection with the existing tracks either in a cut or on a continuous embankment.
The E 47 must be routed over the existing tracks at the Puttgarden harbour.

The construction of the bridge variant will produce approximately 1.30 million $m^3$ of excavated material. A total of approximately 4.50 million $m^3$ of soil material is required for the filling work.

**Construction site establishment, working harbours and production site**

Most of the construction materials will be transported by water. To erect the bridge, temporary working harbours and production sites are needed to manufacture the bridge elements during construction.

In addition to smaller onshore construction site areas, the following areas are planned:

- Fehmarn temporary working harbour
- Temporary working harbour on Lolland including a production site in Rødby
- Odense/Lindø production site

The temporarily used areas will be restored after construction work is completed and the original use resumed.

The working harbour on Fehmarn will be created to the east of the route. The harbour is envisaged as a working harbour for ships which will assist in the construction of the bridge route. It will be used to load and unload construction materials and machines and to transport workers.

The working harbour and the Rødby production site will be set up approximately 450 m to the east of the existing Rødbyhavn harbour facilities and right next to the Fehmarnbelt Fixed Link. They will be used, specifically, to prefabricate the substructures of the ramp bridge, the anchors, the separation pier shafts and the ship impact protection. At the same time, work in the marine area on the ramp and the main bridge will also be supported and all onshore work supplied from the working harbour. After construction is complete, the peninsula created off the coast will be connected by new sandy beaches which will blend into the landscape.

In the Lindø industrial park on the island of Fünen, there is an industrial area with dry docks that were previously used as a shipyard and which is increasingly being used as an industrial park. This area can be used to manufacture the caissons (retaining structures) of the pylons and the superstructures for the main and ramp bridges. All of the components prefabricated in

Odense/Lindø will be transported directly to the installation site at the respective location in the Belt without using the Rødby working harbour.

## 2.2. Spatial resistance analysis

The results of the "Spatial Resistance Analysis and Determination of Relatively Low Conflict Corridors" study (Attachment 17) will be summarised below. Figure 13 to Figure 16 in Section 2.2.3.6 the major findings obtained from the analysis are shown.

### 2.2.1. Objectives and procedure

**Objectives**

The purpose of determining the spatial resistance and identifying relatively low conflict areas or corridors is:

- To develop, at an early planning stage, routes that are as environmentally friendly as possible in accordance with the optimisation and prevention principle;
- To narrow down the area most likely to be investigated in more depth, including corridors favoured for route planning;
- To determine whether it is possible to find a route through relatively low conflict corridors with potentially minor environmental effects, or whether the route is likely to have a more severe environmental impact, which would probably require a more extensive investigation and ultimately result in higher costs for preventative, minimising or compensation measures;
- To gauge the risk of the project of being rejected for environmental reasons during the subsequent approval procedure for a selected route and to secure the procedures for the entire project in technical and legal terms by identifying the main areas of conflict.

As a tool, the spatial resistance analysis is described in detail in the relevant German guidelines (Merkblatt zur Umweltverträglichkeitsstudie in der Straßenplanung MUVS 2001 [Guidance on the Environmental Impact Assessment in Road Planning], Richtlinien für die Erstellung von Umweltverträglichkeitsstudien im Straßenbau RUVS [Guidelines for the Preparation of Environmental Impact Assessments in Road Construction] - Draft 2008).

**Investigation area**

The investigation area for the spatial resistance analysis is defined as the area in which feasible solutions (route variants) for achieving the project goal of the Fehmarnbelt Fixed Link can be found. As the objective of the environmental legislation in both countries is to develop a Fehmarnbelt Fixed Link and minimise the various impairments during the planning stage and since the project and its environmental impacts must be seen in their overall spatial context, it was decided to conduct a spatial sensitivity analysis that covers both the Danish and German territories including the Fehmarnbelt.

The definition of the onshore investigation area on Fehmarn and Lolland is based on the feasible landing points for a bridge or tunnel variant, taking into account the shortest possible fixed link across the Fehmarnbelt. Landing points are generally feasible to both the west and east of the Puttgarden and Rødbyhavn ferry harbours on Fehmarn and Lolland. The boundaries of the investigation area are the Natura 2000 sites (FFH area DE 1532 – 391 "Western and Northern Fehmarn Coast" or SPA DE 1530 – 491 "Eastern Bay of Kiel") on Fehmarn to the west and the Natura 2000 site (FFH area DK006X238 "Smålandsfarvandet nord for Lolland, Guldborgsund, Bøtø Nor og Hyllekrog – Rødsand") on Lolland to the east. The goal is to prevent the possible route from significantly impairing these Natura 2000 sites. In the south of Fehmarn and in the north of Lolland, the borders of the investigation area are determined by the possible connections of the Fehmarnbelt Fixed Link to the existing federal and European motorways and railway lines. Furthermore, the definition of the investigation area takes into account the range of possible impacts of the project on the environmental factors.

The definition of the marine investigation area in the Fehmarnbelt in order to identify potential low conflict corridors is based on a conceivable connection between the external borders of the onshore investigation areas located on Fehmarn and Lolland. The result is an investigation area approximately 6 km in width in the coastal area of Fehmarn and approximately 12 km in width in the coastal area of Lolland. In this investigation area, the corridors or potential route variants can then be developed from the west and east of the ferry harbour on Fehmarn to landing points west and east of Rødbyhavn.

The marine investigation area is shown in Figure 14. An overview of the entire onshore and marine investigation area for the spatial resistance analysis is provided in Table 7.

### Procedure

The Baseline investigation and technical assessment of the environmental factor human beings, which includes human health, fauna, flora and biodiversity, soil, water, climate, air, landscape, cultural heritage and other material assets, and their interaction according to the Environmental Impact Assessment (EIA Act) and the EU's Guideline of the Council on Environmental Impact Assessment (EIA Directive) is performed on the basis of available data and concentrates on the key facts in the spatial resistance analysis. In addition to the analysis of existing data, the baseline definition also included the data collected under the scope of the project up to the summer of 2010. As a result, the data used to determine the spatial resistance in the planning phase was already extremely extensive. An analysis of available data up to the summer of 2010 means that, for the planning step of the spatial resistance analysis, it is not necessary to further update the data beyond this time period. All other findings of the extensive Baseline investigations are taken into account in detail in the next steps of the EIA. However, key findings of the extensive Baseline investigations for the project are taken into account at the level of the spatial resistance analysis where appropriate. Due to the different natural features and legal frameworks, the baseline is defined and evaluated for the Fehmarnbelt Fixed Link for three separate areas: the marine area, Fehmarn and Lolland. It must be kept in mind here that the description and evaluation of the environmental factors in Denmark and Germany reflect not only the European laws but also the national legal regulations and technical standards, which means that they cannot (always) be directly compared.

The potential for conflict in the region, known as "spatial resistance", is determined using this baseline definition and evaluation. To this end, the investigated facts, which are subject to legally binding protection standards and which are therefore not subject to additional expert evaluation, and the facts evaluated by experts, are categorised into three spatial resistance classes (SRC I, II and III). The facts are assigned to the various classes by project and landscape, taking into account the legal requirements and the spatial models that have been established for the region (e.g. for regional and landscape planning).

**Table 7 Definition of spatial resistance classes**

| Spatial resistance class | Definition | Colour in the diagram |
|---|---|---|
| SRC I | Circumstances in which a significant environmental impact is to be expected due to project-related impairments and which may be an obstacle to approval (the basis for this is generally statutory protection standards and circumstances which are likely to lead to particularly severe impairments) | Red |
| SRC II | Circumstances in which a considerable environmental impact is to be expected due to significant project-related impairments and which is significant for the assessment (this is based on statutory/sub-statutory protection standards and an expert assessment of environmental impact) | Orange |
| SRC III | Circumstances in which environmental effects of varying degrees of severity are to be expected due to project-related impairments and which have limited relevance to the decision (these are generally not based on statutory protection standards or circumstances related to environmental protection) | Yellow |
| No class or assignment | Circumstances in which an insignificant or minor environmental impact is to be expected due to project-related impairments | White |

In the first step of the spatial analysis process, spatial resistance classes are determined and shown geographically for each environmental factor. The spatial resistance then represents an overview of all conflict potentials of the individual environmental factors. An area’s spatial resistance is determined by the circumstance which presents the greatest potential for conflict.

The different geographical conflict potentials can be determined on the basis of this overview. In the next step, the corridors relevant to planning are defined as "relatively low conflict corridors” in an iterative process together with the technical planning. As a result of this step, corridors are defined which:

- which, on the one hand, allow for sensible potential alignments for the purpose of fulfilling the transport-related planning task and,
- on the other, do not include, if possible, any areas previously identified as areas of the highest conflict intensity (i.e. areas classified as SRC I and II).

The corridors identified as being as low-conflict as possible therefore represent the areas in which the detailed route planning should be conducted.

If a corridor (unavoidably) runs through an area categorised as
SRC I or if it transects a considerable area categorised as SRC II, a map symbol is used to highlight the high potential for conflict and the main area of conflict to be expected in this location. The main areas of conflict are an indication that more effort may be needed in the planning phase for detailed route planning and the next planning phases in terms of preventative and minimising measures and must be taken into consideration in the evaluation of the individual corridors from an environmental perspective.

Furthermore, to determine the relatively low conflict corridors, it is important

- to show corridors in both countries which are as low conflict as possible for ongoing development of the best possible routing in terms of environmental impact and
- to determine the low conflict corridors regardless of the specific structure, i.e. of a bridge or tunnel solution. Spatial resistance which is only differentiated geographically cannot be used to perform an environmental assessment of the bridge and tunnel solutions at the planning level of the spatial resistance analysis. The description and assessment of the specific environmental impacts of bridge and tunnel solutions is a central focus of the next planning phases of the Environmental Impact Study.

It is also assumed that:

- The body of water in the Fehmarnbelt, its significance as a stopover area for marine mammals (specifically harbour porpoises), the significance of the Fehmarnbelt for bird migration and the natural scenery of the open sea area constitute overall factors of special, supra-regional significance.
  These facts are therefore classified as SRC I. However, since the facts described are significant for the entire marine investigation area and since they have the same spatial resistance throughout, they cannot contribute to any spatial differentiation and can therefore not help determine relatively low conflict areas. As a result, they are not shown in maps here as part of the spatial resistance analysis (see Section 2.2.2.1);
- The potential impacts of a Fehmarn Fixed Link on the factors mentioned above will be taken into account in the next planning phases of the Environmental Impact Study because the structurally-related impacts caused by a bridge or a tunnel are relevant for the conflict potentials and not the alignment of a Fehmarnbelt Fixed Link.

The map overview of the spatial resistance classes (spatial resistance), the relatively low conflict corridors identified including the sections of corridors in areas of higher spatial resistance and the main areas of conflict for the Fehmarnbelt Fixed Link project are shown in Figure 13 to Figure 16 .

### 2.2.2. A summary description of the spatial resistance/areas of particular environmental significance

In the following section, the areas of varying environmental significance determined using the criteria above (by spatial resistance classes) are described in brief for both the marine area and Fehmarn and Lolland. Areas with special environmental significance (SRC I) that should not be crossed by alignments if possible or would create high conflict potential are given special attention.

#### 2.2.2.1. Marine area/Fehmarnbelt

The body of water in the Fehmarnbelt, its significance as a stopover area for marine mammals (specifically, harbour porpoises), the significance of the Fehmarnbelt for bird migration and the natural scenery of the open sea area constitute overall factors of special, supra-regional significance. These facts are therefore classified as SRC I. However, since the facts described are significant for the entire marine investigation area and since they have the same spatial resistance throughout, they cannot contribute to any spatial differentiation and therefore cannot help determine relatively low conflict areas. As a result, the summarised description below does not include these facts; they are addressed in more detail in the next planning phase of the Environmental Impact Study (see Section 2.2.1).

Connected areas in the investigation area in the highest spatial resistance (SRC I) that can be used for spatial differentiation are the offshore areas with SPAs and FFH areas. The "Fehmarnbelt" FFH area on the German side, which runs from west to east (environmental factors fauna, flora, biodiversity), is located in the centre of the investigation area. Other areas classified as SRC I include undersea cables – in addition to a few smaller cable lines – with a fairly large cable area running from north to south between Fehmarn and Lolland. Material assets also classified as SRC I include the harbour facilities/breakwaters and a restricted military area near Fehmarn. The coastlines have areas with the highest spatial resistance consisting of the dykes, beaches and bathing areas which are particularly suitable for recreation (environmental factor human beings), as well as macrophytes and eelgrass or (sand) reefs with mussels which are protected according to German nature conservation laws (Art. 30 of the Federal Nature Conservation Act (BNatSchG) in conjunction with Art. 21 of the and the Nature Conservation Act of the State of Schleswig-Holstein (LNatSchG) (environmental factors fauna, flora and biodiversity). From the point of view of the environmental factor soil, there is a sub-area with "unique geomorphological formations" (by the "Grüner Brink" nature reserves) next to Fehmarn on the western edge of the investigation area. In addition, steep coastlines/cliffs on the eastern edge of the Fehmarn investigation area are geotopes classified as SRC I.

The areas of medium spatial resistance (SRC II) essentially consist of buffer zones around the SPAs and FFH areas (environmental factors fauna, flora, biodiversity), and structures known as "mega ripples" in the Danish part of the Fehmarnbelt that are important from a geomorphological point of view (environmental factor soil). Furthermore, beaches which are of average suitability as recreational areas and the relevant bathing areas were classified as SRC II (environmental factor human beings).

Areas with low spatial resistance (SRC III) mainly relate to the environmental factors fauna and flora including, mussels, areas important for various fish species and other small macrophytes, particularly on the Danish side. .
From a geomorphological point of view, areas with crescent-shaped, approximately 0.5 m high sand ripples in the central region of the Fehmarnbelt were classified as SRC III (environmental factor soil). Near the coast, beaches, bathing zones and surfing areas of secondary importance are assigned to this spatial resistance class (environmental factor human beings). In the Danish marine area, small areas for sand extraction and sand deposits also belong to this category (environmental factor material assets).

The distribution of the spatial resistance in the marine area is shown in Figure 14 .

#### 2.2.2.2. Fehmarn

The areas which make up the investigation area, along with the associated areas of highest spatial resistance (SRC I) are mostly located on-shore on Fehmarn with regard to environmental factors, coastal regions (beaches, dykes, cliffs etc.) and valuable areas from the perspective of nature conservation are located on the norther coast to the west of the investigation area (the "Grüner Brink" nature reserve, Natura 2000 areas) (flora and fauna and biodiversity; soil resources) Material assets of overriding public interest (storm surge dyke, harbour facilities, federal/European roads and railway line/railway systems) are also classified as SRC I. The areas with medium spatial resistance (SRC II) are usually adjacent to areas with high spatial resistance. There is a concentration of the highest spatial resistance in the coastal areas; the settlement centres with the highest spatial resistance are distributed to the west and east of the E 47/ B 207. Material assets of overriding public interest (storm surge dyke, harbour facilities, federal/European roads and railway line/railway systems) are also classified as SRC I.

Areas of medium spatial resistance (SRC II) are generally connected to areas of high spatial resistance. This results in extensive spaces composed of living areas located around the existing settlements (environmental factor: people) in addition to structure-rich agricultural areas located near to settlements on the western edge of the investigation area from Landkirchen in the south to Todendorf in the north and from Burg to Bannesdorf via Presen and Marienleuchte in the south east/ east (environmental factor: landscape). The coastal section is also categorised as having high spatial resistance (SRC I) in areas of varying widths. Here, the dyke and the large area immediately behind the dyke itself are of special importance for recreation (environmental factor human beings, flora/fauna and landscape). The wind farm at Presen represents a further area of medium potential conflict.

When considering the structures described above, it can be seen that the areas of low spatial resistance (SRC III) are located primarily in the central part of the investigation area along the E 47/ B 207 transport axis. They are primarily made up of agricultural areas with a low level of structures on site and located far from settlements where only small numbers of higher value individual structures from a landscape and nature preservation perspective can appear.

#### 2.2.2.3. Lolland

The sections of the investigation area with their adjoining areas of highest spatial resistance (SRC I) are represented on Lolland by settlements (environmental factor human beings). The largest locations are the cities of Rødby, Rødbyhavn, the holiday home areas located in Bredfjed and Hyldtofte Østersøbad and the Lalandia holiday centre. The coastal section - which varies in width - lies within the areas of high spatial resistance (SRC I). Of particular importance here for recreation activities are the dyke (environmental factor: people) and the flora and fauna and landscape as well as the low-lying and overwhelmingly natural areas are of particular importance for flora and fauna. To the east, the Natura 2000 zone intersects the "Saksfjed Inddæmning" area (environmental factor flora and fauna and biodiversity). To the west of the investigation area, there are larger areas classified as SRC I on account of their significant landscape properties of Lidsø and, from a cultural heritage perspective, the significant landscape represented by the dried up former estuary (Rødby Fjord). Similarly this also applies to the north eastern section of the investigation area with its existing landscape properties and (individual) cultural heritage features represent important landscape spaces (environmental factors: landscape and cultural heritage).

In addition, scattered throughout the whole investigation area are smaller zones located in the areas of high resistance (SRC I), which represent particular significance to people (individual houses located in the outlying areas) or flora and fauna and biodiversity (e.g. the numerous small bodies of water). The former railway line is of significant importance as a recreational route and biotype network line (environmental factor flora and fauna and biodiversity) and the overarching rail connection and E 47 (environmental factor: material assets) are smaller, linear elements within the SRC I spatial resistance classification.

Most of the remaining investigation area is categorised as having medium spatial resistance (SRC II) for a variety of reasons (especially its importance for the environmental factors human beings, cultural heritage and landscape).

Only small sections of the investigation area are categorised as having minor spatial resistance (SRC III). Some of these areas lie close to the existing E 47 and the railway line; to the north east of Rødbyhavn and to the east near Bjergemark.

The distribution of the spatial resistance on Lolland is shown in Figure 16 .

### 2.2.3. 2.2.3. Information about potential alignments/identifying low conflict corridors

#### 2.2.3.1. Prerequisites and constraints for identifying corridors for a Fixed Fehmarnbelt Link

The starting point of possible route corridors on Fehmarn and Lolland is the road and rail connection of the Fehmarnbelt Fixed Link to the existing transport infrastructure. Furthermore, when creating routes for the Fehmarn Fixed Line, the railway systems and ferry harbour on Fehmarn and Lolland must be kept clear, so that the ferry service between Germany and Denmark can be sustained. In individual cases, intersections of areas classified as SRC I or SRC

II are unavoidable and this leads to main areas of conflict. It is possible that outlying areas may be used for such purposes as parking spaces and warehouse areas

Ultimately, there are possible applications for the Fehmarnbelt Fixed Link located on the Fehmarn coast to the west and east of the Puttgarden ferry harbour. The boundary of possible landing points to the west of Puttgarden are the high-value "Grüner Brink" nature reserves and the areas to the west (nature reserves, Natura 2000 sites) which should not be crossed. In the east, the only reasonable abutment lies between the ferry harbour and Marienleuchte. Abutments south of Marienleuchte would shift the Fehmarnbelt Fixed Link too far onto the east coast of Fehmarn, which would make the offshore Fixed Link considerably longer.

Possible route corridors on Lolland have to be connected to the E 47 and the railway line north of Rødbyhavn. In this respect, abutments for the Fehmarnbelt Fixed Link can potentially be built to the west and east of Rødbyhavn: in the west, between Rødbyhavn and the Lalandia holiday centre and in the east between Rødbyhavn and the Syltholm wind farm situated approximately 2 km to the east. Abutments further west or east would entail a considerably longer onshore and offshore Fixed Link and also significantly extend the connection to the E 47 and the railway line north of Rødbyhavn.

Corridors in the marine area/Fehmarnbelt may then be developed as a connection between the potential landing points on Fehmarn and Lolland.

In the following section, corridors that are as ‘low-conflict as possible’ are identified for the marine area, Fehmarn and Lolland on the basis of the spatial resistance calculated. Overall, there are no completely continuous low conflict corridors due to the prevailing features. In individual cases, intersections of areas classified as SRC I or SRC II are unavoidable and this leads to main areas of conflict. In this respect, the resulting main areas of conflict are referenced in the description of the corridors in the following sub-sections. These main areas of conflict are described in more detail in Section 2.2.4.

An overview of the corridors in the investigation area is provided in Figure 13.

### 2.2.3.2. Corridors in the marine area/Fehmarnbelt

The corridors in the marine area and their abbreviations (MA-W, MA-E, MA-E1, MA-E2) are shown in Figure 15. The body of water in the Fehmarnbelt and its significance as a stopover area for marine mammals, the significance of the Fehmarnbelt for bird migration and the natural scenery of the open sea are not included here for the reasons listed in 2.2.1 and 2.2.2.1.

In view of the situation described above, there are no continuous, relatively low conflict corridors in the marine investigation area. The main reason is the size of the "Fehmarnbelt" SCI which forms an area classified as SRC I and SRC II in the centre (see main area of conflict MA2, see Section 2.2.4.1). However, there are also no differences relevant to decision-making between the various possible routes in terms of spatial conflict intensity, as the width of the area to be crossed is nearly the same everywhere.

Three corridors can be defined in the marine area:

The western corridor variant (corridor in the western marine area MA-W) essentially runs to the west of the large undersea cable area, cuts through the various buffers zones of Natura 2000 sites on the Fehmarn coast (see main area of conflict MA3) before running through the "Fehmarnbelt" FFH area (main area of conflict MA2). Up to this point, the corridor mainly runs through areas with of higher spatial resistance (SRC I and II). At this point the corridor runs through the associated relatively low conflict areas (SRC III and white areas) - and is only interrupted by crossing underwater sand waves (SRC II, main conflict point MA1) - until it meets up with the western corridor to the west of Rødbyhavn on Lolland (L-W). It is not possible to avoid crossing the dyke in the process (see Section 2.2.4.3, Lolland).

The eastern corridor variant (corridor in the eastern marine area MA-E) runs to the east of the large undersea cable area. In the marine area near the coast of Fehmarn, the corridor is not completely low conflict (see main areas of conflict MA4 or MA5). However, it then runs through connected, relatively low conflict areas (SRC III and white areas) until the unavoidable crossing of the "Fehmarnbelt" FFH area (see main area of conflict MA2). After this crossing, the corridor splits into two sub-variants: The corridor in the eastern marine area 1 (MA-E1) runs to the west of one area of undersea mega ripples while the corridor in the eastern marine area 2 (MA-E2) runs to the east of that area in such a way that it only has to cross the more southerly area with undersea mega ripples. It is therefore possible that the areas of the mega ripples which are important from a geomorphology standpoint (SRC II, M1 main area of conflict) only have to be crossed once by the respective corridors. In the landing area off the coast of Lolland, the two sub-variants merge again and link up with the eastern corridor on Lolland (L-E). It is not possible to avoid crossing the dyke to the east of Rødbyhavn in the process (see Section 2.2.4.3, Lolland).

#### 2.2.3.3. Corridors on Fehmarn

The corridors and their abbreviations (west with F-W and F-MW, centre with F-NW, east with F-E) are shown in Figure 16.

It is shown that all possible route corridors close to the coast in the northern corridor sections can only run through areas with high spatial resistance (SRC I or SRC II), thus resulting in main areas of conflict.

A relatively low conflict corridor in the south of the investigation area starts north of Burg and runs along both sides of the existing B 207/E 47 transport route and the railway ("bird migration route") to the northeast. In the process, small-scale, scattered or linear areas with high spatial resistance, such as hedgerows or small bodies of water, cannot be avoided. Southwest of the intersection of the E 47 and the K 49 district road, the corridor splits into two corridor variants.

The most westerly variant runs as a low conflict corridor (Fehmarn west corridor) between the residential areas at a distance of 500 m to the town of Todendorf and district road 49 to the north. North of the K 63 district road, the corridor can only run through areas of the highest spatial resistance which, due to the environmental factors of flora and fauna and biodiversity are primarily located on the western edge of Puttgarden, around the town's living area as well as the coastal area, through areas of particular recreational significance (environmental factor:

human beings). The corridor can be split into a western and an eastern sub-variant. The western sub-variant (Fehmarn west corridor 1, F-W) runs through the buffer zone to the Natura 2000 site (see main area of conflict F2, Section 2.2.4.2) and, like the eastern variant (Fehmarn west corridor 2, F-MW), leaves out the intermediate grassland areas with small bodies of water due to their status as special stepping stone biotopes for fauna. The F-MW corridor runs through peripheral settlements (residential areas) to the west of Puttgarden (SRC II, see main area of conflict F3) and passes by an individual farmstead (SRC I, see main area of conflict F5) at a close distance. Both sub-variants run into coastal areas that also have the highest spatial resistance (SRC I, see main area of conflict F1). As a result, it is not possible to establish relatively low conflict corridors in the northern sections of the western sub-variant.

Another corridor variant (Fehmarn centre corridor F-NW) starts after the intersection of the B 207/E 47 with the K 49 and runs from Puttgarden to the east as close as possible to the site of the ferry harbour and its transport connection (rail/road) up to the northern coast. The corridor initially runs east of the railway in areas of low spatial resistance (SRC III) before passing through areas of primarily higher spatial resistance on the western edge of the railway systems (Puttgarden residential area, see main area of conflict F7). In the process, it passes close to an individual farmstead and a hotel (see main area of conflict F8). At the coast, the corridor meets the outer edge of the ferry harbour/breakwater and the dyke (SRC I, see main area of conflict F6). Here, too, it is impossible to establish a completely low conflict corridor in the northern section.

The fourth corridor variant (Fehmarn east corridor F-E) runs to the east of the B 207/E 47 transport line and railway line and reaches the coast east of the ferry harbour. The corridor is relatively low conflict (SRC III) between the railway and the Presen wind farm until it reaches the area with a view over the Baltic Sea coast with its beautiful landscape (SRC II, see main area of conflict F9). In the coastal area, this variant runs through subsidiary facilities of the ferry harbour, e.g. a water treatment plant (SRC III), before crossing the remaining part of the semi-natural beach (SRC I) inside the ferry harbour (SRC I, see main area of conflict F9). Here, too, it is impossible to establish a completely low conflict corridor in the northern section.

### 2.2.3.4. Corridors on Lolland

The corridors and their abbreviations (L-E, L-W) are shown in Figure 16 .

It is shown that, as on Fehmarn, all possible route corridors on Lolland close to the coast in the southern corridor sections can only run through areas classified as having high spatial resistance (SRC I and SRC II).

Two corridors have been identified on Lolland: a relatively wide corridor east of Rødbyhavn and a narrow corridor west of Rødbyhavn.

The relatively low conflict corridor east of Rødbyhavn (Lolland east corridor L-E) starts at the existing road and railway line in the north of the investigation area in the potential connection area. It runs along this transport infrastructure for 2 – 3 km and then curves from there until it ends at the south coast of Lolland to the east of Rødbyhavn. The width of the corridor is approximately 1 km. Within the corridor, there is a relatively large area with minor spatial resistance (SRC III) extending between the E 47 and the railway line and the adjoining area further south of the railway. Within the corridor, there are several smaller areas with high spatial resistance (SRC I, see main area of conflict L4, see Section 2.2.4.3), e.g. protected small bodies of water and individual houses in the open landscape. Generally speaking, it is impossible to form a corridor which does not come into contact with any of these conflict areas because they are scattered throughout the investigation area. In the coastal area, the corridor goes through larger areas with high spatial resistance on and directly behind the dyke. The resulting conflicts involve recreational interests, fauna, flora and biodiversity, landscape and cultural heritage (see main areas of conflict L1, L2, L3, L5). The corridor to the east of Rødbyhavn L-E also runs through sizeable areas with medium spatial resistance (SRC II, see main area of conflict L4), but is situated more than 1 km from the town of Rødbyhavn and 2 km to the west of the next FFH area "Smâlandsfarvandet nord for Lolland, Guldborgsund, Bøtø Nor og Hyllekrog – Rødsand", which are areas with high resistance (SRC I). Near the coast, the existing Syltholm wind farm borders the low conflict corridor in the east.

The corridor west of Rødbyhavn (Lolland west corridor L-W) splits from the eastern corridor south of Rødby and then runs in a straight line about halfway between the towns of Rødby and Rødbyhavn to the west. It then turns south where it meets the coast between Rødbyhavn and the Lalandia holiday centre. The width of the corridor is approximately 0.5 km. The southern section of the corridor passes the town of Rødbyhavn and the Lalandia holiday centre – both areas with high spatial resistance (SRC I) – at distances of approximately 200 and 500 m respectively. In the northern section, it passes the edges of Rødbyhavn and Rødby at a distance of more than 500 metres.

The L-W corridor does not cross any areas with low spatial resistance (SRC III) and therefore does not meet the definition of a "relatively low conflict corridor". It therefore has to be classified as a "corridor located in areas of higher spatial resistance". However, if a corridor option in the western investigation area on Lolland is also to be considered, it becomes clear (see Figure 16) that the selected corridor route is the only way to avoid even higher potential conflict: in the part of the investigation area that is located further west, a corridor route would mainly run through areas with the highest spatial resistance (SRC I).

Like the eastern corridor, the corridor west of Rødbyhavn (L-W) contains several isolated, small areas with high spatial resistance (SRC I), e.g. protected small bodies of water and individual houses in the open landscape (see main areas of conflict L7, L9, L10). The corridor west of Rødbyhavn L-W crosses one of the former inlets of the former Rødby Fjord (see main area of conflict for the environmental factors cultural heritage, landscape and soil L8). In the coastal area, the corridor goes through larger areas with high spatial resistance (SRC I) directly behind the dyke (see main area of conflict L6 for the environmental factors human beings, fauna and flora and biodiversity, landscape and cultural heritage).

#### 2.2.3.5. Summary and identification of continuous, relatively low conflict corridors

Connected, continuous corridors for the routing of the Fehmarnbelt Fixed Link – as shown in Figure 13 – can be formed from the corridors described in the three segments above, but no completely low conflict corridor can be identified (see Sections 2.2.3.2 to 2.2.3.4). The conflict intensity of the corridors varies; the main areas of conflict are explained in detail in Section 2.2.4.

#### 2.2.3.6. Cartographic overviews of the corridors

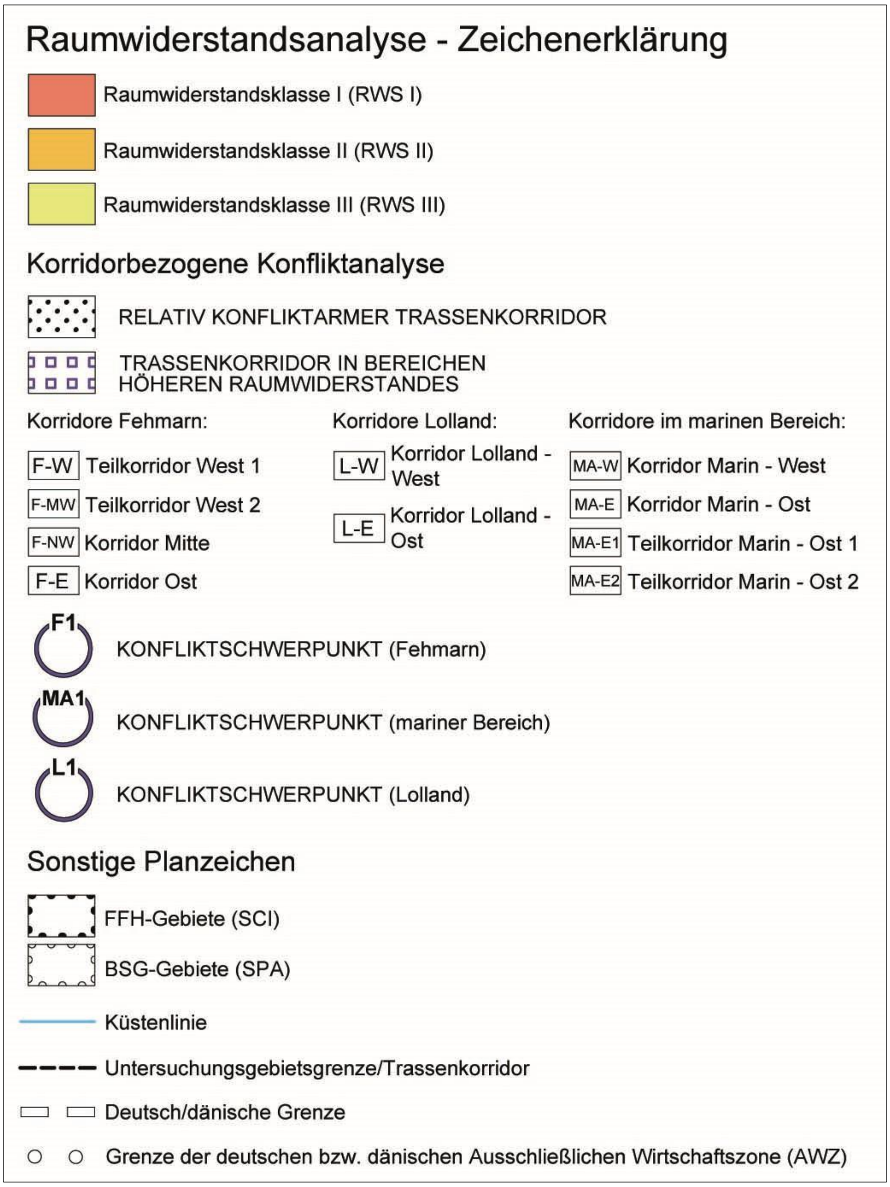



**Figure 12 Key for spatial resistance analysis**

| | |
|---|---|
| Raumwiderstandsanalyse – Zeichenerklärung | Key for spatial resistance analysis |
| Raumwiderstandsklasse I (RWS I) | Spatial resistance class I (SRC I) |
| Raumwiderstandsklasse II (RWS II) | Spatial resistance class II (SRC II) |
| Raumwiderstandsklasse III (RWS III) | Spatial resistance class III (SRC III) |
| Korridorbezogene Konfliktanalyse | Corridor-specific conflict analysis |

| | |
|---|---|
| RELATIV KONFLIKTARMER TRASSENKORRIDOR | RELATIVELY LOW CONFLICT ROUTE CORRIDOR |
| TRASSENKORRIDOR IN BEREICHEN HÖHEREN RAUMWIDERSTANDES | ROUTE CORRIDOR IN AREAS WITH HIGHER SPATIAL RESISTANCE |
| Korridore Fehmarn: | Fehmarn corridors: |
| Teilkorridor West 1 | Sub-corridor west 1 |
| Teilkorridor West 2 | Sub-corridor west 2 |
| Korridor Mitte | Central corridor |
| Korridor Ost | East corridor |
| Korridore Lolland: | Lolland corridors: |
| Korridor Lolland - West | Lolland west corridor |
| Korridor Lolland – Ost | Lolland east corridor |
| Korridore im marinen Bereich: | Corridors in the marine area |
| Korridor Marin – West | Marine west corridor |
| Korridor Marin – Ost | Marine east corridor |
| Teilkorridor Marin – Ost 1 | Sub-corridor east 1 |
| Teilkorridor Marin – Ost 2 | Sub-corridor east 2 |
| KONFLIKTSCHWERPUNKT (Fehmern) | MAIN AREA OF CONFLICT (Fehmarn) |
| KONFLIKTSCHWERPUNKT (mariner Bereich) | MAIN AREA OF CONFLICT (marine area) |
| KONFLIKTSCHWERPUNKT (Lolland) | MAIN AREA OF CONFLICT (Lolland) |
| Sonstige Planzeichen | Other symbols |
| FFH-Gebiete (SCI) | FFH areas |
| BSG-Gebiete (SPA) | Spatial protection areas (SPAs) |
| Küstenlinie | Coastline |
| Untersuchungsgebietsgrenze/Trassenkorridor | Investigation area boundary/route corridor |
| Deutsch/dänische Grenze | German/Danish border |
| Grenze der deutschen bzw. dänischen Ausschließlichen Wirtschaftszone (AWZ) | Border of the German/Danish Exclusive Economic Zone (EEZ) |

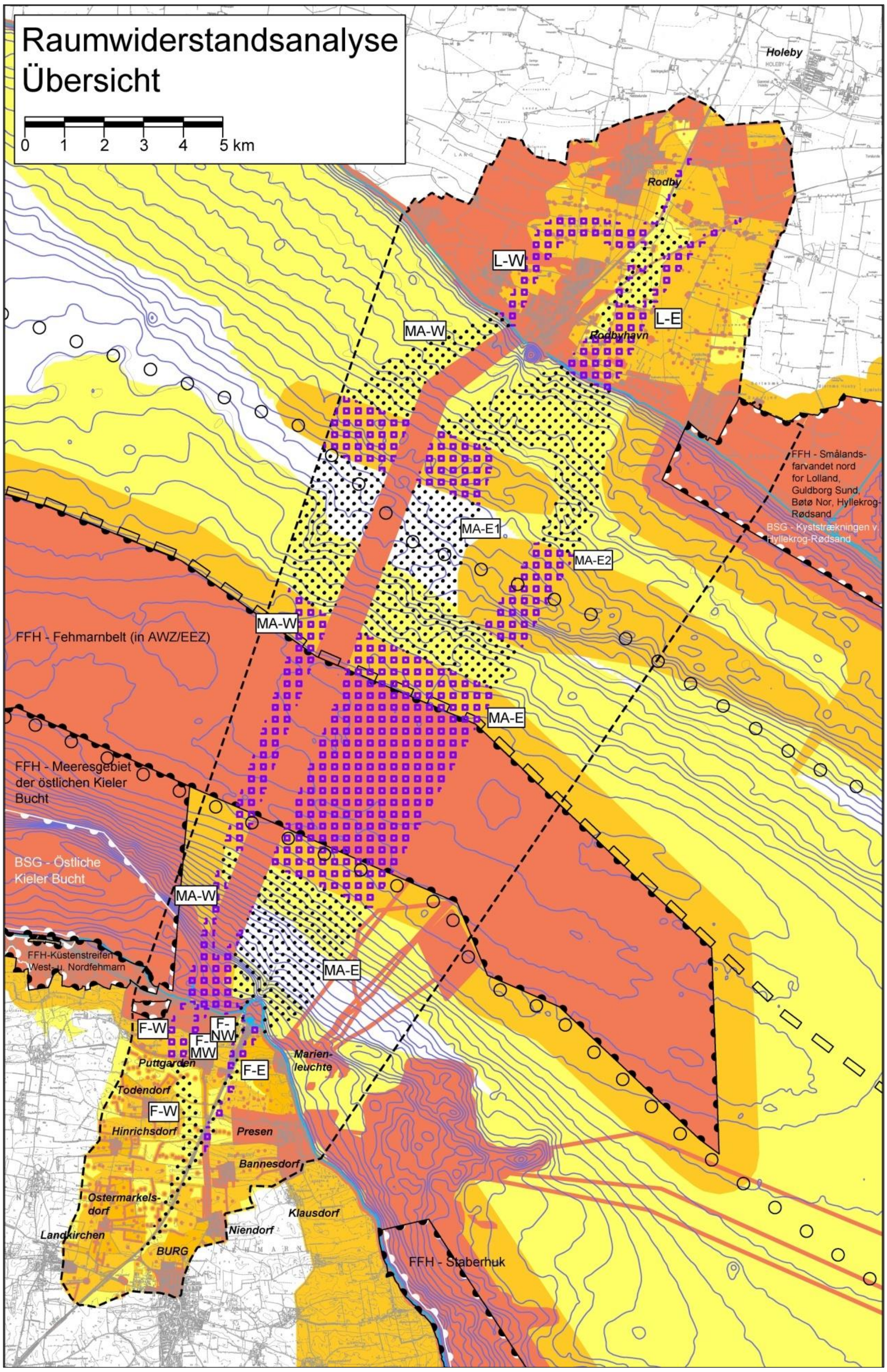



**Figure 13 Overview of the spatial resistance analysis – total spatial resistance and relatively low conflict corridors**

| | |
|---|---|
| Raumwiderstandsanalyse<br>Übersicht | Overview of spatial resistance analysis |

| | |
|---|---|
| FFH – Fehmarnbelt (in AWZ/EEZ) | FFH – Fehmarnbelt (in EEZ) |
| FFH – Meeresgebiet der östlichen Kieler Bucht | FFH – eastern Bay of Kiel marine area |
| BSG – Östliche Kieler Bucht | SPA – eastern Bay of Kiel |
| FFH – Küstenstreifen West u. Nordfehmarn | FFH – Coastal strip West and North Fehmarn |
| FFH – Smålandsfarvandet nord for Lolland, Guld-borg Sund, Bøtø Nor, Hyllekrog-Rødsand | FFH – Smålandsfarvandet north of Lolland, Guld-borg Sund, Bøtø Nor, Hyllekrog-Rødsand |
| BSG – Kyststrækningen Hyllekrog-Rødsand | SCI – coastal strip Hyllekrog-Rødsand |
| FFH - Staberhuk | FFH - Staberhuk |

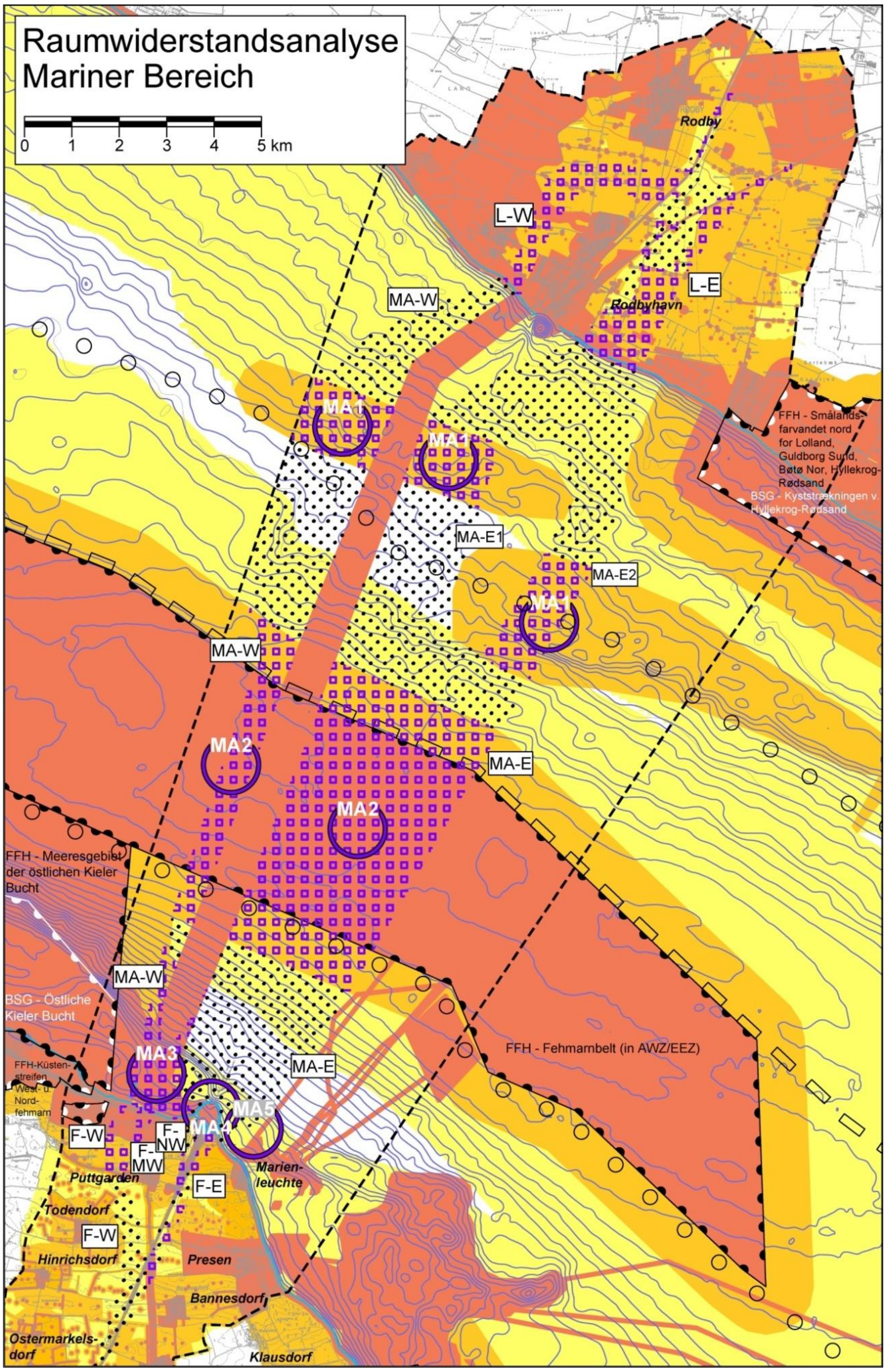



**Figure 14** Overview of the spatial resistance analysis, relatively low conflict corridors and main areas of conflict in the marine area

| | |
|---|---|
| Raumwiderstandsanalyse | Spatial resistance analysis |
| Mariner Bereich | Marine area |

| | |
|---|---|
| FFH – Fehmarnbelt (in AWZ/EEZ) | FFH – Fehmarnbelt (in EEZ) |
| FFH – Meeresgebiet der östlichen Kieler Bucht | FFH – eastern Bay of Kiel marine area |
| BSG – Östliche Kieler Bucht | SPA – eastern Bay of Kiel |
| FFH – Küstenstreifen West u. Nordfehmarn | FFH – Coastal strip West and North Fehmarn |
| FFH – Smålandsfarvandet nord for Lolland, Guld-borg Sund, Bøtø Nor, Hyllekrog-Rødsand | FFH – Smålandsfarvandet north of Lolland, Guld-borg Sund, Bøtø Nor, Hyllekrog-Rødsand |
| BSG – Kyststrækningen Hyllekrog-Rødsand | SCI – coastal strip Hyllekrog-Rødsand |

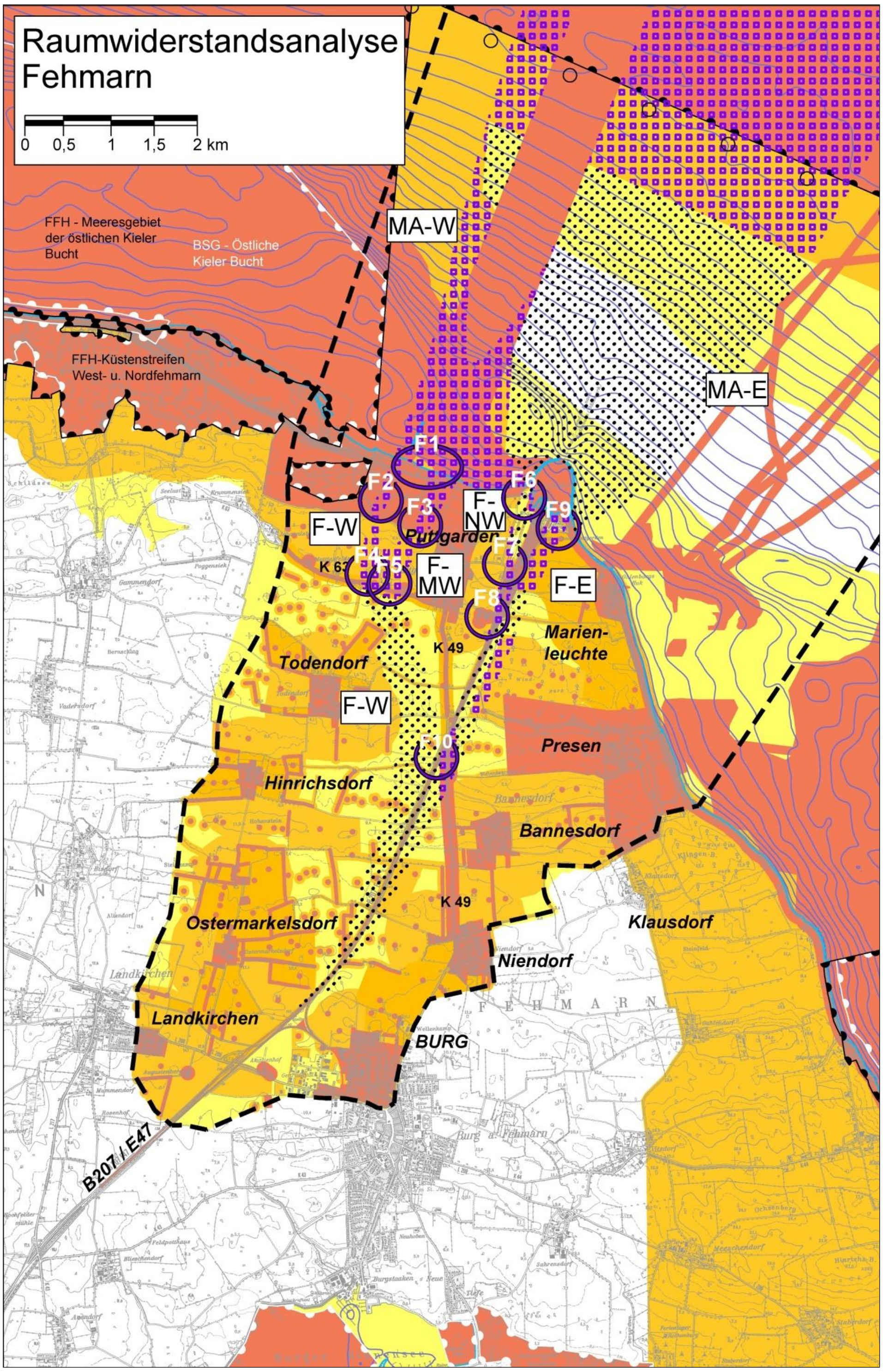



**Figure 15 Overview of the spatial resistance analysis, relatively low conflict corridors and main points of conflict on Fehmarn**

| | |
|---|---|
| Raumwiderstandsanalyse<br>Fehmarn | Spatial resistance analysis<br>Fehmarn |

| | |
|---|---|
| FFH – Meeresgebiet der östlichen Kieler Bucht | FFH – eastern Bay of Kiel marine area |
| BSG – Östliche Kieler Bucht | SPA – eastern Bay of Kiel |
| FFH – Küstenstreifen West u. Nordfehmarn | FFH – Coastal strip West and North Fehmarn |

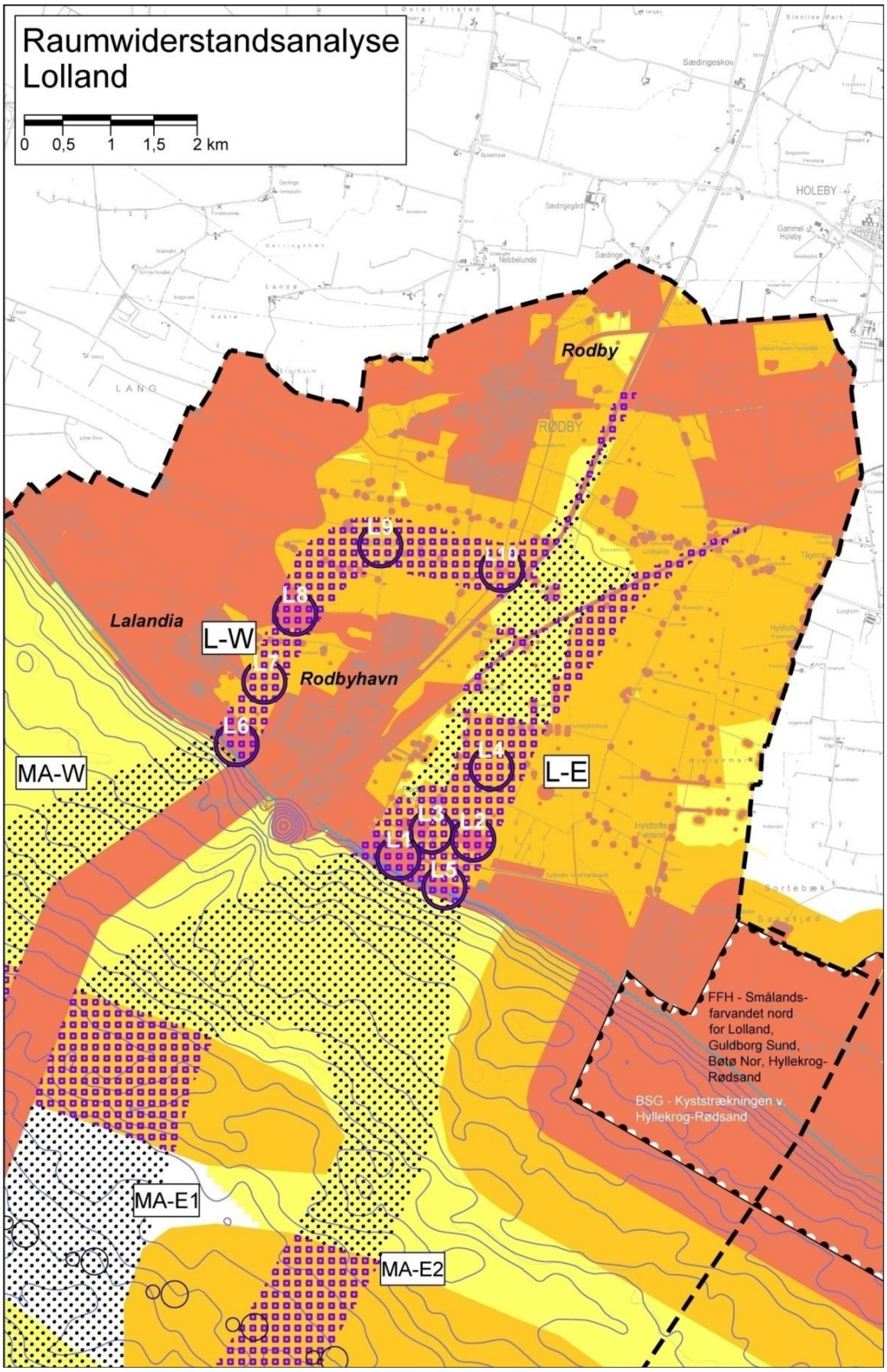



**Figure 16** **Overview of the spatial resistance analysis, relatively low conflict corridors and main points of conflict on Lolland**

| | |
|---|---|
| Raumwiderstandsanalyse<br>Lolland | Spatial resistance analysis<br>Lolland |

| | |
|---|---|
| Rodbyhavn | Rødbyhavn |
| FFH – Smålandsfarvandet nord for Lolland, Guld-borg Sund, Bøtø Nor, Hyllekrog-Rødsand | FFH – Smålandsfarvandet north of Lolland, Guld-borg Sund, Bøtø Nor, Hyllekrog-Rødsand |
| BSG – Kyststrækningen Hyllekrog-Rødsand | SCI – coastal strip Hyllekrog-Rødsand |

### 2.2.4. Main areas of conflict

The various main areas of conflict are already listed in connection with the description of the corridors in Sections 2.2.3.2 to 2.2.3.4. In the following section, the main areas of conflict shown in Table 8 to Table 16 in the marine area on Fehmarn and Lolland are summarised in a list in relation to their location in the corridors and their content is described. The main areas of conflict are then described again with respect to their conflict potential in terms of environmental factors.

#### 2.2.4.1. Marine area/Fehmarnbelt

There are five main areas of conflict, MA1 to MA5, in the marine area.

**Table 8 Main areas of conflict in corridors in the marine area**

<table>
<tr><th colspan="2">Corridors</th><th>Main areas of conflict</th></tr>
<tr><td colspan="2">Marine west corridor MA-W</td><td>MA1, MA2, MA3</td></tr>
<tr><td rowspan="2">Marine east corridor MA-E</td><td>Sub-variant MA-E1</td><td>MA1, MA2, MA4, MA5</td></tr>
<tr><td>Sub-variant MA-E2</td><td>MA1, MA2, MA4, MA5</td></tr>
</table>

**Table 9 Description of the main areas of conflict in the marine area**

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| MA1 | South of the coast of Lolland | Soil ((medium) | Crossing of areas with undersea mega ripples over a distance of approximately 1.4 km |
| MA2 | In the centre of the marine investigation area | Flora, fauna, biodiversity (high or medium) | Crosses the Fehmarnbelt FFH area with the conservation objective "harbour porpoise", among others, on an area with a width of up to 4.6 km (high conflict potential) as well as a buffer zone with a width of 1,000 m (medium conflict potential) for marine mammals (check of FFH compatibility required) |
| | | Soil (high) | Crosses the Fehmarnbelt FFH area with conservation objective related to geomorphologic structures ("reefs and sandbanks") on an area with a width of up to 4.6 km (check of FFH compatibility required) |

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| MA3 | In the area near the coast of Fehmarn north-west of Puttgarden | Human beings (medium) | Potential impairment of recreational activities at Grüner Brink (swimming and surfing area) |
| | | Flora, fauna, biodiversity (high or medium) | Crosses buffer zones of the "Eastern Bay of Kiel" bird protection area and the "Marine area of the Bay of Kiel" FFH area (check of FFH compatibility required)<br>Loss/impairment of large-scale macrophyte and sea grass areas (high conflict potential, legally protected biotopes according to Art. 30 BNatSchG in conjunction with Art. 21 LNatSchG) near the coast |
| | | Soil (high) | Crosses areas with "unique geomorphological formations" in the "Grüner Brink" area |
| | | Cultural heritage and other material assets (high) | Crosses the large undersea cable area |
| MA4 | In the Puttgarden ferry harbour | Flora and fauna, biodiversity (medium) | Impairment of smaller sections of macrophyte stocks (legally protected biotopes according to Art. 30 BNatSchG in conjunction with § 21 LNatSchG) |
| MA5 | East of the Puttgarden ferry harbour | Flora and fauna, biodiversity (medium) | Impairment of a peripheral area with macrophytes (legally protected biotopes according to § 30 BNatSchG in conjunction with § 21 LNatSchG) possible |
| | | Cultural and material assets (medium) | Potentially crosses east of the ferry harbour in the marine area with what are thought to be Stone Age settlement sites (to date it has not been possible to show these spatially) |

**Table 10 Summarised overview of the evaluation of the potential conflict of the main areas of conflict in the marine area by environmental factor**

| Main area of-conflict | Conflict potential related to the following environmental factors: | | | | | |
|---|---|---|---|---|---|---|
| | human beings | Flora fauna and biodiversity | Soil | Water * | Landscape * | Cultural and other material assets |
| MA1 | | | | | | |
| MA2 | | | | | | |
| MA3 | | | | | | |
| MA4 | | | | | | |
| MA5 | | | | | | |

Conflict potential: High Medium Low
Not affected or not significantly affected

* The environmental factors water and landscape are generally classified as SRC I but cannot be spatially differentiated in the spatial resistance analysis in the marine area and are thus not relevant to corridor routing and are not shown here (see Section 2.2.3.2).

### 2.2.4.2. Fehmarn

**Table 11 Main areas of conflict in the onshore corridors on Fehmarn**

| Corridors | | Main areas of conflict |
|---|---|---|
| West corridor | Sub-variant west 1 F-W | F1, F2, F4 |
| | Sub-variant west 2 F-MW | F1, F3, F5 |
| Centre corridor F-NW | | F6, F7, F8, F10 |
| East corridor F-E | | F9, F10 |

**Table 12 Description of the main areas of conflict on Fehmarn**

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| F1 | North coast northwest of Puttgarden | Human beings (high) | Land loss/impairment of the beach with intensive recreational use north of Puttgarden in the "Grüner Brink" area. |
| | | Flora, fauna and biodiversity (high) | Loss of land/impairment of high-value beach biotopes (legally protected according to § 30 BNatSchG in conjunction with § 21 LNatSchG) in connection with the dyke as a focal area in the Schleswig-Holstein biotope network system |
| | | Soil (high) | Loss/impairment of sandy raw soils on beaches/of the emerged beach with special significance |
| | | Water (high) | Construction of the water protection strip with legal protection status (construction ban) |
| | | Landscape (high) | Construction on and impairment of a highly sensitive coastal landscape with beach, dyke and view to the Baltic Sea |
| | | Cultural heritage and other material assets (high) | Construction on/impairment of the national protection dyke |
| F2 | East of the "Blankenwisch" marshlands | Human beings (medium) | Impairment of areas especially suitable for recreation south of the dyke. |
| | | Flora, fauna and biodiversity (high) | Crossing the 500 m wide buffer zone in the onshore Natura 2000 site "West and North Fehmarn Coastal Strip" and the "East Kiel Bight" Special Protection Area.<br>Impairment/ reshuFBFLing of significant faunistic structural relationships and habitats (including, inter alia, nesting birds, amphibians, dragonflies and bats) located in the periphery of a Natura 2000 site/ special protection area located between "Blankenwisch" and extensive grassland areas with small bodies of water. |
| | | Soil ((medium) | Loss and impairment of fen soils used both extensively and intensively |
| | | Water (medium) | Peripheral impairment of the Blankenwisch lowland area with respect to water supply (fen soils close to groundwater) |
| | | Landscape (medium) | Construction on/impairment of a medium-sensitivity, highly structured agricultural landscape north/northwest of Puttgarden |

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| F3 | At the western edge of Puttgarden | Human beings (high) | Impairment of areas particularly suitable for recreation and the residential area of Puttgarden including the western edge of the campsite |
| | | Flora, fauna and biodiversity (high) | Peripheral impairment of high-value biotope structures (extensive grassland areas with small bodies of water) with functional relationship to the Blankenwisch wetlands (incl. breeding birds, amphibians and dragonflies) and loss of hedgerows (legally protected biotope under § 30 BNatSchG in conjunction with § 21 LNatSchG) |
| | | Soil ((medium) | Loss and impairment of fen soils used both extensively and intensively |
| | | Water (medium) | Peripheral impairment of the lowland area with respect to water supply (fen soils close to groundwater) |
| | | Landscape (medium) | Construction on/impairment of a medium-sensitivity, highly structured agricultural landscape north/northwest of Puttgarden and impairment of the northern and western edge of Puttgarden |
| | | Cultural and material assets (medium) | Quality loss of buildings at the north-western edge of Puttgarden |
| F4 | On the K 63 west of Puttgarden | Flora and fauna, biodiversity (medium) | Partial loss of an avenue of trees (breeding bird habitat), loss of a small body of water (legally protected biotope under § 30 BNatSchG in conjunction with § 21 LNatSchG) |
| | | Water (medium) | Loss of a small body of water (legally protected biotope under § 30 BNatSchG in conjunction with § 21 LNatSchG) |
| | | Landscape (medium) | Impairment of a medium-sensitivity landscape area of a avenue of trees along the K 63 from Puttgarden to Johannisberg |
| F5 | On the K 63 west of Puttgarden | Human beings (high) | Fragmentation of the south-western residential area of Puttgarden, (partial) loss of the special radio tower area and considerable impairment of an individual farm |
| | | Flora and fauna, biodiversity (medium) | Partial loss of a avenue of trees (breeding bird habitat), loss of a small body of water (legally protected biotope under § 30 BNatSchG in conjunction with § 21 LNatSchG) |
| | | Water (medium) | Loss of a small body of water (legally protected biotope under § 30 BNatSchG in conjunction with § 21 LNatSchG) |
| | | Landscape (medium) | Impairment of a medium-sensitivity landscape area of a avenue of trees along the K 63 from Puttgarden to Johannisberg |
| | | Cultural and material assets (medium) | Quality loss of buildings at the south-western edge of Puttgarden |

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| F6 | Coast on the western edge of the ferry harbour and parking lot areas of the harbour | Human beings (high) | Impairment of the north-eastern residential area of Puttgarden incl. the eastern edge of the campsite |
| | | Cultural and material assets (medium) | Construction on/impairment of part of the harbour breakwater, possible peripheral impairment of the storm surge dyke |
| F7 | At the eastern edge of Puttgarden/western edge of the railway system | Human beings (high) | Impairment of the eastern edge of the settlement and residential area of Puttgarden including the area around the hotel |
| | | Flora and fauna, biodiversity (medium) | Loss/impairment of small-scale, medium-value biotope structures (grassland, wooded areas) at the edge of the railway and transport systems |
| | | Cultural and material assets (medium) | Quality loss of the hotel building and the buildings at the northern/eastern edge of Puttgarden |
| F8 | At the south-eastern edge of Puttgarden | Human beings (high) | Impairment of the south-eastern residential area of Puttgarden and considerable impairment of an individual farm |
| | | Flora and fauna, biodiversity (medium) | Loss and impairments of medium-value biotope structures of the railway system and peripheral impairment of a faunistic functional relationship (e.g. insects, reptiles) along the railway system |
| | | Cultural and material assets (medium) | Loss of railway system, quality loss of an individual farm and existing buildings at the south-eastern edge of Puttgarden |
| F9 | North-eastern coast, at the eastern edge of the ferry harbour | Flora, fauna and biodiversity (high) | Loss of an area/impairment of the remainder of the (already impacted) beach biotope at the harbour breakwater and loss of two small bodies of water with special significance for amphibians (legally protected biotope under § 30 BNatSchG in conjunction with § 21 LNatSchG) |
| | | Soil (high) | Loss and impairment of (already impacted) raw soils on beaches of the remaining beach biotope at the harbour breakwater |
| | | Water (medium) | Loss/impairment of two small bodies of water. Little to no construction on the water protection area. |
| | | Landscape (medium) | Impairment of a low-sensitivity landscape along the transport systems and a medium-sensitivity landscape of the agricultural landscape with a view of the Baltic Sea |
| | | Cultural and material assets (medium) | Possible construction on/impairment of part of the harbour breakwater |
| F10 | South of the B 207/ K 49 intersection | Flora and fauna, biodiversity (medium) | Loss of medium-value biotopes (rows of trees, field hedges). Loss of small bodies of water with general faunistic significance |
| | | Water (medium) | Loss of two small bodies of water |
| | | Landscape (high) | Impairment of a high-sensitivity landscape area of the lines of trees along the K 49 from Puttgarden to Niendorf |

**Table 13 Summarised overview of the evaluation of the potential conflict of the main areas of conflict on Fehmarn by environmental factor**

| Main area of-conflict | Conflict potential related to the following environmental factors: | | | | | |
|---|---|---|---|---|---|---|
| | Human beings | Flora, fauna and biodiversity | Soil | Water | Landscape | Cultural and other Material assets |
| F1 | High | High | High | High | High | High |
| F2 | Medium | High | Medium | Medium | Medium | Low |
| F3 | High | High | Medium | Medium | Medium | Medium |
| F4 | Low | Medium | Low | Medium | Medium | Low |
| F5 | High | Medium | Low | Medium | Medium | Medium |
| F6 | High | | | | Low | Medium |
| F7 | High | Medium | | | Low | Medium |
| F8 | High | Medium | | Low | Low | Medium |
| F9 | | High | High | Medium | Medium | Medium |
| F10 | Low | Medium | Low | Medium | High | Low |

Conflict potential: High Medium Low
Not affected or not significantly affected

### 2.2.4.3. Lolland

**Table 14 Main areas of conflict in the onshore corridors on Lolland**

| Corridors | Main areas of conflict |
|---|---|
| East corridor L-E | L1, L2, L3, L4, L5 |
| West corridor L-W | L6, L7, L8, L9, L10 |

**Table 15 Description of the main areas of conflict on Lolland**

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| L1 | Southern coast of Lolland, east of Rødbyhavn | Human beings (high) | (Partial) loss/impairment of the dyke including the recreation trail and access to the sea/beach section |
| | | Flora, fauna and biodiversity (high) | (Partial) loss/impairment of the dyke with dry grassland, salt marshes behind the dyke and of lakes (important for birds) |
| | | Soil ((medium) | Loss/impairment of low-lying areas with sandy former seabed areas |
| | | Water (high) | Loss/impairment of a lake with high environmental quality objective |
| | | Landscape (high) | (Partial) loss/impairment of the dyke as a characteristic landscape element |

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| | | Cultural herit-age and other material assets (high) | (Partial) loss/impairment of the dyke as an important cultural heritage and material asset and the low-lying areas behind it which mark the former contour of the sea |
| L2 | East of Rødbyhavn, approx. one km north of the dyke | Flora, fauna and biodiversity (high) | Loss/impairment of wetlands particularly valuable for birds and amphibians |
| | | Soil ((medium) | Loss/impairment of low-lying areas with sandy former seabed areas |
| | | Cultural and material assets (medium) | Crosses low-lying areas that mark the former contour of the sea |
| L3 | East of Rødbyhavn, west of L2 | Human beings (medium) | Loss/impairment of an area designated as a recreational area by the former county |
| | | Flora and fauna, biodiver-sity (medium) | Loss/impairment of medium-value biotope structures (fallow land) |
| | | Soil ((medium) | Loss/impairment of low-lying areas with sandy former seabed areas |
| | | Cultural and material assets (medium) | Crosses low-lying areas that mark the former contour of the sea |
| L4 | East of Rødbyhavn, north of L1 to L3 | Human beings (high) | Potential loss of individual houses and/or the open land around them, impairment of the function of the sites of many individual houses as residential areas and areas around residences through noise, visual impairment, etc. |
| | | Cultural and material assets (medium) | Crosses an area of potential archaeological interest |
| L5 | Near the coast east of Rødbyhavn | Cultural herit-age and other material assets (high) | Loss/impairment of the pumping station as an important mate-rial asset |
| L6 | West of Rødbyhavn, on the south-ern coast of Lolland | Human beings (high) | (Partial) loss/impairment of the dyke including the recreation trail and recreation trails in the reeds behind the dyke as well as access to the sea/beach section |
| | | Flora, fauna and biodiversity (high) | (Partial) loss/impairment of the dyke with dry grassland, of reeds behind the dyke (important for birds and amphibians) |
| | | Soil ((medium) | Loss/impairment of low-lying areas with sandy former seabed areas |
| | | Landscape (high) | (Partial) loss/impairment of the dyke as a characteristic land-scape element |
| | | Cultural herit-age and other material assets (high) | (Partial) loss/impairment of the dyke as an important cultural heritage and material asset and the low-lying areas behind it which mark the former contour of the sea |

| Main area of conflict | Location | Environmental factor affected (with conflict potential) | Short description |
|---|---|---|---|
| L7 | Between Rødbyhavn and Lalandia | Human beings (high) | (Partial) loss and impairment of the residential area between Rødbyhavn and Lalandia. Potential loss of individual houses and/or the open land around them, impairment of the function of the sites of many individual houses as residential areas and areas around residences through noise, visual impairment, etc. |
| | | Landscape (medium) | Crossing/impairment of the Rødby Mark landscape, in part with branches of the former Rødby Fjord, with medium sensitivity |
| | | Cultural and material assets (medium) | Crossing/impairment of the Rødby Mark landscape, in part with branches of the former Rødby Fjord as a cultural heritage asset |
| L8 | Northwest of Rødbyhavn, on a branch of the former Rødby Fjord | Flora and fauna, biodiver-sity (medium) | Crosses the designated biotope network along the former Rødby Fjord |
| | | Soil ((medium) | Loss/impairment of low-lying areas with sandy former seabed areas |
| | | Landscape (medium) | Crossing/impairment of a branch of the former Rødby Fjord with medium sensitivity overall |
| | | Cultural herit-age and other material assets (high) | Crossing/impairment of a branch of the former Rødby Fjord with medium sensitivity overall |
| L9 | Between Rødby and Rødbyhavn | Human beings (high) | Potential loss of individual houses and/or the open land around them, impairment of the function of the sites of many individual houses as residential areas and areas around residences through noise, visual impairment, etc. |
| | | Landscape (medium) | Crossing/intersection of the Rødby Mark landscape space with medium overall sensitivity |
| L10 | On the for-mer railway line from Rødbyhavn to Maribo | Human beings (high) | Crossing/intersection of the recreation trail between Rødbyhavn and Rødby (railway line). Potential loss of individual houses and/or the open land around them, impairment of the function of the sites of many individual houses as residential areas and areas around residences through noise, visual impairment, etc. |
| | | Flora and fauna, biodiver-sity (medium) | Crossing the biotope network line between Rødby and Rødby-havn along the railway line |
| | | Landscape (medium) | Crossing/intersection of the Rødby Mark landscape space with medium overall sensitivity |
| | | Cultural and material assets (medium) | Loss/impairment of the former railway line as a significant for-mer transport route |

**Table 16 Summarised overview of the evaluation of the potential conflict of the main areas of conflict on Lolland by environmental factor**

| Main area of-conflict | Conflict potential related to the following environmental factors: | | | | | |
|---|---|---|---|---|---|---|
| | Human beings | Flora and fauna, biodiversity | Soil | Water | Landscape | Cultural and other Material assets |
| L1 | High | High | Medium | High | High | High |
| L2 | | High | Medium | | Low | Medium |
| L3 | Medium | Medium | Medium | | Low | Medium |
| L4 | High | Low | | Low | Low | Medium |
| L5 | | | | | | High |
| L6 | High | High | Medium | | High | High |
| L7 | High | Low | | | Medium | Medium |
| L8 | | Medium | Medium | Low | Medium | High |
| L9 | High | | | | Medium | Low |
| L10 | High | Medium | | | Medium | Medium |

Conflict potential: High Medium Low
Not affected or not significantly affected

## 2.2.5. Comparative evaluation of the corridors

In the following section, the relatively low-conflict corridors identified are compared to one another and ranked taking into account the assessment of the individually identified main areas of conflict by environmental factor (see Sections 2.2.4.1 to 2.2.4.3). The corridor ranking is a qualitative assessment based on conflict potentials that is carried out without quantitative estimates at the level of the spatial resistance analysis. To calculate the rankings of the corridors, the number of high ("red") conflict potentials is used, followed by the medium ("orange") conflict potentials, with the types of conflict also being taken into consideration in the assessment.

### 2.2.5.1. Marine area/Fehmarnbelt

The environmental factors water, climate/air and landscape cannot be used for spatial differentiation (see Section 2.2.1, 2.2.3.2). For the purpose of the spatial resistance analysis, the conflict potential is assumed to be the same here for all corridors. No further comparative assessment of the corridors is therefore conducted for these environmental factors.

**Table 17 Evaluation of the marine corridors - ranking of the corridors from an environmental perspective**

| | | Individual corridor ranking | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Environmental factor** | | **Human beings including human health** | **Flora, Fauna and biodiversity, Natura 2000** | **Soil** | **Water*** | **Climate/ air*** | **Landscape*** | **Cultural heritage and other material assets** | **Overall ranking** |
| **Corridor** | | | | | | | | | |
| **MA-W** | | 3 | 3 | 3 | Not relevant to the decision | Not relevant to the decision | Not relevant to the decision | 3 | **3** |
| **MA-E** | **MA-E1** | 1 | >1 | 1 | | | | 1 | **1** |
| | **MA-E2** | 1 | >1 | >2 | | | | 1 | **>>2** |

Corridor ranking: 1 = best (with the lowest environmental impact) to 3 = worst (with the greatest environmental impact)
>> very clear advantage over the next corridor in the ranking, > clear advantage over the next corridor in the ranking
* The environmental factors of water, climate/air and landscape cannot be spatially differentiated in the marine area in the spatial resistance analysis.

In the overall view, the middle corridor (MA-E1) scores highest with regard to the environmental factors when assessing conflict potential. In second place, just behind corridor MA-E1, lies corridor MA-E2. The sole criterion used in this assessment is the crossing of areas with underwater sand waves located in front of Lolland because of the longer crossing distance these create (environmental factor: soil M2, see Section 2.2.4.1). Overall, it becomes clear that the western corridor (MA-W) is ranked much lower than the eastern corridors MA-E1 and MA-E2 (see Table 17).

### 2.2.5.2. Fehmarn

**Table 18 Evaluation of the onshore corridors on Fehmarn - ranking of the corridors from an environmental perspective**

| Individual corridor ranking | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Environmental factor** | **Human beings including human health** | **Flora, fauna and biodiversity, Natura 2000** | **Soil** | **Water** | **Climate/ air*** | **Landscape** | **Cultural heritage and other material assets** | **Overall ranking** |
| **Corridor** | | | | | | | | |
| **F-W** | >>2 | 3 | 3 | 3 | Not relevant to the decision | 3 | 3 | **3** |
| **F-MW** | 3 | 3 | 3 | 3 | | 3 | 4 | **3** |
| **F-NW** | 3 | >1 | >1 | >1 | | 1 | 2 | **>1** |
| **F-E** | >>1 | >1 | >2 | >>2 | | >>2 | >1 | **>1** |

Corridor ranking: 1 = best (with the lowest environmental impact) to 4 = worst (with the greatest environmental impact). When two corridors are ranked the same, the next lower corridor is left out to make the ranking more transparent (e.g., ranking 1, 1, 3, 4).
> > a very clear advantage with regard to the next highest-ranking corridor, > a clear advantage to the with regard to the next highest-ranking corridor.
*The environmental factor climate/ air cannot be spatially differentiated in the spatial resistance analysis and is thus not relevant in determining the alignment.

In the overall ranking, the central corridor (F-NW) and the eastern corridor (F-E) are ranked much higher than the western corridors (F-W, F-MW) on Fehmarn in the ranking of the assessment of the conflict potential by environment factor. Corridor F-NW and corridor F-E are so close to each other that no clear statement in favour of either one can be made from an environmental point of view if all environmental factors are considered equal. If the environmental factor human beings is assessed, the conflict potential of corridor F-E is clearly lower since this corridor does not result in any impairments of the residential areas/outskirts of Puttgarden and a distance of more than 500 m can be maintained to Marienleuchte. The conflict potentials for soil, water and landscape are clearly lower in the northern section for the F-NW corridor because the areas that already have railway and transport systems are utilised.

The western F-W and F-MW corridors are also close to one another with respect to their overall conflict potential, making clear differentiation impossible.

Overall, it is evident that the corridors on Fehmarn to the west of Puttgarden are ranked much lower than those to the east of Puttgarden (see Table 18).

### 2.2.5.3. Lolland

**Table 19 Evaluation of the onshore corridors on Lolland - ranking of the corridors from an environmental perspective**

| Individual corridor ranking | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Environmental factor** | **Human beings including human health** | **Fauna, flora and biodiversity, Natura 2000** | **Soil** | **Water** | **Climate/ air*** | **Landscape** | **Cultural heritage and other material assets** | **Overall ranking** |
| **Corridor** | | | | | | | | |
| **L-E** | >>1 | 1 | 1 | 2 | Not relevant to the decision | >1 | 1 | **>1** |
| **L-W** | 2 | 1 | 1 | 1 | | 2 | 2 | **2** |

Corridor ranking: 1 = best (with the lowest environmental impact) and 2 = worst (with the greatest environmental impact)
>> Very clear advantage over the other corridor in the ranking, > Clear advantage over the other corridor in the ranking
*The environmental factor climate/ air cannot be spatially differentiated in the spatial resistance analysis and is thus not relevant in determining the alignment.

In the overall evaluation of the main areas of conflict on Lolland, the eastern corridor (L-E) is ranked much higher than the western corridor (L-W). This applies in particular to the environmental factors human beings, landscape and cultural heritage and other material assets, where the advantage is clearly evident. With respect to the environmental factors flora, fauna and biodiversity, the corridors are largely similar, but the western corridor has slight advantages. The two corridors are also almost the same with regard to the soil environmental factor. The western corridor is ranked higher in relation to the water environmental factor.

An important factor in the ranking of the two corridors is that the western corridor L-W runs entirely through areas of higher spatial resistance (spatial resistance classes SRC I and II) and does not cross any areas with low spatial resistance (SRC III). This higher, continuous spatial resistance of the western corridor (L-W) is clearly evident (see Table 19), which confirms the ranking of the eastern corridor (L-E) as the corridor with a considerably lower environmental impact overall.

### 2.2.5.4. Conclusion

Taking into account the findings of the spatial resistance analysis, the western corridor(s), both onshore and offshore, can be viewed as less advantageous with more environmental conflicts than the eastern corridor in the next steps of the planning process for the alignment of the Fehmarnbelt Fixed Link. This finding is incorporated into the alignment process.

As mentioned above, the facts which are not considered in greater detail in the spatial resistance analysis are considered in the following planning phases:

- Bodies of water in the Fehmarnbelt;

- The importance of the Fehmarnbelt as a migratory area and habitat for marine mammals and
- The importance of the Fehmarnbelt for bird migration;
- and the landscape of the open sea

will be examined more closely in the impact assessment because the structural impact caused by the bridge or tunnel is decisive for the conflict potentials and not the alignment of a Fehmarnbelt Fixed Link in this context.

## 2.3. Baseline investigation and evaluation

In the following section, a summary of the Baseline investigation and evaluation of the environmental factors is provided first before the findings of the preliminary comparison of variants and the main comparison of variants are described in Section 2.4. The evaluation is two-level or four-level (special, general or very high, high, medium, low) (see EIA report, Attachment 15, Annex B, Section 0.2).

Furthermore, based on the duration of the current procedure, the data gathered from the baseline survey is now more than five years old, meaning that an up-to-date study is required. In order to carry out the current status check, up-to-date mappings for the terrestrial area on Fehmarn, new analyses and third-party assessments of available data for the marine investigation area (plausibility check) are required. The results of the plausibility check are shown in Attachment 30.1 (for the marine area) and the up-to-date mappings are shown in Attachment 30.2 (for the terrestrial area) of the plan approval documents.

In 2008 and 2010, a two-year baseline survey was carried out on both the marine and onshore environmental factors as part of the environmental impact assessment (EIA) and the accompanying landscape conservation plan (LCP) for the Fehmarnbelt Fixed Link. This was supplemented by environmental data from a range of other sources in order to compile the comprehensive Baseline investigation. Therefore, on the date the application for plan revision procedures was submitted, the data basis for the EIA-report was six years old. Thus it is necessary to verify the currency of the data on which the EIA-report is based.

Regulatory guidelines and work aids strongly indicate that environmental data accurately represents the environmental factors in question for a period of five years. As a result, these indications do not represent a legal basis for the threshold after which environmental data is no longer valid, but rather the deadline after which time the validity of said data must be checked. Unless significant new findings or indications come to light which would call into question the validity of the data used in the EIA-report before five years has passed, then the data basis must be checked once the 5-year mark has been reached. Therefore, the aim of the check in this particular case is to determine a conservation assessment which will then be used as the basis for a decision on whether a new baseline survey is needed. The working aid on "Observing Species Protection Laws in the plan approval documents of the LBV-SH" (LBV SH 2016) provides the following information, inter alia:

*„(...) The plausibility check will confirm whether the results of the original mappings still present an accurate representation of the current species population and whether said results provide an appropriate basis for the measures to be taken. Should this not prove to be the case, new observations must be made. In this particular case, the scope of the required observations needs to be explained and the aim of the exercise defined in order to avoid or manage species conservation-related conflicts in a legally secure way. The following must be observed during this process:*

*The basis for the plausibility check is a study of the habitat structures in the area in question. Significant changes should be assessed with regard to the possible impacts they may have on species composition or the abundance of a particular species. Should the study determine that there are no serious changes to habitat structures then, as a rule, no new observations of the species need to be carried out. However, should this not be the case, the area must be re-mapped.*

*The older map data becomes, the harder it is to draw accurate conclusions with regard to changes in species status and composition, even if habitat conditions themselves remain unchanged. It may be that general development trends in individual species lead to legacy data no longer offering an accurate representation of the current situation. As an example, certain grassland bird species are showing a decline on the European and national levels whereas previously rare species such as the bluethroat are currently seeing their settlement area expand. For this reason, where the mapping data concerned is more than 5 years old, it is vital that the plausibility checks consider species-specific development trends and assess their relevance from an environmental perspective.*

*For nesting birds, the hazard levels given in the Red List are a deciding factor when dealing with an individual species or Gildeniveau (translator's note: I couldn't find a term for this). Generally speaking, Red Lists are updated roughly every 10 years. It is considered that after 10 years, evaluable data will be able to calculate any changes. As a result, there is a high probability that map data which is more than 10 years old is only slightly relevant in the context of the current landscape.*

*Investigation standards undergo changes. Therefore, it only makes sense to carry out a plausibility check on current data if the data to be checked was obtained according to investigation standards which are still valid. Care should be taken to ensure that older observations correspond to current versions of guidelines and information e.g. the Work Aid on Bats and Road Construction (LBV SH 2011).*

*For these reasons, after 10 years more stringent requirements are enforced with regard to demonstrating the usability of legacy data. Any deviations arising in the plausibility check in the case in question must be explained.*

| ***Age of data*** | ***Assessing the currency of data at the time the plan approval decision is made*** |
|---|---|
| *up to 5 years old (inc.)* | *Generally speaking, the data is sufficiently current for planning approval decisions to be made.* |
| *6 to<br><br>10 years (inc.)* | *The currency of data must be verified as part of the plausibility check (taking into account changes to habitat structures, development trends and observation methods). If necessary, new observations must be made.* |
| *more than 10 years old* | *Such data can only be deemed to be sufficiently current if a second plausibility check is carried out."* |

Additionally, according to case law, an expert investigation must be carried out in this specific case. The stability or dynamism of species, habitats etc. in the investigation area is relevant. This means that data can still be current after more than five years as long as it is remembered that such data must be seen as outdated should substantial changes to the investigation area occur before that time. According to case law, this is first and foremost a nature conservation issue (BVerwG, decision of 23.04.2014, 9 A 25/12, Rn. 63, Rn. 68 et seq. – Juris; HessVGH, decision of 21.8.2009, 11 C 318/08.T, Rn. 631 f. – Juris).

In light of this, the project proponents have arranged for a plausibility check to be carried out on the data basis used for the Fehmarnbelt Fixed Link which will use various methods to verify the environmental validity of the surveys. Various information was used including update mappings, investigation mappings, nature conservation reasons and a broad analysis of current external data and surveys. Since the methods used in carrying out the plausibility check in the marine and onshore areas were different, both these areas shall be subject to greater focus below.

### Plausibility check in the marine area

The plausibility check in the marine area included investigation mappings, analyses of current external data and conservation evaluations on the validity of the data basis.

The marine area represents a stable ecosystem over the mid- to long term which reacts to changing environmental conditions and anthropogenic uses compared with onshore systems. In addition, during the time period in question, no results were found which indicated a sudden shift in the environmental status. Therefore, the aim of the plausibility check carried out in the marine area was to determine whether the baseline studies performed between 2008–2010 still provided a plausible basis for the impact assessments described in the EIA-report, the impact regulations in the LCP and the observations regarding species protection, water rights and Natura 2000 or whether new baseline studies are required.

For this purpose, the first step taken by the project proponents was to investigate whether and to what extent there had been status changes in the project area's ecosystem and the standing stock of individual environmental factors since the baseline studies of 2008–2010 were carried out. The selection of environmental factors and parameters as well as the scope of the studies carried out in the plausibility check were limited with regard to the baseline studies. The observations made as part of the plausibility check were designed as "investigation mappings". They cannot therefore substitute the baseline studies carried out in 2008–2010 and cannot themselves be used as a data basis for the EIA-report or the impact regulation in the LCP or the observations regarding species protection, water rights and Natura 2000.

When selecting the environmental factors to investigate, the main focus was on covering the most diverse areas of the marine ecosystem in order to determine if there had been any potential changes. The investigation included various parameters for the following environmental factors: Phytoplankton, benthic flora, benthic fauna, benthic habitats, fish, marine mammals and resting birds. With regard to abiotic environmental factors, key variables in water quality, hydrography and meteorology were investigated in order to demonstrate the "environment" for aquatic organisms and populations in the water column and on the seabed.

The second step was to compare the results of the new observations with the baseline studies conducted in 2008–2010 and then to evaluate the differences from an environmental perspective. Expected natural fluctuations and the results derived from the analysis of current literature featured prominently in the evaluation. Only in rare cases (five bird species) could noteworthy changes be found. In these cases, approximate studies of the impact assessment were carried out.

Details of the new observations and the comparison with the 2008–2010 observations are summaries in an expert report on the plausibility check carried out in the marine area (Attachment 30.1 of the plan approval documents).

### Update mappings or plausibility checks carried out in the onshore area (Fehmarn)

The plausibility check on Fehmarn comprised targeted update mappings and plausibility checks on nature conservation reasons for the validity of the data basis.

In the case of breeding and resting birds as well as amphibians, an update mapping of the LCP investigation area was carried out. The basis for this was the professional assessment that changes were at the very least conceivable seeing that the conditions of these species were fundamentally dependent on the respective land use. Additionally, the consultants were aware that the Great Crested Newt had been considered to have expanded on Fehmarn, an assumption which was proven by the new studies. Therefore, the project proponents followed the work aid on species protection (see above), according to which species with acknowledged development trends, the relevance of such trends must be studied by experts. The expert evaluation also confirmed the following with regard to nesting birds: Through the Rook colony alone, the number of breeding pairs in the area of the LCP which was relevant to this study had increased by over 300.

An update mapping was then carried out for the bats and biotype types. In the case of the first species, this mapping was made necessary by the provisions of the new work aid produced by the LBV (LBV-SH 2011) which requires that landscape/ecological functions be recorded which were not fully covered by the existing survey. The same applies to biotype types as these have a new and significantly expanded standard list and mapping guidelines (LLUR 2015).

In addition, the expert evaluation indicates that part of the data on dragonflies needs to be updated since this species was reflecting rapidly changing conditions. In this case, the update mapping was limited to those small bodies of water lying within the impact area.

The expert evaluation did not consider it necessary to carry out a new, independent survey on grasshoppers, butterflies, ground beetles and reptiles. In this case, the case for the data's validity was justified in light of the results obtained by the biotype type survey.

The scope and nature of the update mappings carried out on Fehmarn are appropriate to replace the baseline surveys. They have therefore been incorporated into the species protection and impact regulation documents of the LCP as updated basis data. On the basis of the update mappings carried out in the marine area, this data was also used for the plausibility check on the impact assessment conducted as part of the EIA-report's main variant comparison.

### 2.3.1. Human beings/human health (overall project)

The environmental factor human beings and human health is made up of the following three sub-aspects in particular:

- Health and well-being
- Living and living environment function
- Leisure and recreational function

New analyses have not been carried out on either the land area on Fehmarn or the marine area with regard to the human environmental factor. There have been no known significant short-term changes to the partial environmental factors of residential areas and recreation in recent years, nor are any expected. Therefore, the data basis for the human environmental factor described hereinafter in the EIA is still current and thus no alteration is required.

**Marine area**

(see Section 3.1.1, Attachment 15 of the plan approval documents, Volume II A)

*Baseline investigation goals and methods*

- Statements on recreation function (swimming, water sports and fishing) in the Fehmarnbelt (sub-factor recreation).
- Methods: Methods: analysis of existing documents on recreation, recreational facilities and tourism and documents created as part of the project including tourism reports and studies on recreational fishing.

*Key findings of the Baseline investigation and evaluation*

The designated swimming areas on the German and Danish sides are public, mostly well-frequented, easily accessible from the landworks and thus overall extremely important for recreation. Thanks to its central location in the southern Baltic Sea, the water area around Fehmarn is a good starting point and destination for boat cruises to and from the neighbouring areas in southern Denmark or Mecklenburg-Vorpommern. The Fehmarnbelt is thus very important overall for recreational sports. The kite and surfing areas off the German and Danish coasts are of varying importance for active recreation depending on the number of visitors and the local features (high at "Grüner Brink", medium for Presen and Rødbyhavn). In relation to sport fishing (deep sea fishing tours), the coastal areas with high concentrations of fishing grounds within the 5 nautical mile zone off the coast of the island of Fehmarn are particularly important. The island coasts of Fehmarn and Lolland are frequently used for fishing and Fehmarn in particular has a lot of fishing tourism, thus making these areas highly significant for fishing. The "priority area for tourism and recreation" designated in the 2010 state development plan that runs parallel to the coast on the German side is assigned medium significance (see Plan 9 EIA report, Attachment 15).

### Fehmarn

(see Section 3.1.2, Attachment 15 of the plan approval documents, Volume II A)

The human/human health environmental factor is composed of the sub-factors of residential areas and recreation. Statements taken from local development and zoning plans, specialist plans and higher-level plans such as orthophotos, maps, brochures and literature served as the basis for the Baseline investigation. Information related to recreational use was also obtained from the Environment Council in the City of Fehmarn concerning the local situation. Part of the information supplied by the authorities in addition to the literature was checked on-site and analyses of the tourist offering and demand were also included. Specialist assessments were added to the existing impacts caused by noise, environmental and light pollution (Attachment 15 of the plan approval documents, Volume II A, Section 3.1.2).

With regard to impairment of the human environmental factor, it is worth mentioning that the traffic forecast for the Fehmarn Fixed Link and, consequently, studies conducted on noise, pollutants and vibrations were updated in the context of the landscape conservation plan. There were, however, no significant changes recorded, for which reason the corresponding statements from the EIA-report pertaining to significant changes can be eliminated (see Section 3.3).

In summary, there have been no known significant short-term changes to the aforementioned parameters in recent years, nor are any expected. The data basis of the EIA-report is therefore still current and the results obtained from the main variant comparison of the impact assessment likewise remain valid.

*Baseline investigation goals and methods*

- Information on the key areas and functions of living and recreation including the areas of work (e.g. commerce) and supply (e.g. basic social functions) in the investigation area.
- Methods: Analysis of existing documents, particularly analysis of the land use plan and construction plans for the city of Fehmarn in the investigation area, review of land use through supplementary inspections and aerial image analyses. Analysis of the reports on existing noise and air pollution as well as tourism.

*Key findings of the Baseline investigation and evaluation*

*Residential*: Residential and mixed-use areas according to building use regulations represent the largest percentage of settled land in the investigation area. These areas and individual farms are extremely significant for human health and well-being due to their permanent residential function. Facilities with basic social functions (e.g. schools, pre-schools, medical facilities, churches, etc.) are also of great significance to the people in the surrounding area.

Campsites and weekend or holiday houses are generally used by people for longer stays and have a temporary (recreation) and residential function; they are classified as very significant. Green areas in the direct vicinity or inside of settlements are very significant for nearby recreational activities of residents.

Medium significance is assigned to facilities such as the hotel on the outskirts of the ferry harbour and the German military facility in Marienleuchte. The residential area (generally 500 m around connected settlement areas) represents a distance in which the transition from built up areas to open landscapes is clear and there is potential for recreation. Residential areas are of medium significance for the residential function (see Plan no. 1 EIA report, Attachment 15).

*Recreation*: The designated public bathing beaches on the north and east coast are of very high significance for the recreational function for residents and tourists. Owing to their natural obstacles (e.g. lack of a sandy beach) or existing conditions (still of great significance: to the west of the ferry harbour) or the lack of access or nature conservation regulations (low importance: east of the ferry harbour to Marienleuchte and the beach located on the "Grüner Brink" nature reserve) other sections of beach are less commonly used for recreational purposes.

The cross-regional Baltic Sea coastal cycle path and local recreational facilities/services (Burg marine centre) have medium significance. The large-scale areas close to the coast designated as areas particularly suitable for recreation in the Landscape Framework Plan have medium significance due to their general designation (see Plan no. 1 EIA report, Attachment 15).

*Tourism aspects related to the entire island of Fehmarn*: Tourism is very significant to the whole island of Fehmarn. In 2010, the island had approx. 20% of all available beds in the Ostholstein district. More than 16,000 guest beds and 6,500 camping pitches were available on the island of Fehmarn in 2009. Most accommodation on Fehmarn consists of private rooms, holiday homes, holiday flats and apartments rather than hotels. The island is mainly visited as a holiday destination during the summer months. In addition to overnight guests, a large number of visitors also come for the day, primarily from Germany. The main tourist destinations are Burg and the Burgtiefe and Burgstaaken Peninsulas. The north of the island and thus also the investigation area are much less relevant to tourism accommodation and campsites.

### 2.3.2. Hydrography and water quality (marine area)

(see Section 3.2 EIA-report, Attachment 15 of the plan approval documents, Volume II A, Attachment 30.1 of the plan approval documents, Section 2)

In order to bring the hydrographic data basis up to date, the key variables and influence parameters for the time period running from 2005–2015 relating to trends and patterns were analysed (Attachment 30.1 of the plan approval documents, Annex A). The following variables and parameters were used in order to identify possible hydrographic alterations: Wind speed and direction, temperature and salinity. No significant trends could be identified.

The following key variables are good indicators of potential changes in water quality: Nutrient content, oxygen content, visibility depth (Secchi depth) and suspended sediment concentration. In summary, the inventory data for the key variables on water quality are still current and, as a result, the results of the impact assessment in the EIA-report's main variant comparison are still entirely valid and plausible.

**Baseline investigation goals and methods**

- Information on hydrology and the corresponding meteorological constraints, currents, water levels, waves, salinity, temperature and density stratification as parameters for hydrography.
- Information on visibility depth, suspended material/substances, nutrients and oxygen content as parameters for water quality.
- Methods: Analysis of historical data. Under the scope of the project, continuous measurements of the parameters above at 13 measuring stations and monthly measuring cruises in the investigation area, analysis of remote sensing data for suspended material, use and development of numeric hydrodynamic models.

**Key findings of the Baseline investigation and evaluation**

The parameters hydrography and water quality are important overall as framework conditions for the ecosystem in the Fehmarnbelt and in the wider Baltic Sea region. From a hydrological perspective, areas with special significance are those relevant to ensuring an undisrupted current in the Fehmarnbelt and stratification of the body of water (particularly at depths greater than 10 m), and areas close to harbours and swimming areas that lie in the area of possible project-related changes in the current and wave conditions (see Figure 17).

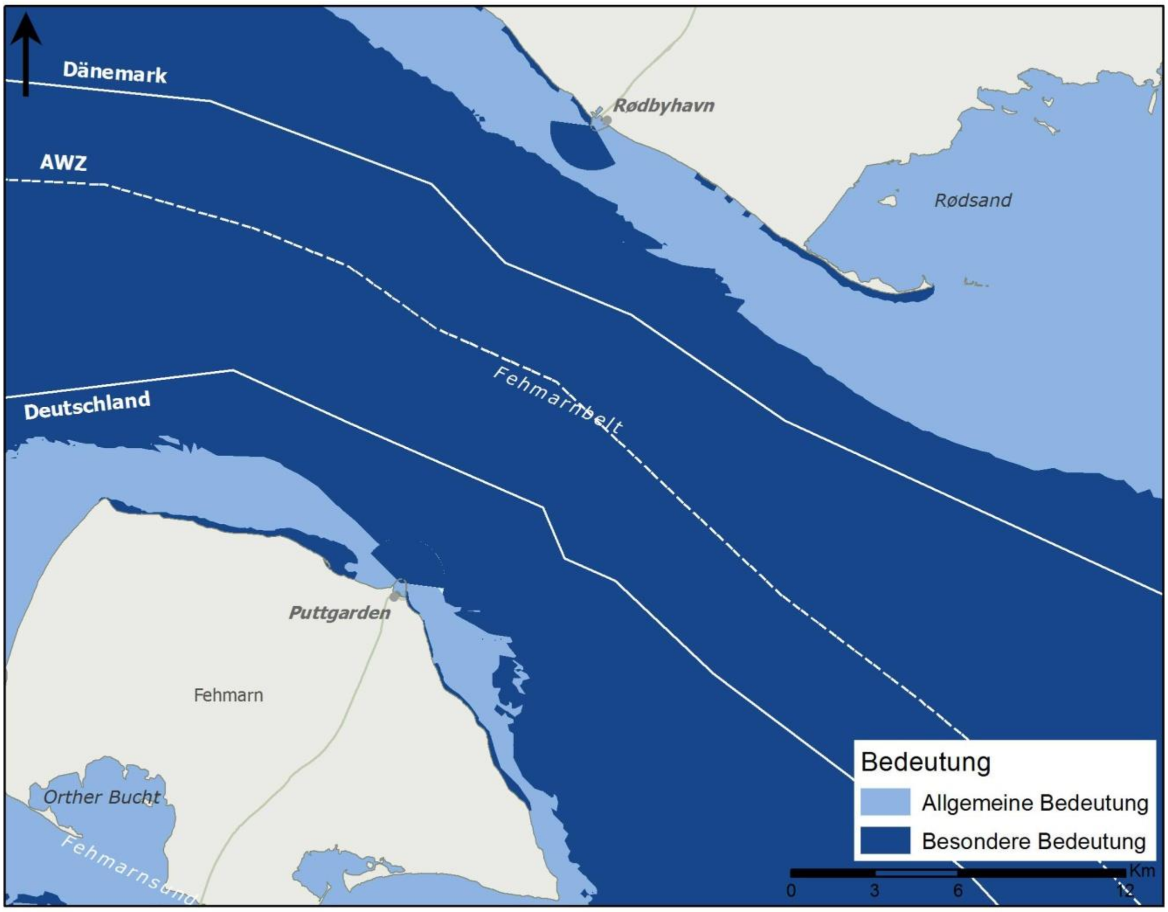



**Figure 17 Spatial distribution of the significance of the sub-factor hydrography in the Fehmarnbelt**

| | |
|---|---|
| Dänemark | Denmark |
| AWZ | EEZ |
| Deutschland | Germany |
| Orther Bucht | Orth Bay |
| Fehmarnsund | Femernsund |
| Bedeutung | Significance |
| Allgemeine Bedeutung | General significance |
| Besondere Bedeutung | Special significance |

According to the bathing waters ordinance, bathing beaches (sandy beaches, up to a water depth of 3 m) are of particular importance to the sub-factor of water quality. All other areas are of general importance (see Figure 18).

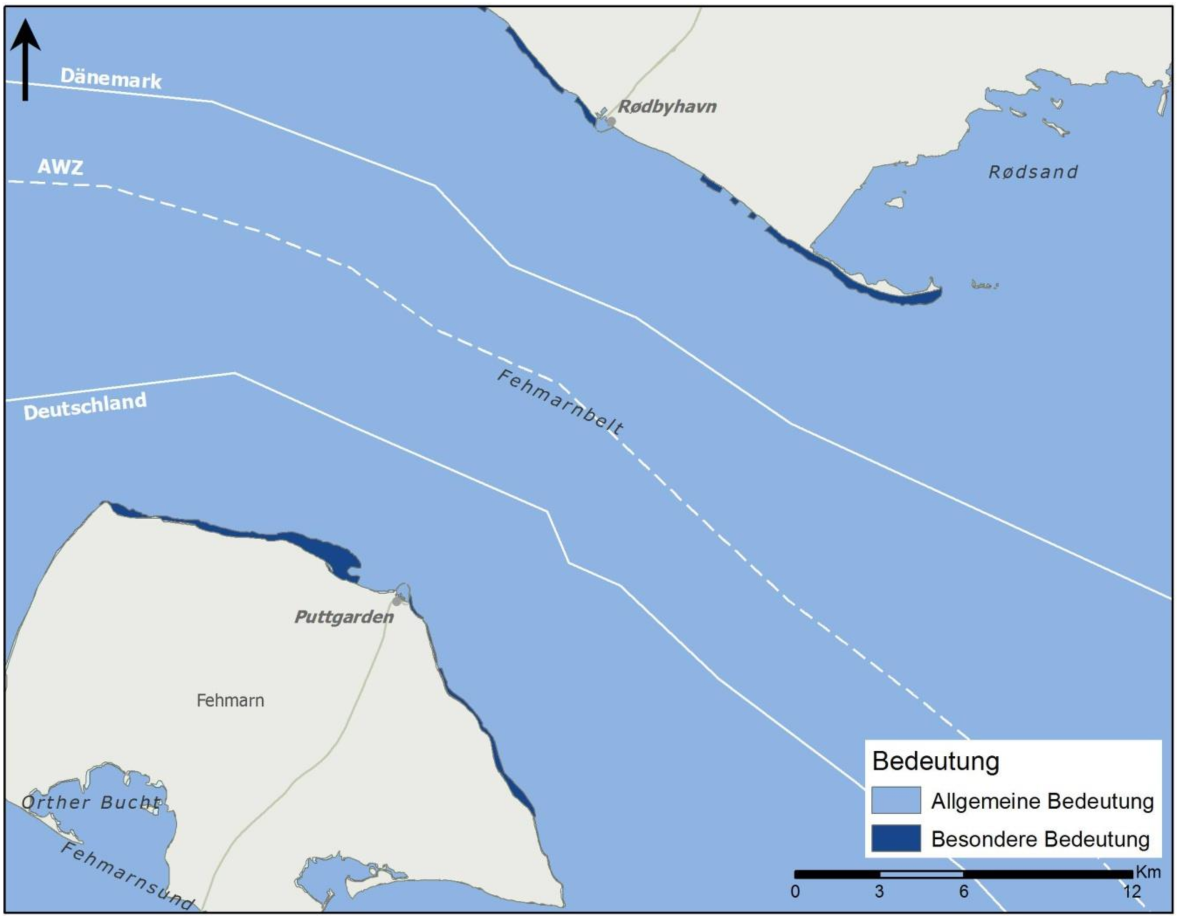



**Figure 18** **Spatial distribution of the significance of the water quality sub-factor in the Fehmarnbelt**

| | |
|---|---|
| Dänemark | Denmark |
| AWZ | EEZ |
| Deutschland | Germany |
| Orther Bucht | Orth Bay |
| Fehmarnsund | Femernsund |
| Bedeutung | Significance |
| Allgemeine Bedeutung | General significance |
| Besondere Bedeutung | Special significance |

## 2.3.3. Seabed morphology and sediments

(see Section 3.3 EIA report, Attachment 15, Volume II A)

No new surveys were carried out for the morphology and sediments sub-factor since there had been no events had taken place within the last few years which had led to short-term changes in hydrographic variables such as flow rates, flow directions and wave dynamics.

### Baseline investigation goals and methods

- Statements on geology, sediments and sediment transport on the seabed, seabed geometries and bathymetry as well as interaction between current and seabed geometries.
- Methods: Methods: under the scope of the project, aerial image analysis, collection of echo sounding measurement data, sampling with lab analyses for substrate identification, use of hydrodynamic models, use of a sediment transport model.

### Key findings of the Baseline investigation and evaluation

The seabed in the Fehmarnbelt outside of the coastline consists of seabed geometries that are the result of the interaction between available sediments and the current (see Figure 19). Particular significance is attached to seabed areas that feature natural and semi-natural seabed geometries of the dunes (mega ripples) in protected areas and Natura 2000 sites with corresponding conservation objectives for the seabed. Outside of the protected areas, areas with seabed geometries such as dunes (mega ripples), crescent-shaped seabed forms and other active seabed forms are classified as highly significant. All other seabed areas that have not been transformed by human activity are considered to be of medium significance. Seabeds that have been significantly transformed by human activity, e.g. in the area of excavation sites, are of low significance.

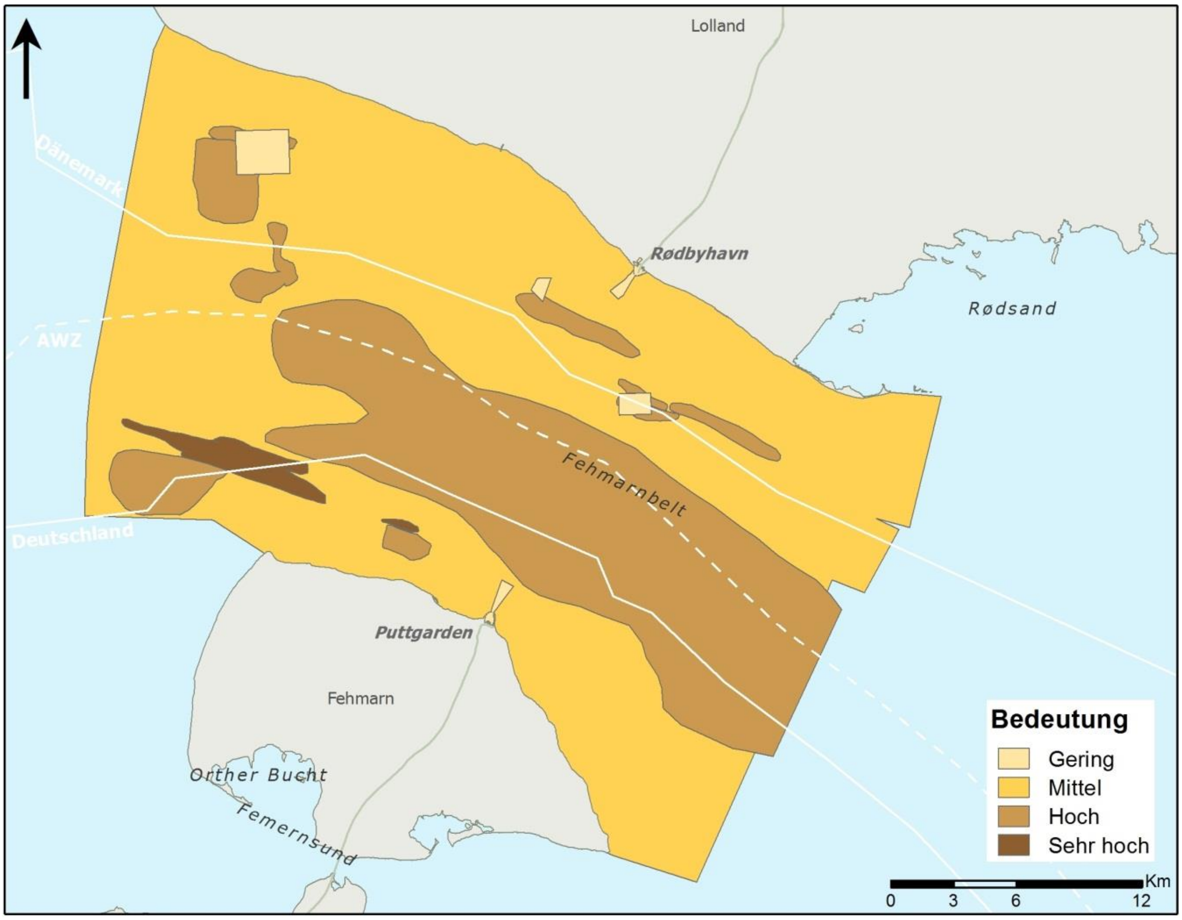



**Figure 19 Spatial distribution of the significance of the seabed in the Fehmarnbelt**

| | |
|---|---|
| Orther Bucht | Orth Bay |
| Bedeutung | Significance |
| Gering | Low |
| Mittel | Medium |
| Hoch | High |
| Sehr hoch | Very High |

### 2.3.4. Coastal morphology (marine area)

(see Section 3.4 of the EIA, Attachment 15 of the plan approval documents, Volume II A)

No new surveys were carried out for the coastal morphology sub-factor since there had been no events had taken place within the last few years which had led to short-term changes in morphological processes.

**Baseline investigation goals and methods**

- Information on coast sections of Lolland and Fehmarn in the Fehmarnbelt with respect to morphological processes (sediment transport, coast erosion and sediment deposits, influence of existing coast protection facilities).
- Methods: analysis of historical maps and literature on the development of the coastline. Under the scope of the project, creation of coast profiles by means of levelling, echo sounding and aerial image analysis.

**Key findings of the Baseline investigation and evaluation**

Coastal areas with natural and semi-natural characteristics in protected areas or Natura 2000 areas are of high significance as long as they have appropriate conservation objectives in relation to coastal morphological formations and processes. These include, in particular, the coast sections with special morphological structures such as the "Hyllekrog/Rødsand" sand banks on Lolland and the formation in the "Grüner Brink" on Fehmarn. Outside of protected areas, areas where dunes and spits occur including coast lagoons, sandy beaches and areas with sand banks and stone reefs close to the coast are classified as highly significant. All other coast sections that have not been greatly altered by human activity are considered to be of medium significance. Coast sections that have been considerably transformed by human activity, e.g. in the area of harbours and coastlines without natural beach sections, are of low significance.

### 2.3.5. Planktic fauna and flora (marine area)

(see Section 3.5 EIA-report, Attachment 15 of the plan approval documents, Volume II A, and Attachment 30.1 of the plan approval documents, Section 3)

The main focus of the update investigation was the phytoplankton's chlorophyll a biomass parameter (which is a constituent element of biomass; significant for benthic light availability and a source of nutrients for pelagic and benthic fauna) and the phytoplankton's species assemblage (e.g. the existence of potentially toxic cyanobacteria). As part of this investigation, data was taken from four stations in the Fehmarnbelt and surrounding waters. When comparing the newly-obtained data with that contained in the EIA-report, it became evident that the data basis used in the EIA-report was highly representative over the whole 2009–2014 period. In this respect, the Baseline investigation and survey are still fully valid.

### Baseline investigation goals and methods

- Information on plankton (based on the species composition parameters, including invasive and potentially damaging species, chlorophyll a concentration and primary production of phytoplankton, and composition of zooplankton communities), horizontal, vertical and seasonal characteristics and the spatial distribution of the plankton communities in the investigation area.
- Information on the occurrence of jellyfish, their (seasonal) population development and spatial distribution, and the pressure they put on zooplankton as predators in the investigation area.
- Methods: Analysis of historical data. Under the scope of the project, monthly investigation trips to sample/measure the parameters above, taking into account the measurements for the parameters hydrography and water quality (see Section 2.3.2).

### Key findings of the Baseline investigation and evaluation

The significance of planktic organisms in the Fehmarnbelt region is defined by the functional value of the three components phytoplankton, zooplankton and jellyfish and is heavily dependent on parameters such as primary production or biomass.

The main function of plankton for the ecosystem stems from the production of biomass, which is available as food for the next trophic levels in the food chain. The production can be depicted spatially and depend significantly on water depth. At depths of more than 6 m, average plankton production and biomass per unit of area are twice those in shallower depths. Greater production in areas of deeper water is crucial as the main food source for fauna living on the seabed. For this reason, this depth contour was used as a boundary between the general and special importance of planktic flora and fauna (cf. Figure 20).

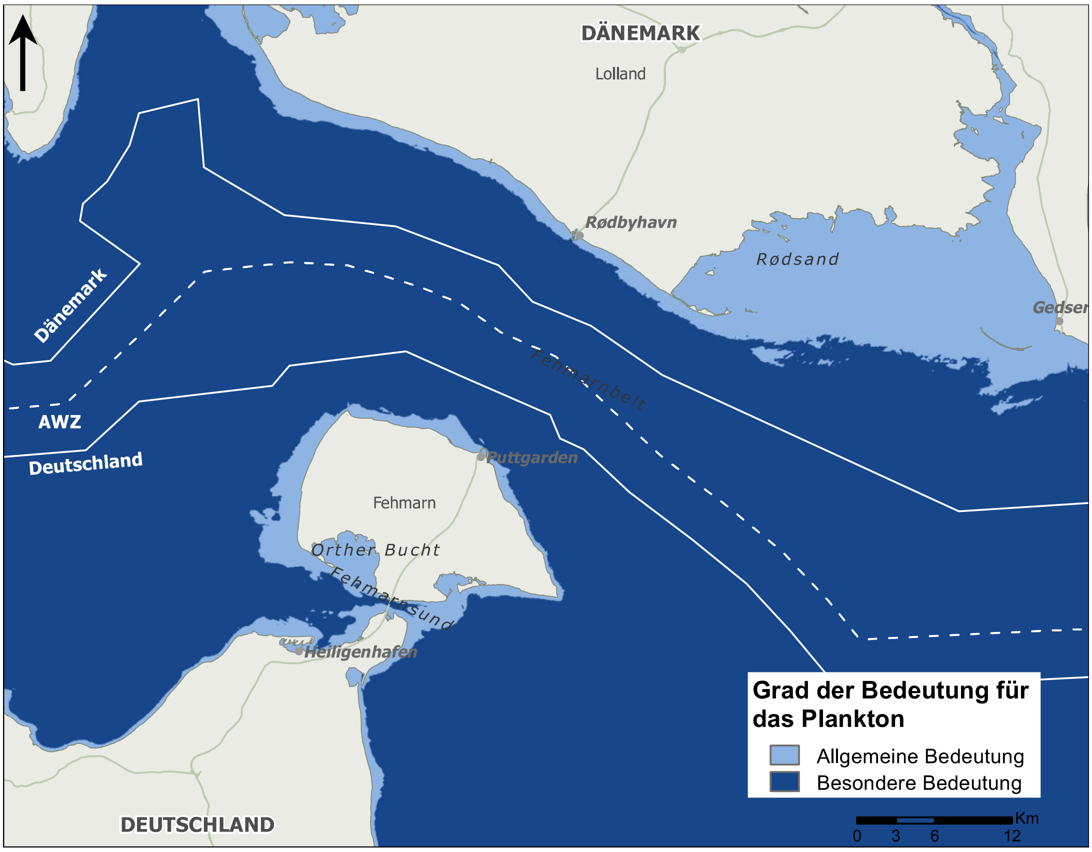



**Figure 20 Significance of plankton in the Fehmarnbelt and in adjacent areas**

| | |
|---|---|
| DÄNEMARK | DENMARK |
| Dänemark | Denmark |
| AWZ | EEZ |
| Deutschland | Germany |
| Orther Bucht | Orth Bay |
| DEUTSCHLAND | GERMANY |
| Grad der Bedeutung für das Plankton | Degree of significance for the plankton |
| Allgemeine Bedeutung | General significance |
| Besondere Bedeutung | Special significance |

### 2.3.6. Benthic flora (marine area)

(see Section 3.6 EIA-report, Attachment 15 of the plan approval documents, Volume II A, and Attachment 30.1 of the plan approval documents, Section 4)

Different data on benthic flora is available for the period 2006-2015. This data was collected by Femern A/S and as part of Danish and German national monitoring programmes. The update investigation focussed on individual key species (red and brown algae and seaweed), which are typical of the benthic plant communities in that area. Large annual fluctuations in both degree of coverage and biomass were detected in the surveyed macroalgae species and seaweed for all available time series. This illustrates the significant natural fluctuations in flora which confirms that this data can be used as a basis for the validity of using the baseline survey as a basis for the EIA-report.

**Baseline investigation goals and methods**

- Information on species composition, spatial occurrence, coverage/frequency and biomass of the marine benthic communities of macroalgae and higher plants in the investigation area, also compared with historical studies.
- Information on depth limit of individual seagrasses and seaweed types (*zosters marina*, *fucus* spp) and the general vegetation limit in the investigation area.
- Documentation and characterisation of green vegetation of all nearby Natura 2000 sites.
- Methods: analysis of historical data and data from national environmental monitoring. Under the scope of the project, mapping of marine vegetation with remote sensing methods (aerial image analysis, acoustic sediment documentation) combined with the analysis of underwater video transect data, vegetation sampling and estimates of the coverage at sampling stations during diving investigations, model-supported (GAM – "Generalised Additive Modelling"), creation of a general vegetation community and habitat maps.

**Key findings of the Baseline investigation and evaluation**

The significance of benthic vegetation (= benthic flora) is derived from the functional value of the vegetation for the ecosystem. Due to its function as a habitat, spawning area, nursery and feeding ground for invertebrates and fish (to a lesser extent for birds and mammals too), benthic vegetation is a valuable and important part of the ecosystem.

The *fucus*, seagrass, tasselweed/dwarf seagrass and the seagrass/algae communities – and additionally, for the German investigation area, the *furcellaria-phycodrys/ delesseria*and *saccharina*communities with a coverage of > 50% – are of very high significance in the investigation area due to the high importance of their role in forming habitats, their low seasonal variability and their national and international protection and red list status. The otherwise occurring red algae communities (*furcellaria*, *phycodrys/delesseria*) and the *saccharina* community with a coverage of > 50% have high significance for the Danish investigation area; for the German investigation area, all communities with perennial character species are assigned high significance as long as the coverages reach > 25-50%. All perennial plant communities with more than 10% coverage (but lower coverage than in the previously mentioned significance levels) have medium importance. Even if their contribution to habitat formation is reduced primarily for fish due to their low coverage, they are still important for invertebrate fauna. The filamentous algae community (usually single-year species, high biomass variability within one year) and all forms of vegetation with a coverage of less than 10% have only low significance.

The spatial distribution of the significance levels of the benthic vegetation in the investigation area is shown in Figure 21. Large-scale vegetation areas with very high significance are primarily located within the shallow, low-exposure marine bays of Rødsand lagoon and Orth Bay due to the large-scale and dense occurrence of the seagrass and tasselweed/dwarf seagrass community. Areas with vegetation of *high significance* are grouped around the areas with very high significance. The coverage/density of the *perennial* plant communities there is not sufficient for them to be assigned very high significance. Other large-scale areas of high significance are situated off the coast of Lolland and Langeland (*furcellaria, phycodrys/delesseria* and/or *saccharina* communities). Large-scale areas with plants of medium significance can be found along the entire coast of Lolland, off Langeland, around Fehmarn and, on a small scale, in the lower areas of the Sagas Bank, the Fehmarnbelt and the eastern Bay of Kiel (perennial algae communities with lower coverage). Large-scale areas of low significance are found throughout the entire investigation area (filamentous algae community and individual vegetation with a coverage of less than 10%). The deep sections of the investigation area and very shallow sandbank areas are free of vegetation.

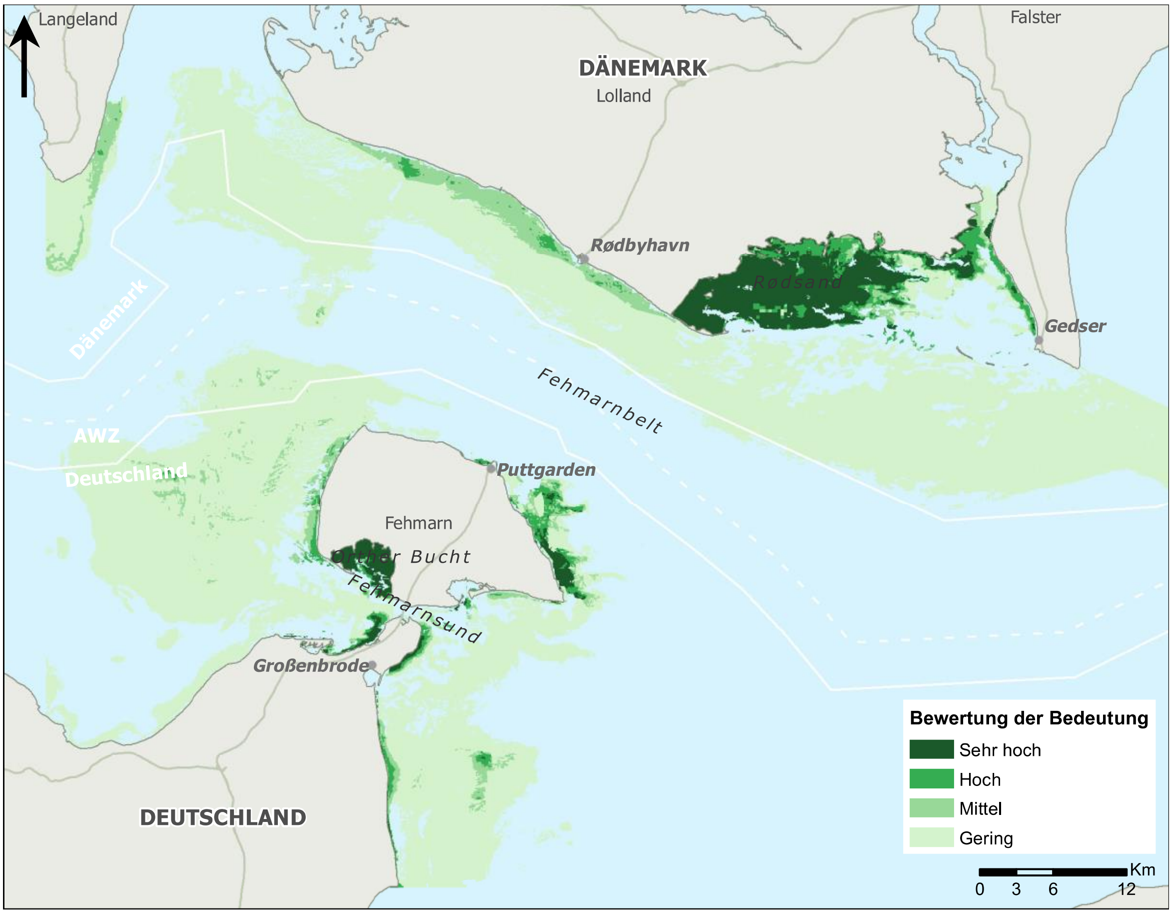



**Figure 21 Spatial distribution of the significance of the benthic flora in the investigation area**

| | |
|---|---|
| DÄNEMARK | DENMARK |
| Orther Bucht | Orth Bay |
| DEUTSCHLAND | GERMANY |
| Bewertung der Bedeutung | Significance |
| Sehr hoch | Very high |
| Hoch | High |
| Mittel | Medium |
| Gering | Low |

## 2.3.7. Benthic fauna (marine area)

(see Section 3.7 EIA-report, Attachment 15 of the plan approval documents, Volume II A, and Attachment 30.1 of the plan approval documents, Section 5)

In order to investigate to what extent the results of the Baseline investigations in the EIA-report still reflect the current relations, data on epi- and infauna and blue mussels from the Fehmarnbelt and surrounding waters was collected and analysed. To do this, data from various institutions as well as the German and Danish monitoring programmes, which cover a longer period (2005–2014 or 2001–2013), was assessed.

Overall, the results show no significant changes in the parameters of benthic infauna and mussel communities since the baseline survey for the Baseline investigation in the Fehmarnbelt was conducted. Naturally, all the data shows greater fluctuations which are, on the one hand, caused by the methodologies used and which are inevitable and, on the other, by the variability in environmental parameters such as oxygen depletion. However, there is no indication of trends here, which means that the current results of the EIA-report with regard to benthic fauna in the Fehmarnbelt are still valid.

In conclusion, the overall results of the plausibility check show that the current results of the EIA-report with regard to benthic fauna in the Fehmarnbelt are still valid.

### Baseline investigation goals and methods

- Information on species composition, spatial occurrence, abundance, biomass and community structure of the marine benthic macrofauna in the investigation area, taking special account of the blue mussel (*mytilus edulis*), also compared to historical studies.
- Documentation and characterisation of the benthic fauna in all nearby Natura 2000 sites.
- Methods: Analysis of historical data and data from existing national environmental monitoring. Within the scope of the project, mapping of the benthic fauna with remote sensing methods (aerial image analysis, acoustic sediment documentation) combined with the analysis of underwater video transect surveys, sampling at sampling stations separately in shallow water and deep water areas as well as infauna and epifauna, model-supported (CART modelling "Classification and Regression Trees"), creation of a general map of the fauna communities, creation of a community model from all data which shows the relationships between abiotic factors and species and symbioses found and their frequency.

### Key findings of the Baseline investigation and evaluation

Nine different communities of benthic fauna were recorded in the investigation area, four of which were found only in deep water and three only in shallow water. The importance of the individual fauna communities is classified in four levels (low, medium, high and very high). This is determined firstly on the basis of legal regulations and secondly on the basis of scientific factors. The criteria used are the Habitats Directive, the HELCOM Red List of threatened species and habitats, ecological functions, BNatSchG, LNatSchG, the Biotope Ordinance (Biotopeverordnung) and national red lists.

The areas classified as very highly significant with the Arctica community are mainly in the deeper Fehmarnbelt, the areas of the Rissoa community in the western part of the Rødsand lagoon and in Orth Bay. The areas classified as highly significant are primarily in the coastal area of Lolland, the slopes and deeper regions of the Langelandbelt, part of the eastern Bay of

Kiel and areas off the Rødsand lagoon and the Albuen Bank near Lolland. These areas are dominated by the mytilus, dendrodoa and tanaissus community. The areas classified as having medium significance are mainly the shallow waters around Fehmarn, the Sagasbank southeast of Fehmarn, the area of the Fehmarnsund and the eastern part of the Rødsand lagoon. These areas are dominated by the gammarus and tanaissus community. Classified with low importance are the coastal sections west of Fehmarn and off Gedser as well as two narrow strips north and south of the central Fehmarnbelt (predominantly bathyporeia and corbula communities, see Figure 22).

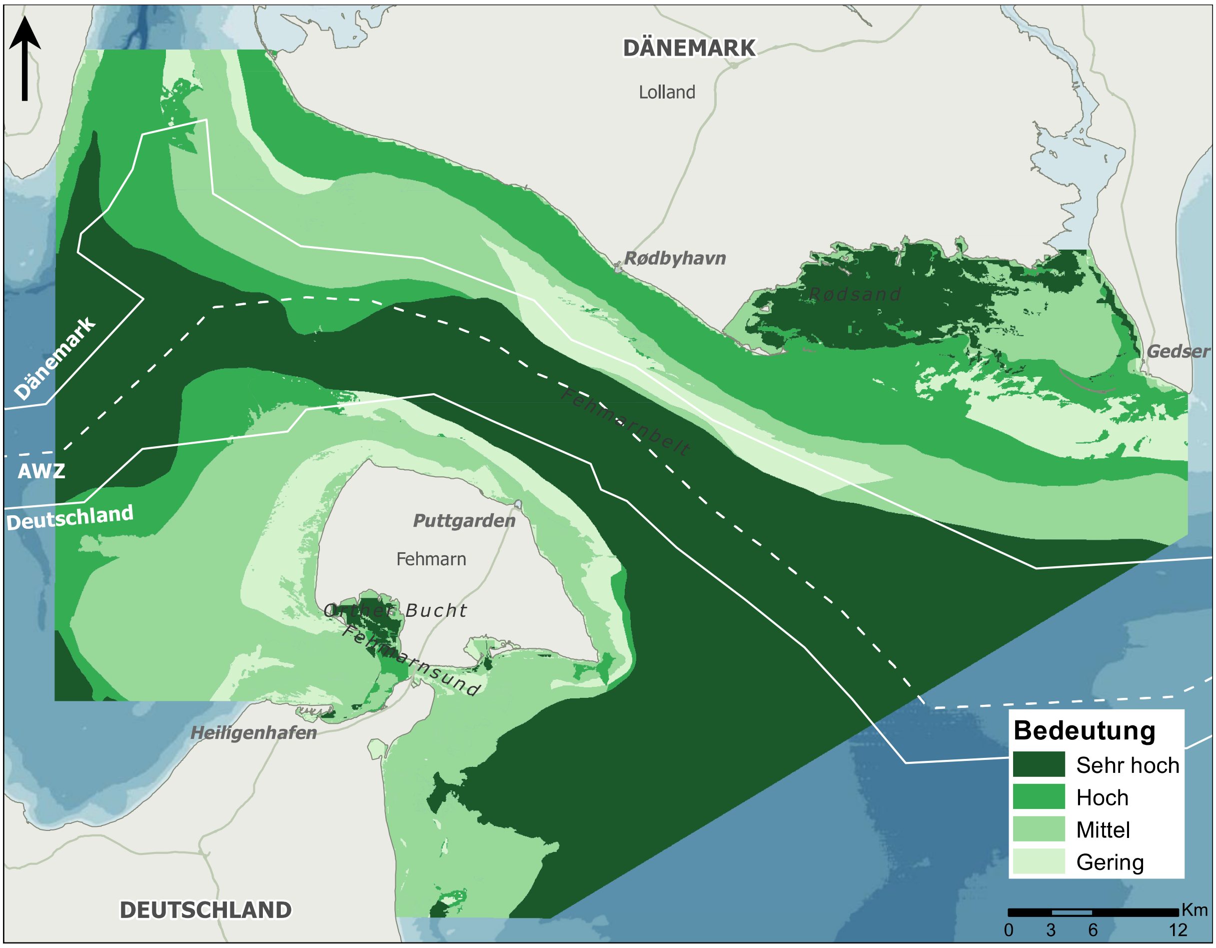



**Figure 22 Spatial distribution of the significance of the benthic fauna in the investigation area**

| | |
|---|---|
| DÄNEMARK | DENMARK |
| Dänemark | Denmark |
| AWZ | EEZ |
| Deutschland | Germany |
| Orther Bucht | Orth Bay |
| DEUTSCHLAND | GERMANY |
| Bedeutung | Assessment |

| | |
|---|---|
| Sehr hoch | Very high |
| Hoch | High |
| Mittel | Medium |
| Gering | Low |

### 2.3.8. Benthic habitats (marine area)

(see Section 3.8 EIA-report, Attachment 15, Volume II A: Attachment 30.1 to the plan approval documents, Section 6)

In the EIA-report, the benthic habitats formed the basis for the habitat type (HT) mapping found in Annex I of the FBFL guideline and the biotype type protected by § 30 of the Federal Nature Conservation Act (BNatSchG). In addition to their own observations, existing data gathered by the State of Schleswig-Holstein was used for mapping the HT on the German side.

On completion of the baseline survey, the State of Schleswig-Holstein carried out additional data surveys and mappings of the marine HT. This led to the spatial demarcation of certain HTs in Schleswig-Holstein being updated and, as a result, differences in the current demarcations compared with those shown in the baseline survey. This took place as part of the updates carried out on the Standard Spreadsheets for the sites of community interest. At the same time, in 2015, updated mappings and biotype codes, including the explanations associated therewith, were released in Schleswig-Holstein. These contained accurate information on performing a mapping exercise and the definition of the HTs and biotype types.

At the end of 2015, Femern A/S, in a joint approval process with the State of Schleswig-Holstein (MELUR and LLUR) adapted the mapping results from the baseline survey to the current data gathered by the State. The current HT maps, which were altered by the State of Schleswig-Holstein, formed the basis for this. In order to obtain a map which was consistent with the HT for both the benthic habitats and the § 30 biotype types, and following a vote based on the criteria used in the EIA-report (Attachment 15 of the plan approval documents), the maps for the § 30 biotype type according to BNatSchG and the benthic habitats were adapted.

**Baseline investigation goals and methods**

- Classification and documentation of the spatial distribution of marine benthic habitats on the basis of abiotic (physical habitats) and biological descriptors (benthic communities) in the investigation area.
- Documentation of the spatial distribution of marine Natura 2000 habitat types that are listed in Annex I of the Habitats Directive (Fauna-Flora-Habitat Directive), on the basis of the definitions, criteria and limits specified in the EU guidelines for interpreting EU habitat types and by the responsible authorities.
- Classification of the results according to the natural features, previous anthropogenic impairments and a comparison of the defined benthic habitats with the habitat definition

of the red list of endangered biotope types in Germany, the legally protected biotope types in accordance with Art. 30 BNatSchG and the red list of the marine biotopes in accordance with HELCOM.

- Methods: A combination of the abiotic descriptors (depth zones, substrate) for physical habitats and the biological descriptors for benthic communities (flora and fauna communities), followed by a merging of the two habitat categories for benthic habitats in accordance with the classification specified by EUNIS (see Attachment 15. Annex A, Section 0.1.2.8).

### Key findings of the Baseline investigation and evaluation

A total of 19 benthic habitats have been identified in the investigation area. The significance of the benthic habitats is derived from the functional value of the benthic habitats as a permanent habitat, spawning area, nursery and feeding ground. The suitability of the benthic habitats for these functions is classified on the basis of expert assessments using the following criteria:

- Complexity (multidimensionality)
- Stability (resistance)
- Degree of fragmentation (minimum density)

The result of the classification is reviewed for compliance with the international and national laws and guidelines and modified if necessary. This means that areas protected under § 30 of the Biotope Law (DE only) and/or Natura 2000 habitat types (DK and DE) are assigned very high significance regardless of these criteria. It can generally be said that hard bottoms are of greater significance than mixed or soft bottoms and that communities growing on stone further increase the complexity. Perennial vegetation has greater significance than blue mussels due to its higher resistance. Soft bottoms with vegetation are of greater significance than those without vegetation due to their greater three-dimensionality in the water column.

All benthic habitats characterised by *coarse or mixed sediment* and a long-lived community such as *dendrodoa, perennial algae* or *seagrass/algae* have very high significance. The coarse sediment (large proportions of blocks and stones) expands the three-dimensional habitat into the water column, which then expands again and becomes more diverse through the growth of flora or fauna. Even when the protective function of the habitat is reduced in mixed sediment because the density of rocks and stones is lower, the very high complexity is maintained as a result of the growth. Substrates with a large particle-size and long-lived communities are also very stable and thus also suitable as a habitat and not just a feeding ground. Moreover, the benthic habitat *infralittoral sand with higher plants* is classified as having very high significance because the three-dimensionality is expanded far into the water column and all the plants are long-lived and durable. As a result, in addition to its function as a habitat, the area also serves a special function as a spawning area and nursery for fish and a feeding ground for birds.

All habitats characterised by *coarse, mixed*- or soft bottoms (*sand*, *silt*) in combination with short-lived communities (*mytilus*) or low-density vegetation (*mixed flora/fauna community*) are classified as having high significance. Compared to the communities of very high significance, the possible expansion into the water column is limited because the structure-giving components hardly protrude over the level of the seabed (*mytilus*) or coverage is so low that a clear community classification is not possible (*mixed flora/fauna community)*. If the vegetation has a low density, the protective function of the habitat is largely lost. Benthic habitats with *mytilus* are also less stable because consumption by starfish and highly varying degrees of reproductive success limit the durability of the habitat. Blue mussels are a source of food for various duck species.

All habitats that are characterised by mixed bottoms in combination with communities in the top sediment layers (*infauna*) are classified as having medium significance. Even though the mixed bottoms contain scattered rocks and stones, their density is too low to give the vegetation communities an important role for the habitat. The complexity of the habitat is thus limited solely to the area in the sediment. The different sediment conditions promote the formation of a very broad range of infauna types because, in addition to sand or silt inhabitants, species that prefer gravelly or coarse sand sediment also find a habitat. The diversity is largely limited to one ecosystem level (invertebrates).

All habitats that are characterised solely by soft bottom (*sand, silt*) and communities in the top sediment layers (*infauna*) are classified as having low significance. Neither the substrate nor a vegetation component expands the habitat into the water column. Habitats for invertebrates and several fish species are present in the sediment or on the surface of the sediment. This can provide food for birds in the shallow water. The complexity of the habitat and the stability (mobile sediment), primarily in shallow water, is limited. For the spatial distribution, see Figure 23.

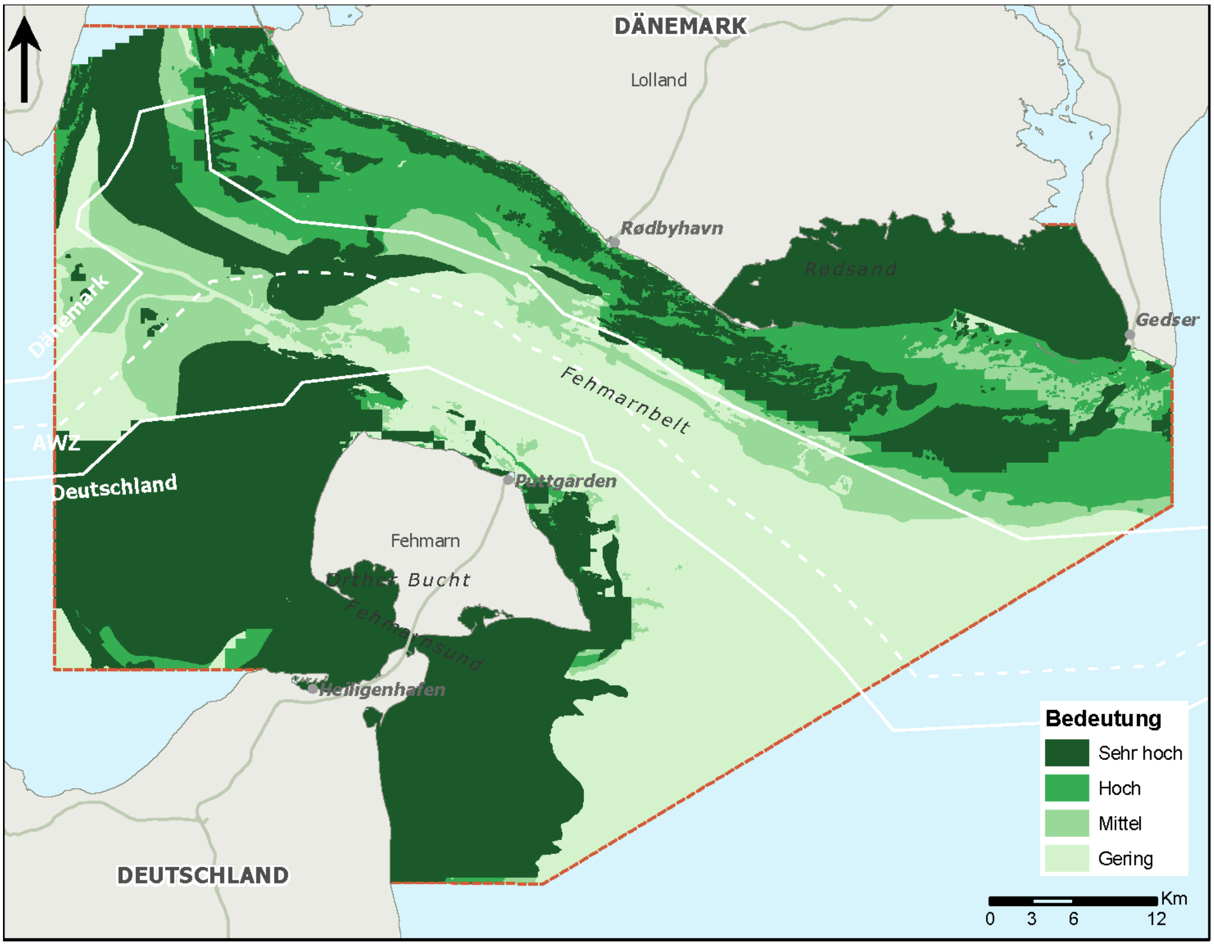



**Figure 23 Spatial distribution of the significance of the benthic habitats in the investigation area**

| | |
|---|---|
| DÄNEMARK | DENMARK |
| Dänemark | Denmark |
| AWZ | EEZ |
| Deutschland | Germany |
| Orther Bucht | Orth Bay |
| DEUTSCHLAND | GERMANY |
| Bedeutung | Assessment |
| Sehr hoch | Very high |
| Hoch | High |
| Mittel | Medium |
| Gering | Low |

## 2.3.9. Fish (marine area)

(see Section 3.9 EIA-report Attachment 15 of the plan approval documents, Volume II A; Attachment 30.1 of the plan approval documents, Section 7)

The aim of the update investigation is to assess whether the currently established fish communities in the area of the Fehmarnbelt remain in compliance with the key assumptions in fish ecology made in the EIA-report and, therefore, whether the results of the impact assessment are still valid.

As part of the update investigation, an assessment of the fish communities was carried out based on the ICES monitoring data, data from the baseline survey on the Fehmarnbelt, current fisheries data and fish stock status data gathered by ICES.

Overall, the results show no significant changes in the species assemblage of the most important species in the Fehmarnbelt from the perspective of commercial fishing since the baseline survey for the Baseline investigation in the Fehmarnbelt was conducted. As far as the pelagic and benthic communities are concerned, these are still dominated by the same species which dominated when the baseline survey was conducted and, although there are abundance trends for certain key species, specifically flatfish, these developments are not so extensive as to lead to a change in the grading of the area's importance or to an assessment of the project's impacts which differs from that laid out in the baseline survey.

There is currently no data with regard to shallow water communities. Since no significant changes in the marine environment and corresponding habitats along the coasts are expected, there is no reason to assume there will be any significant change in the assemblage of shallow water species.

With regard to the sturgeon, it should be pointed out that recapture data and interviews conducted by Danish and German fishers in the last five years have shown no evidence of the Atlantic sturgeon in the Fehmarnbelt region. Based on individual evidence in the southern marine area of the island of Fehmarn, the appearance of Baltic sturgeon in the Fehmarnbelt region during construction works cannot be ruled out in principle. Based on the current information on the distribution of the Atlantic sturgeon, the Fehmarnbelt region holds no relevance for this species of fish.

### Baseline investigation goals and methods

- Information on species composition, spatial distribution, temporal occurrence and habitat use during different stages of development (e.g. growth areas) in relation to pelagic, benthic fish communities and the fish community in the shallow waters (littoral fish community).
- Methods: Methods: monthly fish catches in a defined station net using beach seines, young fish trawls ("YOY trawl survey") for shallow water fish communities, multi-mesh gillnets, traps and a trawl for benthic fish communities. Documentation of the existing habitat structures with underwater video transect surveys at gillnet and trap stations. Documentation of pelagic and semi-pelagic fish communities through hydroacoustic recordings with echo sounding compared to fish catches. Studies of gonad maturation, sampling of fish eggs and larvaeand tracking of eggs and larvae using a backtracking model.. Tagging of cod and (t-bar tags) to record migration routes.

### Key findings of the Baseline investigation and evaluation

A total of 69 different fish species were registered in the investigation area as part of the investigations. Of these, 42 species were representatives of the benthic, 8 of the pelagic and 18 of the shallow water fish community. In addition, a parasitic species (river lamprey) was found that cannot be clearly assigned to one of the fish communities above.

The three fish communities were dominated by the species typical for the western Baltic Sea:

- Pelagic fish community by herring and European sprat
- Benthic fish community by cod, whiting, flounder, plaice and common dab
- Shallow water community by sand goby, three-spined stickleback, lesser sand eel and great sand eel

The fish species group was assessed on the basis of an individual species evaluation in accordance with the criteria of international/national protection status or red list status as well as the functional significance for the natural environment and the ecosystem in the Baltic Sea area and the Fehmarnbelt.

The European eel was classified as having very high significance. It is listed as "critically endangered" in the HELCOM Red List (2007) and as an endangered species at risk of extinction in the OSPAR list (convention for the protection of the marine environment of the North-East Atlantic). It is also on the red list in Denmark and Germany and is part of Annex II of the Washington Convention on International Trade in Endangered Species of Wild Flora and Fauna. The Fehmarnbelt is highly significant for the migration of the European eel from the Baltic Sea region in the direction of the Atlantic.

High significance is assigned to the following species on the German Red List: snake blenny (at risk of extinction) and sea stickleback (endangered). The herring is also assigned high significance because the autumn-spawning form is included on the red list as "seriously endangered" and on the HELCOM Red List (HELCOM 2007) as "endangered". The spring-spawning form, however, is not assigned to a risk category. Outside of spawning periods, the two forms are very difficult to distinguish from one another and are thus assessed together. Cod, which has special ecological importance for the Baltic Sea, is also classified as highly significant because the western stocks of Baltic Sea cod are partially responsible for recruiting the eastern cod stocks of the Baltic Sea. Geographically speaking, the central part of the Fehmarnbelt is of potentially high significance as a spawning area and parts of the waters close to the coasts off Lolland and Fehmarn are of medium significance as a nursery area for cod in the investigation area.

The Atlantic salmon is listed in Annex II of the Habitats Directive and is classified as endangered on the red list of Germany, Denmark and the HELCOM; according to the findings of the studies, however, this fish only passes through the Fehmarnbelt. As a result, it is only assigned medium significance. The Red List states that the sea trout (Fricke et al. 1996) is classified as "seriously endangered" and as "vulnerable" on the HELCOM Red List (2007). As is also the case with salmon, it is assumed that the Fehmarnbelt is only used by sea trout as a transit area for migration. Consequently, this species is also classified as having medium significance. Species that are characteristic for the Fehmarnbelt and the adjacent bays are also assigned medium significance. This includes species such as whiting, European sprat, flat fishes (common dab, flounder, plaice) and shallow water fish species (e.g. sand goby, three-spined stickleback and lesser sand eel).

All other species – despite the fact that some are included in the red lists – are classified as having low significance due to the limited ecological significance of the species in the investigation area or because they only occur in the Fehmarnbelt as "accidental visitors".

### 2.3.10. Marine mammals

(see Section 3.10 EIA-report, Attachment 15 of the plan approval documents, Volume II B; Attachment 30.1 of the plan approval documents, Section 8).

The update investigation of the data gathered on marine mammals consisted of new observations on the one hand and an evaluation of the most recent publications on harbour porpoises and seals in the Fehmarnbelt area on the other. The aim of this study was to determine whether and to what extent changes in stocks had occurred and whether this would mean changes to the Fehmarnbelt's ecological function as a habitat and feeding area and migration route for harbour porpoises. In light of the comments and arguments on this topic which were brought up during the discussions, the importance of the Fehmarnbelt as a migration corridor for the harbour porpoise was re-assessed. An extension of the underwater noise modelling was also carried out. A detailed explanation of the results of the update investigation can be found in Attachment 30.1 of the plan approval documents, Section 8. The results of the expanded underwater noise modelling can be found in the noise protection concept in Attachment 22.5 and the impact assessment of certain strictly protected species in Annex 21 of the plan approval documents, Section 9.2.4.

#### Baseline investigation goals and methods

- Information on abundance, spatial distribution and habitat use of harbour porpoise, harbour seal and grey seal
- Information on distribution concentrations and gradients in the occurrence of the various species and the physical health of the seals
- Information on the crossing behaviour of harbour porpoises under existing bridges
- Methods harbour porpoise: analysis of existing data. Under the scope of the project, air-based counts, counts from the ferry line, passive acoustic monitoring with click detectors (C-PODs), satellite telemetry studies, model-based analyses
- Methods seals: analysis of existing data. Under the scope of the project, air-based counts, telemetry studies

#### Key findings of the Baseline investigation and evaluation

The harbour porpoise is found throughout the entire year in the area of the Fehmarnbelt; calves were found in summer. The entire investigation area is of medium significance as a habitat for the harbour porpoise. Some sub-areas are of high and very high significance, particularly to the west of the Fehmarnbelt (see Figure 24). The significance levels are similar in summer and winter, although in winter some areas are classified as having low significance. The function of the Fehmarnbelt as a nursing ground for calves is assigned medium significance. The Fehmarnbelt serves as a migration corridor for the migrations of the harbour porpoise between the eastern and western Baltic Sea and is assigned medium significance.

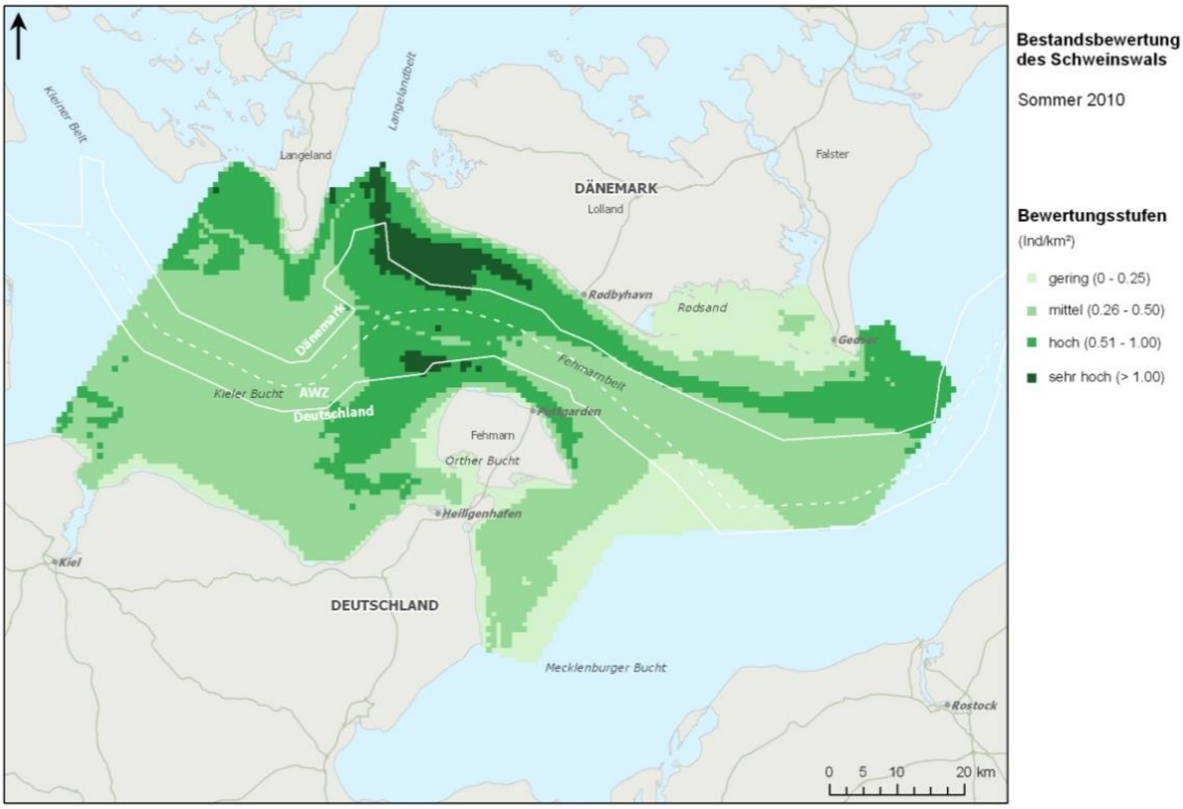



**Figure 24** **Spatial distribution of the significance for harbour porpoises in the Fehmarnbelt in the summer 2010**

| | |
|---|---|
| Kleiner Belt | Little Belt |
| Dänemark | Denmark |
| AWZ | EEZ |
| Deutschland | Germany |
| Kieler Bucht | Bay of Kiel |
| Orther Bucht | Orth Bay |
| Mecklenburger Bucht | Bay of Mecklenburg |

The occurrence of harbour seals and grey seals in the area of the Fehmarnbelt is concentrated on the colonies in the Rødsand lagoon. The significance of the Rødsand lagoon and adjacent feeding grounds is classified as very high for harbour seals and high for grey seals. In addition, the Rødsand lagoon is important as a reproductive and nursery area for the entire population of harbour seals in the Baltic Sea. The significance of the remaining Fehmarnbelt investigation area is classified as low for both species as they do not use it very much.

### 2.3.11. Passage migrant birds (marine area)

#### Baseline investigation and evaluation

(see Section 3.11 EIA-report, Attachment 15 of the plan approval documents, Volume II B; Attachment 30.1 of the plan approval documents, Section 9).

The update investigation of the data gathered on resting birds consisted of new observations on the one hand and an evaluation of the most recent publications on the standing stock of resting birds in the Fehmarnbelt area on the other. The aim of the investigation was to determine whether and to what extent there had been changes to the resting bird stocks wintering in the Fehmarnbelt.

In the case of new surveys, a total of five digital and three visual observation flights were conducted in the Fehmarnbelt investigation area between January and June 2015. A detailed explanation of the results of the update investigation can be found in Attachment 30.1 of the plan approval documents, Section 9.

The current observation flights and the evaluation of updated external data essentially confirms the abundance and spreading pattern of the various species of water fowl in the Fehmarnbelt region, as described in the EIA-report. The altered abundance levels or spreading patterns observed for a total of 5 species (great crested grebe, Slavonian grebe, common scoter, groosander and guillemot) do not lead to significant alterations in the evaluation of the results contained in the EIA-report. This is particularly the case since the differences have either no or very little impact on the immediate area of the alignment or the fault zone determined for construction activities related to the Fehmarnbelt Fixed Link.

#### Baseline investigation goals and methods

- Information on abundance, distribution and development trends as well as habitat use (feeding and resting grounds in particular) for sea and water birds in the area of the Fehmarnbelt.
- Information on food ecology of water birds.
- Information on migration and local flight movements of land, sea and water birds.
- Methods: analysis of existing data from monitoring programs and scientific studies in the area of the Baltic Sea. Under the scope of the project, monthly air and ship counts of resting birds along transects, documentation of radio, satellite and GPS telemetry data on the search for food and local movements of certain water bird species, and collection of band recovery data from analyses of the origins of populations in the Fehmarnbelt. Model-supported calculation of the distribution and density of

water bird levels using parameters on typography, hydrography, benthic food resources and existing anthropogenic impairments. Individual-based model to show the correlations between wintering eider ducks and their food sources.

### Key findings of the Baseline investigation and evaluation

With respect to breeding water birds, all of the existing SPAs in the investigation area are classified as particularly significant (DE 1530-491 eastern Bay of Kiel, DE 1633-491 Baltic Sea east of Wagrien, DK 006X083 Hyllekrog-Rødsand, DK 006X087 Mariboseen).

With respect to non-breeding water birds (passage migrant birds in the marine area), two criteria complexes are combined with one another for the assessment of the species-specific significance: the population of the species migrating over the Fehmarnbelt in proportion to the biogeographic population of the species and the endangered status of the species as indicated above. The recognised criterion for the international importance in the sense of the Ramsar Convention is used as the basis for population-related importance. According to this, areas that host at least 1% of the biogeographic population of a species are of the highest significance. In Table 20 the significance of the resting and wintering bird species found in relation to the entire investigation area of the Fehmarnbelt can be seen.

**Table 20 Significance of the passage migrant birds found in the investigation area in relation to the Fehmarnbelt**

| Significance | Species |
|---|---|
| Very high | Gannet/Arctic diver, red-necked grebe, cormorant, mute swan, whooper swan, Bewick's swan, grey goose, barnacle goose, widgeon, gadwall, shoveller, pochard, tufted duck, scaup, eider duck, long-tailed duck, black scoter, smew, red-breasted merganser, little gull |
| High | Brent goose, white-tailed eagle, common gull, sandwich tern, black guillemot |
| Medium | Bean goose, common teal, common goldeneye, bald coot, black-headed gull, herring gull, great black-backed gull, razor-billed auk |
| Low | Great crested grebe, horned grebe, white-fronted goose, mallard, velvet scoter, goosander, lesser black-backed gull, common tern/Arctic tern, common guillemot |

The investigations show that the Fehmarnbelt region is of very high significance for non-breeding water birds and sea ducks in particular. Populations of international significance (>1% of the population) were recorded in the investigation area for 19 species. Particular attention must be drawn to the high percentage of the eider duck population (43%) in the Fehmarnbelt region – it makes the region the most important wintering area of the Baltic Sea mud flats population. Other mussel-eating sea ducks and diving ducks also have populations in the region with international significance. The mollusc-water bird food chain is thus an extremely important channel for energy flow in this ecosystem. A significant portion of species with international significance – wading ducks, swans and geese – are associated with habitats inland or close to the coast. The mute swan, for instance, is concentrated for moulting in the Rødsand lagoon giving this area an extremely important function for this species. In addition, the populations of several fish-eating species have international significance. The Fehmarnbelt therefore has high significance for various ecological groups and clearly has very high value for bird protection. The Fehmarnbelt region overall is considered one of the most important areas for non-breeding birds in the Baltic Sea region. Within the region, the following areas have the highest value: the shallows away from the coast to the east and west of Fehmarn (e.g. Sagasbank), the Albue Bank and the Rødsand Lagune.

### 2.3.12. Biodiversity (marine area)

(see Section 3.12, Attachment 15 of the plan approval documents, Volume II B; EIA-report, Annex C)

The baseline surveys for individual biological sub-factors were used as the data basis for the Baseline investigation of the EIA-report in recording biodiversity in the marine area (EIA-report, Attachment 15 of the plan approval documents, Volume II B, Section 3.12). Newly-gathered data on these environmental sub-factors are evaluated in the new Annex C EIA-report, Attachment 15 of the plan approval documents: planktic flora and fauna (Section 3.2.5), benthic flora (Section 3.2.6), benthic fauna (Section 3.2.7), benthic habitats (Section 3.2.8), fish (Section 2.1.9), marine mammals (Section 3.2.10) and resting birds (Section 3.2.11). In addition, Annex C, Section 4.1, contains additional explanations related to the area of biodiversity. The data relating to the environmental sub-factors listed above are assessed as being current in their respective sections. They are therefore suitable for use in describing biodiversity.

#### Baseline investigation goals and methods

- Information on the diversity/biodiversity between the species and the diversity of habitats or ecosystems in the marine investigation area.
- Methods: summarised description of the biodiversity in the marine area from the Baseline investigations of the individually assessed abiotic and biotic (sub-) environmental factors.

#### Key findings of the Baseline investigation and evaluation

The Fehmarnbelt plays an important role in biodiversity because approx. 70% of the water exchange to the actual inner Baltic Sea flows through this water channel. This means that the biodiversity of the interior of the Baltic Sea is heavily dependent on ecological conditions and biodiversity. Certain species of benthic fauna inhabit the waters located to the east of the Fehmarnbelt, although they are incapable of reproducing there. As planktic larva, they mainly drift across the Fehmarnbelt to the area. This "stepping stone function" of the Fehmarnbelt is also used by other species groups. Around one-third of the eels migrating from the Baltic Sea region (sexually mature silver eels) as well as the autumn-spawning herring, the European sprat and the river lamprey use the Fehmarnbelt as a transit route to reproduction sites. For many migrating birds, the Fehmarnbelt is an important migration route because it represents the shortest connection between two landmasses in this section of the Baltic Sea. The eider duck, common scoter and long-tailed duck prefer to migrate across the water. Other species link migration with the search for food on the water.

There is a strong relationship of reciprocal links between the various species groups and they depend upon one another and their habitats. With its various shallow- and deep-water habitats, the Fehmarnbelt forms an area with comparably greater biodiversity on the various trophic and spatial levels. Access here is via the individually assessed environmental (sub-)factors (planktic fauna and flora, benthic flora, benthic fauna, benthic habitats, fish, marine mammals, resting birds and migrating birds) as well as the species it contains and not as is does on land via the conservation areas because in the marine area, only the Natura 2000 areas play a role and the interchange of species is guaranteed by their distribution with the sea current.

The significance of the sub-factors for marine biodiversity cannot be quantified overall in the marine area. In principle, the entire investigation area has the same high level of significance throughout because every loss and every impairment can influence biodiversity. The associated sub-factors are integrated with one another in such a way that project impacts in one location can trigger effects elsewhere because, for instance, fish, birds and mammals are mobile organisms. The significance of all areas should therefore be considered equally high.

During the course of the plausibility check, none of the environmental sub-factors studies, which together account for the biodiversity in this area, has shown that the habitat suitability for any species has been restricted in such a way that there will be no consequences to the manifestation and quality of biodiversity in the investigation area.

### 2.3.13. Landscape (marine area)

(see Section 3.13, Attachment 15 of the plan approval documents, Volume II B)

No new surveys have not been carried out in the marine area with regard to the landscape environmental factor. The open marine and onshore areas were described and evaluated in the Baseline investigation of the EIA-report. Statements on superordinate guide plans and general data bases such as maps and orthophotos (EIA-report, Attachment 15 of the plan approval documents, Volume II, Section 3.13) were used as the basis for this investigation. There have been no significant short-term changes to marine landscape areas in recent years.

#### Baseline investigation goals and methods

- Information on sensory perceptions of above-water manifestations of the marine landscape from the perspective of diversity, unique character and beauty and taking into account previous anthropogenic impairments.
- Methods: documentation of the landscape through on-site data collection and analyses of orthophotos and existing plans and maps of the investigation area.

#### Key findings of the Baseline investigation and evaluation

The central area of the straits of the Fehmarnbelt between the islands of Fehmarn and Lolland has a landscape of unique character and beauty due to the wide open natural surface of the water that prevails despite shipping and, in particular, because there are no fixed installations such as offshore wind farms. The landscape of the open marine area of the Fehmarnbelt is therefore of special significance. The special character and diversity of the coastal marine area off Fehmarn and Lolland with a view of semi-natural and relief-like coastal sections (including beaches and dykes) shape its special natural character and beauty and lend it special significance overall. In individual areas, the semi-natural landscape of the marine area close to the coast is disrupted by technical installations such as the ferry harbours or the visual impact of onshore wind farms.

### 2.3.14. Cultural heritage and other material assets (marine area)

(see Section 3.14 EIA-report, Attachment 15, Volume II B)

No new surveys have not been carried out in the marine area with regard to the cultural heritage and other material assets environmental factor. In the Baseline investigation of the EIA-report, cultural assets were described and evaluated as (isolated) monument-relevant, archaeological finds on the seabed. This was in addition to material assets which have a direct link to the environment or which have some societal value. Statements on superordinate plans, maps, registers and written notes issued by relevant public administrative bodies and existing studies (EIA-report, Attachment 15 of the plan approval documents, Volume II, Section 3.14) were used as the basis for this investigation. There have been no significant short-term changes to cultural heritage and material assets in the marine area in recent years.

**Baseline investigation goals and methods**

- Information on significant cultural heritage and other material assets located in the marine section of the investigation area.
- Methods used for cultural heritage assets: Methods for cultural heritage assets: documentation of the marine archaeology by Vjkingeskibsmuseet, Roskilde together with the Schleswig-Holstein State Archaeological Department in a 2 km (in deep water) to 5 km (in shallow water) wide corridor from coast to coast, starting with geophysical investigations of objects on the seabed (including side scan sonar, sediment sonar, geomagnetic investigations) and sampling for sediment investigations to identify potential former settlement remains. After analysis of the data, identification of potentially interesting archaeological objects using divers or diving robots as well as analyses of sediment samples. Determination of the cultural historical importance of individual findings.
- Methods for material assets: Documentation of other material assets using existing land registers and maps and inquiries with authorities.

**Key findings of the Baseline investigation and evaluation**

*Cultural heritage assets*: A shipwreck from the 17th century ("*Lindormen”*) on the German side is the most important archaeological underwater monument in the Schleswig-Holstein Baltic Sea. It has special cultural historical significance due to its good state of preservation, reliable chronological classification and involvement in important northern European wars (Nordic Wars/Thirty Years’ War). There is also a shipwreck on Danish territory which is very likely to be the Dutch ship "*Swarte Arent“*. It relates to the same historical events as the "*Lindormen"* shipwreck described above and also has a high cultural historical value and special significance. An anchor off the Danish coast dated between 1850 and 1920 could also be protected by the Danish Museum Act and has special importance.

*Other material assets.*: An underground cable between Germany and Denmark is classified as having overriding public interest due to its cross-border functions (telecommunication) and thus a material asset with special significance. The areas for sand extraction and deposit are given general significance on the basis of their comparably small scope and relatively good possibilities for replacement (see Plan 9, EIA report, Attachment 15).

### 2.3.15. Soil (Fehmarn)

(see Section 3.15 EIA-report, Attachment 15 of the plan approval documents, Volume II C)

No new surveys have not been carried out on Fehmarn with regard to the soil environmental factor. The Baseline investigation carried out with regard to the soil environmental factor concerns, inter alia, the topics of geological development, soil development and types as well as geotopes. The data basis for the soil baseline survey is made up of the following: Drilling in the abutment area, relevant map series on soil, geology and raw materials as well as the literature associated with the soils found in Schleswig Holstein. It was also based on superordinate plans, databases and land registers concerning the topic of soil as well as data and information supplied by industry associations. In order to gather and assess this data, relevant guidelines and guiding frameworks were also included (EIA-report, Attachment 15 of the plan approval documents, Section 3.15). There have been no events which have caused significant short-term changes to soil in recent years. Therefore, the data basis for the EIA-report is still current.

**Baseline investigation goals and methods**

- Statements on geology, geomorphologically valuable objects, soil types with the key soil parameters.
- Methods: Methods: analysis of existing data and pedological and geological maps. Under the scope of the project, analysis of soil surveys.

**Key findings of the Baseline investigation and evaluation**

In terms of geomorphology, the geomorphologically valuable objects and geotopes (storm beaches and cliffs) in the coastal area have special significance. Raw soils on emerged beach deposits are considered to have special significance because they are very natural and uncommon and are naturally limited to coastal regions. Special significance is also assigned to pseudogley and black chernozem pseudogley called "Fehmarn black earth"because they are naturally very fertile and occur almost everywhere in the investigation area. Fen soils with special significance are also scattered around the Blankenwisch area northwest of Puttgarden. Brown luvisol occurring on a small-scale in the investigation area is also assigned general significance due to average location factors and their extensive distribution (see Plan 2 EIA report, Attachment 15).

### 2.3.16. Water (Fehmarn)

(see Section 3.16, Attachment 15 of the plan approval documents, Volume II C)

No new surveys have not been carried out on Fehmarn with regard to the water environmental factor. The Baseline investigation for the water environmental factor is made up of the areas of groundwater, running water and standing bodies of water, including protective strips. The data basis for the water baseline survey is made up of the following: Drilling in the abutment area and the specialist literature associated with the theme of water. It was also based on superordinate plans, databases and land registers concerning the topic of water as well as data and information supplied by industry associations and those authorities responsible for water. In order to gather and assess this data, relevant guidelines and guiding frameworks were also included and surface water investigations carried out (EIA-report, Attachment 15 of the plan approval documents, Section 3.16). There have been no events which have caused significant short-term changes to these parameters in recent years. Therefore, the data basis for the EIA-report is still current.

#### Baseline investigation goals and methods

- Information on groundwater conditions and surface waters in the investigation area.
- Methods: Methods: analysis of existing data and pedological and geological maps. Under the scope of the project, analysis of soil surveys/drillings with respect to water-carrying soil layers. Inspection of the surface waters in the investigation area.

#### Key findings of the Baseline investigation and evaluation

*Groundwater:* Due to its ecological significance, the high groundwater level in the area of the fen soils in the Blankenwisch wetlands is classified as having special significance. In the rest of the investigation area, locally limited layers containing groundwater are only present at greater depths or close to the surface in some sections. Because, however, it must be assumed from Section 4.2 that, in the boulder clay and marl areas, this groundwater consists of very small areas of local backwater and subterranean water and not a connected aquifer, the region is assigned general significance overall with respect to groundwater (see Plan 3 EIA report, Attachment 15).

*Surface waters:* In the investigation area, the trenches and a small section of the Kopendorf floodplain represent the only flowing waters with special significance for the water supply. Still waters are present mainly in the form of numerous, legally protected small bodies of water in the farmland of the investigation area. There are two estuaries with special significance, also due to their legally protected status, at the "Grüner Brink". The water protection areas on the coast also enjoy special significance due to their legally protected status under §. 35 LNatSchG. There are no drinking water protection areas.

### 2.3.17. Animals (Fehmarn)

(see Section 3.17 EIA-report Attachment 15 of the plan approval documents, Volume II C; Attachment 30.2 of the plan approval documents)

The update mappings shown in Attachment 30.2 of the plan approval documents relate to the LCP investigation area on Fehmarn. Only the update for resting birds relates to the EIA-report investigation area. The results of the 2010/2011 update mapping show that the stock situation for the species groups studied as part of the EIA-report remains essentially unchanged, which means that, for the EIA-report level of the SGA, only changes to the stock situation for resting birds will be analysed in greater detail hereinafter. The results of the mappings carried out as part of the EIA-report remain valid for all other animal species. A detailed explanation of the faunistic stock for the LCP validity area is described from Section 4.2 onwards.

### Baseline investigation goals and methods

- Information on the species groups medium-sized and large mammals, bats, breeding and resting birds, amphibians, reptiles, insects (dragonflies, grasshoppers, butterflies/Zygaenidae, ground beetle, night-flying moths) as well as other strictly protected species in the investigation area in relation to species range, spatial distribution and habitat use.
  Methods: Evaluation of existing data and expert opinions, particularly those pertaining to the Straßenhinterland (can't find this word) connection B 207. As part of the project, species-specific mappings in the investigation area (see following points). Medium-sized and large mammals: analysis of hunting routes and questioning of people who know the area. Bats: overview mapping at evenly distributed sample points. Followed by documentation of the species range and the land use pattern with ultrasound detectors and audio surveys of species-specific orientation calls using bat detectors at selected points. Analysis of data about bat migration. Breeding birds: documentation of the breeding territories of all species. Resting birds: documentation of resting areas through visual observation. Amphibians: documentation of amphibians (spawn, larva, adults) at the potential spawning waters through visual observation, catches with landing nets and small fish traps, audio surveys of the species. Reptiles: transect mappings with artificial hiding places, visual observation. Dragonflies: documentation of the dragonflies at potentially suitable waters through visual observation and net catches, analysis of exuviae (larva skin left over after hatching), dead dragonflies found, larva and egg deposits. Grasshoppers: transect mappings through visual observation and audio surveys of singing males with ultrasound detectors, targeted search for special species. Diurnal butterflies/Zygaenidae: transect mappings through visual observation and net catches. Moths: documenting the moths at reference points with mobile living light traps or presence light systems or bait catches. Ground beetles: transect mappings through ground traps. Other strictly protected species: Targeted search for other species such as dormouse, sand lizard, other butterfly species and wood-dwelling beetles.

### Key findings of the Baseline investigation and evaluation

*Medium-sized and large mammals (without bats):* consistent with the homogenous, habitat features mainly characterised by intensive use in the investigation area, no preferred areas and areas of concentration can be identified and thus the significance does not vary for specific species. There are no long-distance migration routes for mammals in the investigation area. Among medium-sized and large mammals, roe deer and hares are present in high densities in the investigation area. The European otter was not found in the investigation area; they are known to be present 10 km away in Wallnau.

*Bats:* six species were found in the investigation area, but of these only three common species appear regularly (serotine bat, common noctule and common pipistrelle). All in all, the bat fauna in the investigation area is to be considered average. The eight areas documented with higher bat relevance for the environment have medium to low significance. They all serve as hunting habitats for bats. Potential living functions (nursery roosts/winter roosts) are to be expected in the Blankenwisch wetlands and in the settlements. In the project area close to the route, no nursery or winter roosts were found but two mating areas of the common pipistrelle were identified (see Plan 4a/b EIA report, Attachment 15 of the plan approval documents).

*Breeding birds:* 75 breeding bird species were found in the investigation area. There are no breeding bird habitats with very high significance. The beach to the west of the ferry harbour is of high significance. The large-scale breeding bird habitat type of fields with little wood in the investigation area is assigned medium significance due to the low population of the skylark and the only temporary presence of the northern lapwing. Other habitat types with medium significance are the Blankenwisch wetlands, most settlement areas and the ferry harbour and railway systems at Puttgarden. In terms of breeding birds, the rest of the investigation area is of low significance (see Plan 4a/b EIA report, Attachment 15 of the plan approval documents).

*Resting birds:* Two resting places with high significance (southeast of Todendorf, northeast of Landkirchen) were identified for only two of the 26 species of passage migrant birds found in the investigation area (black-headed gull and common gull) (see Plan 4a/b EIA-report, Attachment 15 of the plan approval documents).

Between September 2014 and April 2015, the resting birds on Fehmarn were recorded by a total of 9 mapping exercises carried out over the whole of the EIA-report investigation area. These revealed 40 species with 18,413 individuals. In contrast, the mapping exercise carried out in 2009/10, 26 species of birds with 8,541 individuals were detected. These clear differences can mostly be explained by the different weather conditions in both winters in which the investigation took place. The results of the mappings carried out in Winter 2009/2010 (December to February) were strongly marked by exceptional snowfall. By contrast, the Winter of 2014/2015 was rather mild, for which reason many resting birds remained in the area and wintered on Fehmarn.

As expected, the differences between the mappings carried out in 2009/10 and 2014/15 show that the importance of the intensively-used landscape areas fluctuated widely from year to year. Whereas in the 2009/10 mapping only one area was assigned high importance, this is an intensively-used field meadow located to the southeast of Todendorf and west of the B 207/ E 47 (see Attachment 12.1 of the plan approval documents, Plan 2), the mapping carried out in 2014/15 evaluated two areas as being of high importance for resting birds (Mole Puttgarden, on account of the cormorants and arable land on Nielandsgraben on account of the bean geese; four areas of high importance (arable land to the east of the B 207 on Nielandsgraben on account of the standing stock of common gulls and three areas west of the B 207on account of the greater white-fronted goose, whooper swans and herring gulls). These areas do not overlap with the significant areas identified in the mapping of 2009/10.

*Amphibians*: In the survey, eight species were identified in a total of 208 amphibian waters in the investigation area. With respect to amphibians, the Grüner Brink nature reserves and the Blankenwisch wetlands in conjunction with the connected, newly created waters to the east are by far the most significant area within the investigation area. Six of the total of eight bodies of water with very high significance (4% of the amphibian waters) are situated in this area. In addition, there are another six with high significance in the investigation area (3%). Most waters have only medium (12%) or low significance (81%) due to the limited species range (see Plan 4c/d EIA report, Attachment 15 of the plan approval documents).

*Reptiles:* Reptiles: only one reptile species, the common lizard, was found within the investigation area. The area of the B 207/E 47 railway and road embankment has medium significance as a habitat and functions as an expansion axis and regional habitat (see Plan 4c/d EIA report, Attachment 15 of the plan approval documents).

*Dragonflies:* in the 179 bodies of water studied in the investigation area, 140 dragonflies from a total of 25 species were identified. As many ubiquitous and specialised species are lacking, the dragonfly fauna in the investigation area is just considered to be of medium significance. Four waterways have very high significance (3% of the dragonfly waterways) and eight have high significance (6%). Overall, it was found that the focus of the higher-value dragonfly waterways is situated in the surroundings of Puttgarden and the connected western area of the "Grüner Brink" nature reserves and the Blankenwisch wetlands. The vast majority of the waterways has medium (23%) to low significance (68%) (see Plan 4c/d EIA report, Attachment 15 of the plan approval documents).

*Grasshoppers:* No locations with very high or high significance were identified in the investigation area. There are no locations where species were found which were of high or higher significance. Only two locations were of medium importance (beach to the west of Puttgarden, Presen lowlands). 93% of the locations were of low significance. Special structures suitable for locust habitats are only present on a small-scale in scattered areas. As a result, no extensive habitat can be defined in the plan.

*Diurnal butterflies/Zygaenidae:* A total of 18 non-endangered species were found in the investigated transects. The distribution of the butterfly fauna in the investigation area is below average due to the intensive agricultural use and the associated structural poverty. Of the 27 locations where butterflies were found, six are of medium significance (22%) and 21 of low significance (78%). The lack of any highly specialised species is a clear indication of how intensive use negatively impacts even small disruptive areas in the landscape that often represent refuge habitats elsewhere. No habitats for diurnal butterflies can therefore be defined.

*Moths:* A total of 128 species (large butterflies only) were found in the investigation area. The range of species found is typical for the habitat but classified as below average from a supra-regional point of view. The locations where species were found, Blankenwisch and the shunting yard with a northern and southern section, each have a relatively high percentage of species found only in this location.

*Ground beetles:* a total of 67 species were found in the investigation area. With respect to the ground beetle fauna, the investigation area is characterised as below average. The investigations showed, however, that the B 207/E 47 railway and road embankment functions as a connecting axis for ground beetles with areas of low and medium significance found based on the similar structures of the linear woodlands. Since the investigation focussed on evidence of habitat traditions and connectivity axes, ground beetle habitats were extensively delimited but only the function of the connectivity axes was displayed in a linear manner (see Plan 4c/d EIA-report, Attachment 15 of the plan approval documents).

*Strictly protected species:* all bats and several amphibian species found are strictly protected species according to Annex IV of the Habitats Directive. Neither the dormouse or the sand lizard or other strictly protected butterfly and wood-inhabiting beetle species were found in the investigation area. The European otter was also not found in the investigation area; they are known to be present 10 km away in Wallnau.

### 2.3.18. Plants (Fehmarn)

(see Section 3.18 EIA-report, Attachment 15 of the plan approval documents, Volume II C; Attachment 30.2 of the plan approval documents, Sections 4.1 and 4.2)

As part of the update mappings (Attachment 30.2 of the plan approval documents, Section 4.1), a total of 373 different locations were identified within the LCP investigation area in 2014-15, which were assigned to 57 different biotope types or biotope type combinations in accordance with the new and current standard list on biotope types in Schleswig-Holstein (LLUR 2015).

Although the new mapping cannot be directly compared with the survey carried out in 2009 as a result of the updated biotope type standard list (LLUR 2015), the picture presented is near-identical. As before, the valuable areas generally comprise dune and beach biotopes along the coastline (inc. the cliff near Marienleuchte). There are small bodies of water and hedgerows or field hedges spread all over the investigation area which are subject to biotope protection laws. Given that there were no changes in use in the LCP investigation area in the time period analysed between 2009-2015, no significant changes to the valuable biotope types were expected.

With regard to plants listed on the Red List, the results from the mappings conducted in 2014/15 and 2009 are nearly identical. The number of Red List species detected in the various endangered categories and plant species hidden behind the figures laid out are nearly identical in comparison. Even in 2009, dyer's mayweed, floating heart, ballota nigra and yellow rock rose were found in the same locations. In 2014/15, the common ox tongue was the only endangered species accounted for in Schleswig-Holstein. Given the near-identical plant populations, there are no changes to the evaluation of these locations.

The update mappings shown in Attachment 30.2 of the plan approval documents relate to the LCP investigation area on Fehmarn. The results of the 2010/2011 update mapping show that the stock situation for the biotope types studied as part of the EIA-report remains essentially unchanged, which means that, for the EIA level of the SGA, the results obtained from the mappings conducted as part of the EIA-report are still valid. A detailed explanation of the floristic stock for the LCP validity area is described from Section 4.2.5.1 onwards.

**Baseline investigation goals and methods**

- Information on biotopes, including legally protected biotopes, in accordance with § 30 BNatSchG in conjunction with § 21 LNatSchG, flora/areas of botanical value with regard to characteristics, species range and spatial distribution of the fungus population.
- Methods: Evaluation of the existing data and expert opinions, in particular from records used for the EIA-report and on the B 207 Straßenhinterlandanbindung. Extensive biotope type mapping. Survey of legally protected biotope and plant species listed on the Red List through field work and aerial photo interpretation. Extensive mycological overview mapping focusing on fungus species on the red list and signal types through field surveys.

**Key findings of the Baseline investigation and evaluation**

*Biotope types/biotopes:* 87 different biotope types from the standard list of biotope types in Schleswig-Holstein (LANU 2003) were found in the investigation area. Agricultural habitats are predominant throughout the area. Significance levels are assigned to the biotope types based on the nature protection value in the "Road construction orientation framework“ (MWAV & MUNF 2004) and taking into account the legal protection status. Legally protected biotopes and biotopes with high significance can be found on larger expanses of land as beach biotopes (here in particular in the area of the Grüner Brink nature reserves, as reed areas in the Blankenwisch wetlands, which are, like the Grüner Brink, part of the "Western and Northern Fehmarn Coast" SPA and the "Eastern Bay of Kiel" SCI) and in scattered or linear areas as small bodies of water (some with shoreline shrubs/reeds) in the farmland and hedgerows or avenue of trees. The unused railway areas south of the ferry harbour and the alder/birch forests of the Blankenwisch wetlands are classified as having high significance (see Plan 5a/b EIA report, Attachment 15). The biotope types of the rows of trees, forests, bushes and field hedges as well as mesophilic grassland, dyke grasslands and (ruderal) meadows that are usually distributed over a small-scale throughout the investigation area are of medium significance. Due to the high percentage of farmland in the investigation area, large areas of land have low significance from the perspective of biotope protection.

*Plants:* 41 plant species from the Schleswig-Holstein red list and 30 species from the endangered species list were found in the investigation area; in addition, 15 of the species found appear on the red list of the Federal Republic of Germany. High significance was assigned to two areas where plant species were found from a floristic/botanical perspective (unused railway track areas south of the Puttgarden ferry harbour, grey dunes south of Marienleuchte). Four of the habitats with plant species – mainly coastal locations – have high significance. In addition, 41 locations have medium significance; low significance was assigned to 297 areas with respect to the floristic features for plant species on the red list. Locations not found to have plant species appearing on the Schleswig-Holstein red list were not analysed (see Plan 5a/b EIA report, Attachment 15).

*Fungi:* A total of 93 fungus taxons were found in 22 locations in the investigation area. Eight were found for the first time in Schleswig-Holstein which, however, must be qualified by the incomplete knowledge about fungi overall at state level. One species in danger of extinction, three critically endangered species and three endangered species were found. The focus of the valuable fungi growing in the investigation area is the large-scale biotope complexes of the Grüner Brink nature reserves and the Blankenwisch wetlands with highly significant levels. In addition, there are many small-scale biotopes with fungi of low to medium significance on the northern section of the coast, also in relation to the rest of the investigation area, although from a mycological perspective, there are very few noteworthy small structures east of the B 207/E 47 apart from the population on the steep coast and near Presen.

### 2.3.19. Biodiversity (Fehmarn)

(see Section 3.19, Attachment 15 of the plan approval documents, Volume II C)

The aspects of genetic diversity, species diversity and ecosystem diversity were used to survey biodiversity on Fehmarn as the data basis for the Baseline investigation for the EIA-report. To do this, broad reference was made to the inventory data for the environmental factors of flora and fauna. The data for soil and water was also used for site conditions for flora and fauna. When the data obtained from the survey years 2009/10 is compared with that obtained in 2014/15, it can be determined that these environmental sub-factors are current and, therefore, are suitable for use in the sections on biodiversity.

#### Baseline investigation goals and methods

- Information on the diversity/biodiversity between the species and the diversity of habitats or ecosystems in the investigation area.
- Methods: Methods: summarised description of the biodiversity based on the environmental factors flora, fauna, soil, water and the protected areas, biotope network structures, biotope complexes and functional spaces as an instrument to ensure biodiversity.

#### Key findings of the Baseline investigation and evaluation

On Fehmarn and in the investigation area, the protected areas founded for nature conservation (SCIs, SPAs, nature reserves) and the
biotope network planning for the state of Schleswig-Holstein and thus also the more significant areas for biodiversity are concentrated on and near the coasts. The biotope complex beach/dyke north of Puttgarden, the Grüner Brink nature reserves and the adjacent northern marine lowlands as part of the Natura 2000 sites DE 1532-391 and DE 1530-491 are classified as having very high significance. The Blankenwisch „marshlands“ and the beach to the south of Marienleuchte with a coastal cliff area near Marienleuchte are of great importance for

biodiversity. In the area affected by the project, the beach section lies between Puttgarden and Marienleuchte with a section of steep cliffs. The value of the sections as a (potential) dispersal line and as a biotope network structure is very limited as a result of the fragmentation of Marienleuchte and the Puttgarden ferry harbour (medium significance). The bird migration route with the railway/B 207 functions as a faunistic functional area for individual species and is of medium significance for the biodiversity of Fehmarn with the biotope types of the slopes and peripheral structures – compared to the adjacent farmland (see Plan 6 EIA report, Attachment 15).

Outside of the protected area systems, biodiversity is covered in particular by the focus on special species protection (see impact assessment of certain strictly protected species as a separate document, Attachment 21).

### 2.3.20. Landscape (Fehmarn)

(see Section 3.20 EIA report, Attachment 15, Volume II C)

No new surveys have not been carried out on Fehmarn with regard to the landscape environmental factor. There have been no significant short-term changes to landscape areas on Fehmarn in recent years, which means that the evaluation results in the EIA-report are still current.

**Baseline investigation goals and methods**

- Information on landscape types and areas, their landscape quality (visual, natural, aesthetic and cultural-historical aspects) as well as the visual sensitivity.
- Methods: analysis of existing documents. Under the scope of the project, terrain inspections, photo analyses, analysis of aerial images and topographic maps, analysis of the biotope type mapping as well as the information on the other environmental factors investigated.

**Key findings of the Baseline investigation and evaluation**

The coastal landscapes in the investigation area are highly diverse, unique and beautiful thanks to their natural features, the views of the Baltic Sea and the high experiential quality. Overall, they have very high significance in relation to the environmental factor landscape. The low-lying landscapes of the Blankenwisch wetlands and near Presen as well as the special tree-lined structure on the K 49 are assigned high significance. Individual locations with a relatively high proportion of green areas, low building density, alternating residential buildings and agricultural farms and/or some historical buildings and structures are also highly significant. Newer settlement areas are of medium or low significance for the visual appearance of the town. Cleared farm landscapes are assigned low significance while farm landscapes with a view of the Baltic Sea or highly structured agricultural landscapes with a high portion of wooded areas, hedgerows and grasslands have medium significance. The "bird migration route" including the railway/B 207 functions as a kind of backdrop for the surrounding landscape thanks to its accompanying vegetation structures and thus has medium landscape significance (see Plan 7 EIA report, Attachment 15).

### 2.3.21. Cultural heritage and other material assets (Fehmarn)

(see Section 3.21, Attachment 15 of the plan approval documents, Volume II C)

No new surveys have not been carried out on Fehmarn with regard to the cultural heritage and other material assets environmental factor. According to current scientific knowledge, there have been no significant short-term changes to cultural heritage and other material assets in recent years, which means that, with regard to the cultural heritage and other material assets environmental factor, the evaluation results in the EIA-report are still current.

#### Baseline investigation goals and methods

- Information on areas and objects relevant for the purpose of heritage conservation, such as historical monuments, archaeological monuments and sites, historical land use forms, historical cultural landscapes and cultural landscape parts in the investigation area.
- Information on existing, significant material assets such as overarching transport infrastructures, supply systems and wind farms in the investigation area.
- Methods: Analysis of documents from the authorities for the protection of historic buildings and monuments, topographic and historical maps and own evidence gathered on location.

#### Key findings of the Baseline investigation and evaluation

*Cultural heritage assets:* Extensive, connected historical cultural landscapes with homogenous historical cultural landscapes and elements are not present in the investigation area. As listed historical monuments under Art. 5 Denkmalschutzgesetz (DSchG, Preservation of Historical Monuments Act), the historical lighthouse in Marienleuchte and the Bannesdorf church are of very high significance. Individual buildings as simple historical monuments as well as the old "Fortadorf" structures in the towns have high significance for cultural heritage. The former site of the Peter-and-Paul chapel is assigned medium significance. There are no archaeological monuments in the investigation area but it is assigned at least low significance due to the possibility of archaeological findings (see Plan 8 EIA report, Attachment 15).

*Other material assets.:* due to its outstanding protective function, the storm surge dyke is considered to be a material asset of very high significance. Transport infrastructure such as harbour facilities, the federal/European road and the railway line with overarching public function is considered a highly significant material asset. Significant material assets such as large-scale wind farms, the radio tower and the new Marienleuchte lighthouse are of medium significance. Other less significant material assets such as the parking lots on the outskirts or simple municipal supply and disposal facilities are assigned a low level of significance.

### 2.3.22. Bird migration (overall project)

(see Section 3.22, Attachment 15 of the plan approval documents, Volume II C)

When putting together the EIA-report, extensive investigations were conducted on bird migration in the Fehmarnbelt and a highly detailed data basis was produced. Because of this, the EIA-report is based on the best data basis available with regard to bird migration in the Fehmarnbelt. Since the impairments to bird migration one would expect to be caused by the construction and use of a tunnel have been classified as being low, bird migrations are not considered further in this update investigation.

**Baseline investigation goals and methods**

- Information on the composition, number, flock size and fight routes, altitudes and characteristics as well as daily and annual distribution of individual birds and flocks of birds for bird migration across the Fehmarnbelt, taking into account meteorological factors and the documentation of local exchange patterns between resting and feeding areas.
- Analysis of existing data on bird migration. Under the scope of the project, visual and radar observation as well as acoustic surveys in the area of the Fehmarnbelt during migration months and from onshore stations and ships during the moulting period.

**Key findings of the Baseline investigation and evaluation**

The Fehmarnbelt is of international significance for a large number of migrating bird species. During the Baseline investigations, 230 bird species that migrate through the Fehmarnbelt were documented. Of these, 47 bird species are species in Annex I of the VSchRL (Birds Directive), four species are globally threatened European species ("SPEC1 species"), 20 species whose population is concentrated in Europe and which have an unfavourable conservation status in Europe ("SPEC2 species") and 51 species whose population is concentrated outside of Europe but which have an unfavourable conservation status in Europe ("SPEC3 species").

In relation to the migrating birds, two criteria complexes are combined for the assessment of the species-specific significance: the population of the species migrating over the Fehmarnbelt in proportion to the biogeographic population of the species and the endangered status of the species as indicated above. The recognised criterion for the international importance in the sense of the Ramsar Convention is used as the basis for population-related importance. According to this, areas are classified with the highest significance if they are home to at least 1% of the biogeographic population of a species which can also be transferred to flight corridors.

Table 21 shows the significance of the migrating bird species found in relation to the entire investigation area of the Fehmarnbelt.

**Table 21: Significance of the passage migrant birds found in the investigation area in relation to the Fehmarnbelt**

| Significance * | Species |
|---|---|
| Very high | Gannets/Arctic divers, cormorants, white stork, grey goose, barnacle goose, brent goose, northern pintail, eider duck, black scoter, red-breasted merganser, European honey buzzard, black kite, red kite, white-tailed eagle, western marsh harrier, sparrow-hawk, common buzzard, osprey, shaheen falcon, crane, red knot, dunlin, bar-tailed god-wit, Eurasian curlew, little gull, sandwich tern, stock dove, wood pigeon, woodlark, grey wagtail, rook, European serin, European goldfinch, common linnet, twite |
| High | Horned grebe, Bewick's swan, whooper swan, gadwall, shoveller, greater scaup, north-ern harrier, common kestrel, merlin, avocet, European golden plover, common gull, com-mon tern/Arctic tern, little tern, skylark, barn swallow, common house martin, starling |
| Medium | Red-necked grebe, mute swan, bean goose, Eurasian wigeon, black-bellied plover, black-headed gull, European herring gull, great black-backed gull, meadow pipit, Scandi-navian rock pipit, yellow wagtail, jackdaw, fink species, green finch, Eurasian siskin, owls* (tawny owl, long-eared owl, short-eared owl), songbirds that migrate mainly at night* (Eurasian wryneck, tawny pipit, red-throated pipit, wren, thrush nightingale, com-mon redstart, winchat, ring ouzel, sedge warbler, marsh warbler, Acrocephalus warbler, icterine warbler, whitethroat, common whitethroat, Eurasian blackcap, greenish warbler, wood warbler, common firecrest, spotted flycatcher, red-breasted flycatcher, European pied flycatcher, European treecreeper, short-toed treecreeper, red-backed shrike, north-ern shrike, Lapland longspur, snow bunting, Ortolan bunting, corn bunting) |
| Low | Great crested grebe, northern gannet, great egret, grey heron, greater white-fronted goose, barnacle goose, Eurasian teal, mallard, Garganey, common pochard, tufted duck, long-tailed duck, velvet scoter, common goldeneye, common merganser, rough-legged buzzard, Eurasian hobby, Eurasian oystercatcher, little ringed plover, common ringed plover, northern lapwing, sanderling, curlew sandpiper, ruff, common snipe, whimbrel, spotted redshank, common redshank, common greenshank, green sandpiper, wood sandpiper, common sandpiper, ruddy turnstone, Mediterranean gull, lesser black-backed gull, black tern, common murre, razorbill, Eurasian collared dove, common cuckoo, swift, great spotted woodpecker, sand martin, tree pipit, white wagtail, Bohe-mian waxwing, dunnock, European robin, black redstart, northern wheatear, blackbird, fieldfare, song thrush, redwing, mistle thrush, garden warbler, chiffchaff, willow warbler, goldcrest, bearded reedling, long-tailed tit, coal tit, blue tit, great tit, Eurasian jay, Eura-sian magpie, carrion crow, house sparrow, Eurasian tree sparrow, chaffinch, brambling, common redpoll, red crossbill, parrot crossbill, Eurasian bullfinch, hawfinch, yellowham-mer, common reed bunting |

* For 32 species that migrate at night (owls and most songbirds), it is not possible to derive the significance in relation to the abundance because no quantitative data is available. Owls are not characteristically migratory birds and a concentration of birds that migrate at night is generally not expected in the Fehmarnbelt; broad-front migration is assumed instead. It is recommended to classify species for which no quantitative data is available as having medium significance.

The results of the investigations show that the Fehmarnbelt region is of very high to high significance for a range of species from different ecological groups and with varying migration strategies. The area is very important to land birds which migrate during the day, especially birds of prey, pigeons and also song birds which migrate during the day, crossing the Fehmarnbelt between Lolland and Fehmarn at the shortest point. For several of these species, including those with a highly endangered status, a high to very high portion of the Scandinavian breeding birds migrates along what is known as the bird migration route.

Furthermore, very large to large proportions of the populations of a number of water bird species migrate through the Fehmarnbelt. The Fehmarnbelt serves as a migratory corridor for these species, which tend to migrate across the sea and cross as little land as possible. This is particularly true for diving birds and sea ducks but also large parts of the tern and little gull populations. In addition, a series of water bird species with mixed migration strategies such as geese and waders were counted which led to the classification of the area's significance as very high or high. The Fehmarnbelt is on the most important flight path for these species between their roosting sites at the mudflats and their breeding grounds in the north. For land birds that migrate at night – the group of birds migrating through the region with the largest number of individual species – no species-specific quantitative data is available. It is assumed that these species fly over the region in a broad front. If the migratory rates identified in the area of the planned project are placed in proportion to the very large population numbers, the figures indicate only low significance. Because this data is still subject to considerable uncertainty, medium significance is assumed as a precaution (see comment on Table 21).

### 2.3.23. Bat migration (overall project)

(see Section 3.23 EIA-report, Attachment 15 of the plan approval documents, Volume II C; Attachment 30.2 of the plan approval documents, Section 4.7.1.4)

Special investigations on bat migration over the Fehmarnbelt were carried out for the EIA-report. Overall, migration in the area of the Fehmarnbelt Fixed Link should be classified as conservative. Investigations carried out as part of the EIA-report showed massive migration over the Grüner Brink and Katharinenhof. This would indicate either a broad-front migration or a stronger migration along the coastline. In contrast, migration over the island body and, in particular, the area of the FBFL is significantly more limited which means that there is nothing of significance here (Attachment 30.2 of the plan approval documents, Section 4.7.1.4).

#### Baseline investigation goals and methods

- Information on characteristics, intensity, species composition and flight-specific species behaviour in relation to a potential migration of bats across the Fehmarnbelt between Scandinavia and Germany during the migration periods in spring and autumn taking into account the weather conditions.
- Methods: Methods: documentation of bats across the Fehmarnbelt with ultrasound detectors of radar ships (including with an ultrasound detector kite system for the purpose of documenting a potential high-level bat migration) and ferries equipped with a combination of GPS receivers and ultrasound detectors; documentation of bats on the coastlines of Fehmarn and Lolland by means of detector inspections, stationary ultrasound detectors (AnaBats) and bat box inspections.

#### Key findings of the Baseline investigation and evaluation

The investigations documented activity of a total of ten bat species (six bat species in the Fehmarnbelt and four others in the coastal areas). A migratory pattern was found for the three species Nathusius' pipistrelle, soprano pipistrelle and common noctule taking into account the phenology of the species, the departures observed on the coasts and offshore directional flights found in the expected primary migration direction. The Nathusius' pipistrelle accounted for the majority of the observations.

Protracted periods of maximum activity of the three species were found to occur in particular in the autumn and, to a much lesser extent and for shorter periods, in the spring. Particularly low activity was registered during the summer months. An initial assessment of other studies shows that bats probably use the same migratory routes as migratory birds. As there are no guidelines for either the sea or the Fehmarnbelt and bats were found at all locations investigated within the Fehmarnbelt, it is assumed that the bats cross large areas of open water and the Fehmarnbelt in a broad front.

It is difficult to assess the importance of the Fehmarnbelt in terms of migration intensity and importance as a migration space because there are only a few comparable studies of bat migration in Europe. An evaluation of the significance has to be qualitative because the number and abundance of crossing bats cannot be determined. No four-level assessment is made because there are no knowledge base or recognised assessment schemes. Instead, a two-level scale is used to assess the significance of the Fehmarnbelt:

- The Fehmarnbelt is deemed to be of special significance for a species if a special migration route can be assumed to exist for that species between Lolland and Fehmarn.
- The Fehmarnbelt is deemed to be of general significance for a species if a bat migration between Lolland and Fehmarn is identified but there was no indication of a special migration route.

In this respect, general significance is assigned for the three bat species Nathusius' pipistrelle, common noctule and soprano pipistrelle for the Fehmarnbelt because it must be assumed that they cross the Fehmarnbelt across a broad front.

### 2.3.24. Climate/air (overall project)

No new surveys have not been carried out on Fehmarn with regard to the climate and air environmental factors. The only new data obtained which have any interest for climate and air consists of wind data. The focus here was on the regional and local areas. Superordinate plans, measurements and calculations of pollutants and noise emissions were conducted on the Island of Fehmarn to form a data basis for the Baseline investigation. In addition, data supplied by the meteorological service was used as well as, guidelines, guiding frameworks, instructions and relevant literature were also included (EIA-report, Attachment 15 of the plan approval documents, Volume II C, Section 3.24). There have been no significant short-term changes to the climate/air environmental factors areas on Fehmarn in recent years, which means that the evaluation results in the EIA-report are still plausible.

#### Regional climate

(see Section 3.24.3, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Description of the overarching regional climate events of the (western) Baltic Sea region.
- Analysis of existing weather and air quality data. Under the scope of the project, determining pollutants in the Fehmarn investigation area.

*Key findings of the Baseline investigation and evaluation*

In the investigation area, local climate events are largely determined by the regional climate of the (western) Baltic Sea region; as a result, the first step is to provide a general climate assessment for the entire onshore and offshore area. The regional climate in the (western) Baltic Sea region can be described as mild and oceanic with moderate humidity (cool summers and mild winters onshore, above average temperatures for the interior due to heat storage from the Baltic Sea from July until winter). The predominantly westerly weather and wind conditions create a leeward effect in the Baltic Sea which means there is less precipitation here than in the areas further west. This results in low cloud cover and long hours of sunshine (1,700 to 1,800 hours/year) in the area of Fehmarn. The climate in the area of the Baltic Sea is also called a bracing climate because the weather elements such as wind and storms and the clear, clean air help to improve people’s health.

The regional climate in the (western) Baltic Sea region itself is not assessed because assessments of the environmental factor climate are more oriented around the local climate conditions such as impact and compensation areas. Due to the lack of pollution, the air in the Baltic Sea region in general and in the Fehmarnbelt region is very clean, a factor which is of special significance for the environmental factor air.

**Fehmarn (local climate)**

(see Section 3.24.3.2, Attachment 15 of the plan approval documents, Volume II C)

No new surveys have not been carried out on Fehmarn with regard to the climate and air environmental factors. The only new data obtained which have any interest for climate and air consists of wind data which is described in Section 2.3.2 under hydrography and water quality. Climate and air were considered together in the EIA-report as they are closely linked to one another. The focus here was on the regional and local areas. Superordinate plans, measurements and calculations of pollutants and noise emissions were conducted on the Island of Fehmarn to form a data basis for the Baseline investigation. In addition, data supplied by the meteorological service was used as well as, guidelines, guiding frameworks, instructions and relevant literature were also included (EIA-report, Attachment 15 of the plan approval documents, Volume II C, Section 3.24).

With regard to impairment of the climate/air environmental factor on Fehmarn, it is worth mentioning that the traffic forecast for the Fehmarn Fixed Link and, consequently, studies conducted on pollutants, inter alia, were updated in the context of the LCP. There were, however, no significant changes recorded, for which reason the corresponding statements from the EIA-report pertaining to significant changes can be eliminated (see EIA-report, Attachment 15 of the plan approval documents, Appendix C, Section 3.4.3).

There have been no significant short-term changes to the climate/air environmental factors areas on Fehmarn in recent years, which means that the evaluation results in the EIA-report are still plausible.

*Baseline investigation goals and methods*

- Information on climatic parameters on Fehmarn and derivation of local climate functions as well as information on air quality for the investigation area.
- Methods: Analysis of existing weather and air quality data. Under the scope of the project, determining pollutants in the Fehmarn investigation area.

*Key findings of the Baseline investigation and evaluation*

When assessing the local climate, the modifying influence of the topography on the regional climate is usually described. Dueto the very low topographical differences on the island of Fehmarn and the very strong effect of the climate of the (western) Baltic Sea on the weather and the air, hardly any differences were found between the local and regional climates. Special local climate situations in the area of settlements in the sense of an "urban climate" are not present due to the rural structure of the area. In addition, there are no significant wooded areas with their own microclimates that generate fresh air in the investigation area. No areas with functions relating to the local climate can be defined or assessed due to the major impact of the regional climate on the investigation area described above and the lack of special microclimatic conditions.

Thanks to the dominating marine climate with plenty of wind and a lack of industrial use, air quality on Fehmarn is very good.

### 2.3.25. Interactions

(see Section 3.25, Attachment 15 of the plan approval documents, Volume II C)

**Baseline investigation goals and methods**

- Information on "interaction complexes" in the onshore and offshore area that reflect interactions between spatially adjacent and separate ecosystems. Existing interactions within the environmental factors and interactions between environmental factors are generally already adequately documented in the Baseline investigation and description of the individual environmental factors.
- Methods: Definition of important existing "interaction complexes" in the investigation area through a cross-factor overview of the key interdependencies.

**Key findings of the Baseline investigation and evaluation**

The following interaction complexes can be identified in the investigation area of the Fehmarnbelt Fixed Link:

- Marine area: In the Fehmarnbelt itself, there are a variety of interactions between the hydrographic conditions (current conditions, water exchange, water quality, salinity, etc.), marine habitat types, maritime flora (plankton, macroalgae, etc.), maritime fauna (e.g. feeding and resting places of water birds, habitats of marine mammals, fish spawning grounds, benthic fauna, etc.) and seabed conditions. The two most important interfaces between the environmental factors are the food chain and the habitat function. Interactions also exist in the lifecycle of the different flora and fauna groups.
- Coastal landscape on Fehmarn: Coastal landscape on Fehmarn: interactions between marine and terrestrial, biotic and abiotic structures and the (land) use (use for recreation, coastal defences etc.) in the transitional zone between sea and coast.
- Low-lying areas and wetlands on Fehmarn - "Blankenwisch Wetlands": interactions between fauna, flora, land use (humans) and abiotic structures, particularly the water supply.

As the environmental factors were all handled correctly in terms of their significance before it came to processing the interactions, it is not necessary to determine additional parameters for the significance of the interactions. The analysis of the interaction complexes and the interpretation of their system structure aims instead to determine whether effects could arise that have to be considered beyond the assessment of the environmental factors.

### 2.3.26. Environmental factors on Lolland (for information only)

There is no new information regarding the environmental factors on Lolland, not have there been any known changes. Therefore, the current data basis is still current.

#### 2.3.26.1. Human beings/human health

(see Section 3.26.1, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Information on the key areas and functions of living and recreation including the areas of work (e.g. commerce, operations) and supply (e.g. basic social functions) in the investigation area.
- Methods: analysis of existing documents, particularly analysis of the municipal plan of the municipality of Lolland in the investigation area.

*Key findings of the Baseline investigation and evaluation*

*Residential:* the settlement structure of the investigation area is primarily a rural one consisting of individual farms. The municipalities of Rødby and Rødbyhavn are located to the west of the E 47. The areas used primarily for residences in the cities are extremely significant as are individual farms due to their permanent residential functions with respect to human health and well-being. Facilities with basic social functions and areas with a public function (e.g. schools, pre-schools, medical facilities, churches, etc.) also have high significance for the people in the surrounding area.

There are three holiday home areas in the investigation area (Bredfjed, Hyldtofte, Lalandia). The residences registered here can almost be completely ascribed to (temporary) living functions; there is also a campsite in the northern part of the investigation area. Campsites and weekend/holiday homes are classified as highly significant. Workplaces on Lolland with more than 50 employees are also classified as having high significance, while workplaces with fewer than 50 employees are assigned medium significance.
The residential area (generally 500 m around connected settlement areas and individual buildings) represents a distance in which the transition from built up areas to open landscapes is clear and there is potential for recreation. Residential areas are of medium significance for the living function.

*Recreation:* the significance of this sub-factor was assessed on the basis of proximity to nature, accessibility and the proximity to residential areas and is related both to use by the local population and by tourists.

Areas highly significant for recreation in the investigation area such as bathing beaches with parking spaces, the dyke with its hiking trail and cycle path as well as the semi-natural areas behind the dyke are located on the coast. Also classified as highly significant are wooded areas in the investigation area that are popular destinations for excursions despite their low number and size, a golf course west of Lalandia, the sailing harbour, overnight accommodation in the Rødbyhavn harbour and fishing ponds. The municipal plan also designates a special recreational area that stretches from the dyke of Rødbyhavn to Hyllekrog and Østersøbadet.

Recreation options not dependent on a specific location, e.g. the go-cart track, are of medium significance. Medium significance is also assigned to facilities that increase the recreational value or function but do not themselves possess an experiential value (e.g. train station, ferry harbour, overlooks) and landscape sections with limited recreational functions (e.g. coasts without special possibilities for swimming).

*Tourism aspects related to the entire region of Lolland-Falster:* compared to other areas in the Sjælland region, the Lolland-Falster area, particularly the island of Lolland, plays a leading role in tourism. In terms of tourism in Denmark as a whole, however, it only accounts for a relatively low percentage of 2.8%. The direct tourism industry in the Lolland-Falster region comprises 62 companies. In 2007, 894,900 guests stayed overnight on Lolland, most of them in the investigation area in the Lalandia holiday centre, which alone accommodates 700,000 overnight stays per year. The recreational activities primarily involve bathing, water sports, use of the hiking and cycle trails and activities offered by the Lalandia holiday centre.

#### 2.3.26.2. Soil

(see Section 3.26.2, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Information on geology and soil types
- Methods: analysis of existing data, pedological and geological maps and aerial images.

*Key findings of the Baseline investigation and evaluation*

Soils with special significance include the Holocene soils such as fen soils and soils from salt and freshwater deposits of the low-lying lands that are concentrated in the investigation area in the coastal area, behind the dyke and in the west of the investigation area. They are considered valuable on the basis of their cultural-historical and landscape-ecological aspects. Classified with general significance are soils from the original material of the base moraine because they are very widespread in Denmark.

### 2.3.26.3. Water

(see Section 3.26.3, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Information on groundwater conditions and surface waters in the investigation area.
- Methods: Methods: analysis of existing data and pedological and geological maps. Under the scope of the project, analysis of soil surveys/drillings with respect to water-carrying soil layers. Inspection of the surface waters in the investigation area.

*Key findings of the Baseline investigation and evaluation*

*Groundwater:* No groundwater and drinking water samples were taken in the investigation area. The groundwater close to the surface in the low-lying areas of the former Rødby Fjord has a special ecological significance while the remaining areas are assigned general significance.

*Surface waters:* the system of flowing waters in the investigation area of Lolland is comprised mainly of artificially created trenches and strictly regulated watercourses. Watercourses with average water quality and biologic value are of medium significance, and heavily polluted trenches and watercourses of low significance.

The Strandholm Sø with its abundance of water plants is assigned high significance. The Stengård Sø with its steep slopes and sparse water plant vegetation, on the other hand, is classified as having low significance. The significance of the pools and ponds is assessed as part of the environmental factors flora and fauna.

### 2.3.26.4. Climate

(see Section 3.26.4 EIA-Report, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Information on climatic parameters on Lolland and derivation of local climate functions as well as information on air quality for the investigation area.
- Methods: Analysis of existing weather and air quality data. Under the scope of the project, determining existing pollutants in the Lolland investigation area.

*Key findings of the Baseline investigation and evaluation*

When assessing the local climate, the modifying influence of the topography on the regional climate is usually described. Dueto the very low topographical differences on the island of Lolland and the very strong effect of the climate of the (western) Baltic Sea on the weather and the air, hardly any differences were found between the local and regional climates. No areas with functions relating to the local climate can be defined or assessed due to the major impact of the regional climate in the investigation area described above and the lack of special micro-climatic differences.

The air quality in the entire onshore area of Lolland is of special significance because it is a largely unpolluted area.

### 2.3.26.5. Flora and fauna, biodiversity

(see Section 3.26.5 EIA-REPORT, Attachment 15 of the plan approval documents, Volume II C)

The environmental factors fauna, flora and biodiversity are described together in one section because, in particular, the assessment of the investigation areas on Lolland was performed for all three environmental factors together.

*Baseline investigation goals and methods*

- Information on the biotope types and the species groups of mammals including bats, breeding birds, resting birds, reptiles, amphibians, insects (dragonflies, grasshoppers, butterflies/Zygaenidae and night-flying moths, ground beetles), flowering plants, mosses and lichens, fungi and biodiversity in relation to species range, spatial distribution and habitat use.
- Methods: Methods: analysis of existing data and reports. Under the scope of the project, preselection of 291 sites that could be potentially significant for fauna and flora in the investigation area, based on aerial images, maps, inspections and expert knowledge, creation of species lists. Targeted documentation of other individual species groups see points below. Biotope types: creation of species lists and documentation of structural characteristics at all sites, derivation of legally protected biotopes in accordance with § 3 of the Danish Nature Conservation Law. Medium-sized and large mammals: documentation of random sightings. Bats: documentation of the species range and the space usage pattern with ultrasound detectors at selected points. Registration of all trees suitable as resting or living places. Breeding and passage migrant birds: Breeding and resting birds: documentation of breeding grounds

and resting birds at 29 sites through visual observations and audio surveys. Amphibians: documentation of the amphibians in potential spawning waters, followed by metapopulation analysis. Reptiles: documentation linked to the biotope mappings. Dragonflies: Documentation of the dragonflies at 19 potentially suitable waterways through visual observations and net catches. Grasshoppers: mappings at five locations by means of visual observation and audio surveys of singing specimens, targeted search for special species. Ground beetles: Transect mappings at five locations by means of ground traps. Diurnal butterflies/Zygaenidae: Transect mappings, targeted search for the willowherb hawkmoth. Flowering plants: Data collection during biotope mapping for species lists. Mosses and lichens: Documenting at potential growth locations. Fungi: systematic documentation in the entire investigation area.

*Key findings of the Baseline investigation and evaluation*

*Medium-sized and large mammals (without bats):* The mammal species common on Lolland – hare (endangered), roe deer, striped field mouse, mole, brown rat and red fox – were recorded as random finds. Among medium-sized and large mammals, hares and roe deer are present in high densities in the investigation area. Consistent with the homogenous habitat features mainly characterised by intensive use in the investigation area, no preferred areas can be identified and thus the significance does not vary for specific species.

*Bats:* Six species were found in the investigation area (Daubenton's bat, Nathusius' pipistrelle, common pipistrelle, soprano pipistrelle, serotine bat and common noctule).
None of these species is classified as rare or endangered in Denmark, but all bat species are listed in Annex IV of the Habitats Directive. Most of the bats found were individual specimens. No accumulations along potential route structures or hunting habitats were found. The areas with the largest number of bat species in relative terms include two wooded areas (within Saksfjed Inddamning and near Byhave Skov) and the abandoned tracks near Rødbyhavn, which were both classified as having high significance. Of the remaining 26 investigation areas, 11 were assigned medium and 15 low significance. No protected nursery roosts or habitats were found during the investigations. However, all potential roosts in old trees or buildings were registered.

*Breeding birds:* 73 breeding bird species were found in the investigation area. The specialised and red list species as well as species in Annex I of the Birds Directive are concentrated in the semi-natural biotopes along the coast, particularly the wetlands behind the dyke. Of 29 locations, the significance of nine locations with occurrences of Annex I bird species was classified as very high, two locations with red list species as high. All other locations are of low significance.

*Resting birds:* Smaller or medium-sized clusters of tufted ducks, widgeons, grey, bean and barnacle geese were encountered in late summer and during the winter mainly in the areas of ponds and wetlands behind the dyke. However, all locations investigated were assessed as having low significance for resting birds. Species listed in Annex I do not appear regularly at any location. Based on the information currently available, clusters of resting birds with international, national or local significance are an exception.

*Amphibians:* In the survey, eight species were identified in a total of 176 amphibian waters in the investigation area. All locations with occurrences of the Annex IV species green toad, agile frog, moor frog and crested newt have very high significance. All other locations where other amphibian species were found are of medium significance.

*Reptiles:* Duringthe course of the investigations, evidence of both the common lizard and grass snake was found. It is likely that the slow worm also exists in the investigation area. Whether the common European adder also appears there is not known.

*Dragonflies:* a total of 24 species were found in the investigation area. The only area in the investigation area found to be significant for dragonflies is the "Ringsebølle Mose" wetlands approximately 2 km west of Rødby, where 17 dragonfly species were found including the stenotopic species hairy dragonfly and yellow-winged darter. All other locations have up to ten dragonfly species and are of low significance.

*Grasshoppers:* A total of eleven grasshopper species were found in the investigation area. Only four areas were investigated because only small parts of the investigation area are suitable as a habitat for grasshoppers. Due to the occurrence of the blue-winged grasshopper, the significance of the abandoned tracks is classified as very high, whereas the other areas are classified as having medium significance.

*Diurnal butterflies/Zygaenidae:* A total of 31 butterfly species and two Zygaenidae were found in the investigation area. Most of the registered butterfly species are concentrated in the area of the dyke, the fallow areas behind the dyke and in the area of the abandoned tracks.

*Ground beetles:* A total of 60 species was found in four sample areas in the investigation area. Most registered ground beetle species are concentrated in the area of the dyke, the fallow areas behind the dyke and along the abandoned tracks. Due to the occurrence of ground beetle species on Denmark's red list, all locations investigated are assigned high significance.

*Biotope types:* In terms of biotope types, a distinction was drawn between flowing waters, lakes and ponds, beaches and dunes, salt marshes, meadows, pastures, wetlands, deciduous forests, ruderal areas/edges of roads and railways, pine forests and forestry plantations, farmland (in use or fallow), settlements and recreational areas (parks, gardens, sports facilities). The legally protected biotopes in the investigation area were also documented. The significance of the biotope types is indirectly incorporated into the overall assessment in the form of the species occurring in them as well as any ecological functions. The biotope types were not assessed for specific environmental factors.

*Flowering plants:* A total of 528 species were registered in the investigation area. In botanical terms, the entire dyke and the adjacent areas to the north constitute a region with many rare plant species in Denmark. These locations are of national significance. Due to the occurrence of plants on the Danish red list, locations north of Hyldtofte Østersøbad and in the area of Saksfjed Inddæmning are classified as having very high significance. The abandoned railway tracks are assigned high significance due to the occurrence of plants that appear on the regional red list of the former Storstrøms country office:

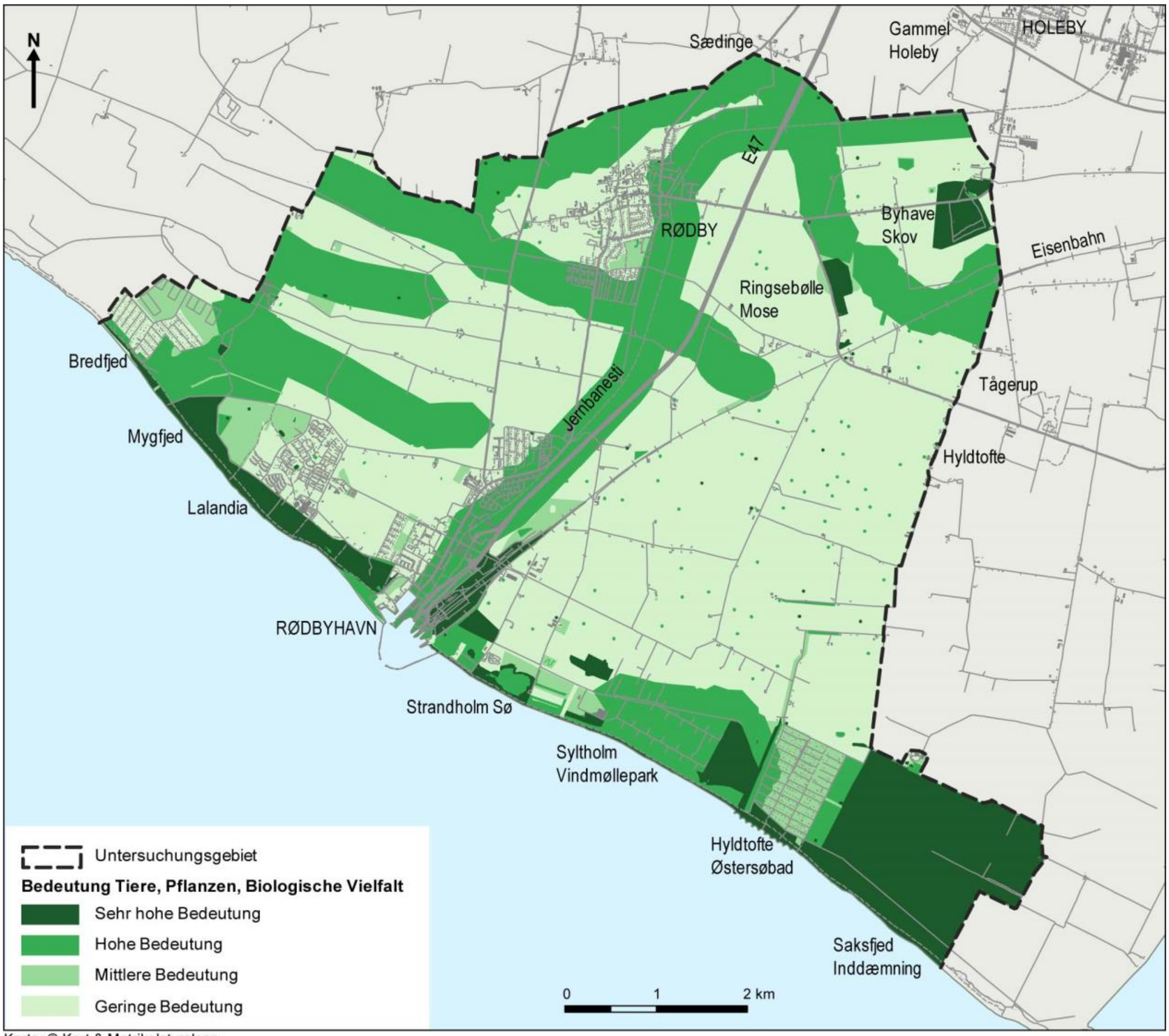
*Mosses and lichens:* 70 mosses were registered in the investigation area. Lichens were investigated in selected areas along the dyke. A total of 19 species of the Cladonia genus were found. The locations investigated were not assessed separately according to the occurrence of mosses and lichens.

*Fungi:* 200 fungus species were found in the investigation area. The fungus flora of the investigation area is generally described as having a low number of species with very few rare species. Due to the occurrence of species on the red list, the five locations dyke near Mygfjed, dyke west of Rødbyhavn, dyke at Syltholm, dyke at Hyldtofte Østersøbad and Saksfjed Inddamning are assigned high significance.

*Biodiversity:* Together with the biotopes surrounding it, the dyke forms a biotope complex along the coast that has the highest biodiversity in the investigation area. One location with a special microclimate and a special range of species is the abandoned railway tracks in Rødbyhavn. The area of Saksfjed Inddamning near the coast constitutes another biotope complex with a high number of species. Within the intensively used agricultural areas in the hinterland, the small forest of Byhave Skov is the only area that features a high level of biodiversity.

In the investigation area, the species-rich biotope complexes along the coast are part of a biotope network. The harbour and town of Rødbyhavn form an axis together with the E 47 and the railway line that interrupts the biotope network in the north-south direction. Further biotope networks in the investigation area are formed by the flowing waters and by the old railway route.

*Overall assessment of the significance of fauna, flora and biodiversity:* The overall assessment takes into consideration all investigated species groups including biodiversity. As with the assessment of biodiversity, the high to very high significance of the coastal biotopes is highlighted in the overview, whereas the agricultural areas have low significance as expected. In the overall assessment of significance, the areas of the biotope network are also assigned high significance (see Figure 25).



Karte: © Kort & Matrikelstyrelsen

**Figure 25 Summarised assessment of the significance of the investigation area for flora fauna, flora and biodiversity on Lolland**

| | |
|---|---|
| Eisenbahn | Railway |
| Jernbanesti | Railway path |
| Untersuchungsgebiet | Investigation area |
| Bedeutung Tiere, Pflanzen, Biologische Vielfalt | Significance of fauna, flora, biodiversity |
| Sehr hohe Bedeutung | Very high significance |
| Hohe Bedeutung | High significance |
| Mittlere Bedeutung | Medium significance |
| Geringe Bedeutung | Low Significance |

## 2.3.26.6. Landscape

(see Section 3.26.6, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Information on landscape types and areas as well as their landscape quality (visual, natural, aesthetic and cultural-historical aspects).
- Methods: analysis of existing documents. Under the scope of the project, documentation of the landscape areas using the "methodology for characterising the landscape" of the Danish Environmental Ministry (Miljøministeriet 2007) by terrain inspections, photo analyses, analysis of aerial images and current and historical maps as well as information on the other environmental factors investigated.

*Key findings of the Baseline investigation and evaluation*

In the investigation area, eight primary landscapes areas were documented that were broken down further, particularly in the area of the coast. To determine the significance of the environmental factor landscape and individual landscape areas, the legal protection status or planning guidelines (e.g. protected areas according to the Lolland municipal plan) as well as the assessment of the landscape qualities with the criteria of the unique character of the landscape, the conditions (including historical continuity, geomorphology, prior impacts) and the visual experiential value (including natural landscape elements, orientation points, spatial impression) are taken into account.

The Saksfjed Inddæmning landscape area is classified as having very high significance because it is protected under nature conservation law. The land in front of the dyke that runs parallel to the coast with Rødbyhavn is a special coastal landscape with natural and cultural characteristics with high significance overall. The drained coastal zone behind the dyke has different sections with high, medium and low significance for the environmental factor landscape. The Lidsø estate has a distinct character and high significance, while the Lungholm and Højbygård estate has certain existing impairments and is assigned medium significance. The characteristics of the Rødby Mark can only be partially identified. As a result, this landscape area is assigned medium significance. The agricultural landscape around Rødby and Bjergemark as well as the industrial landscape of Rødbyhavn is of low significance in terms of the environmental factor landscape (see Figure 26).

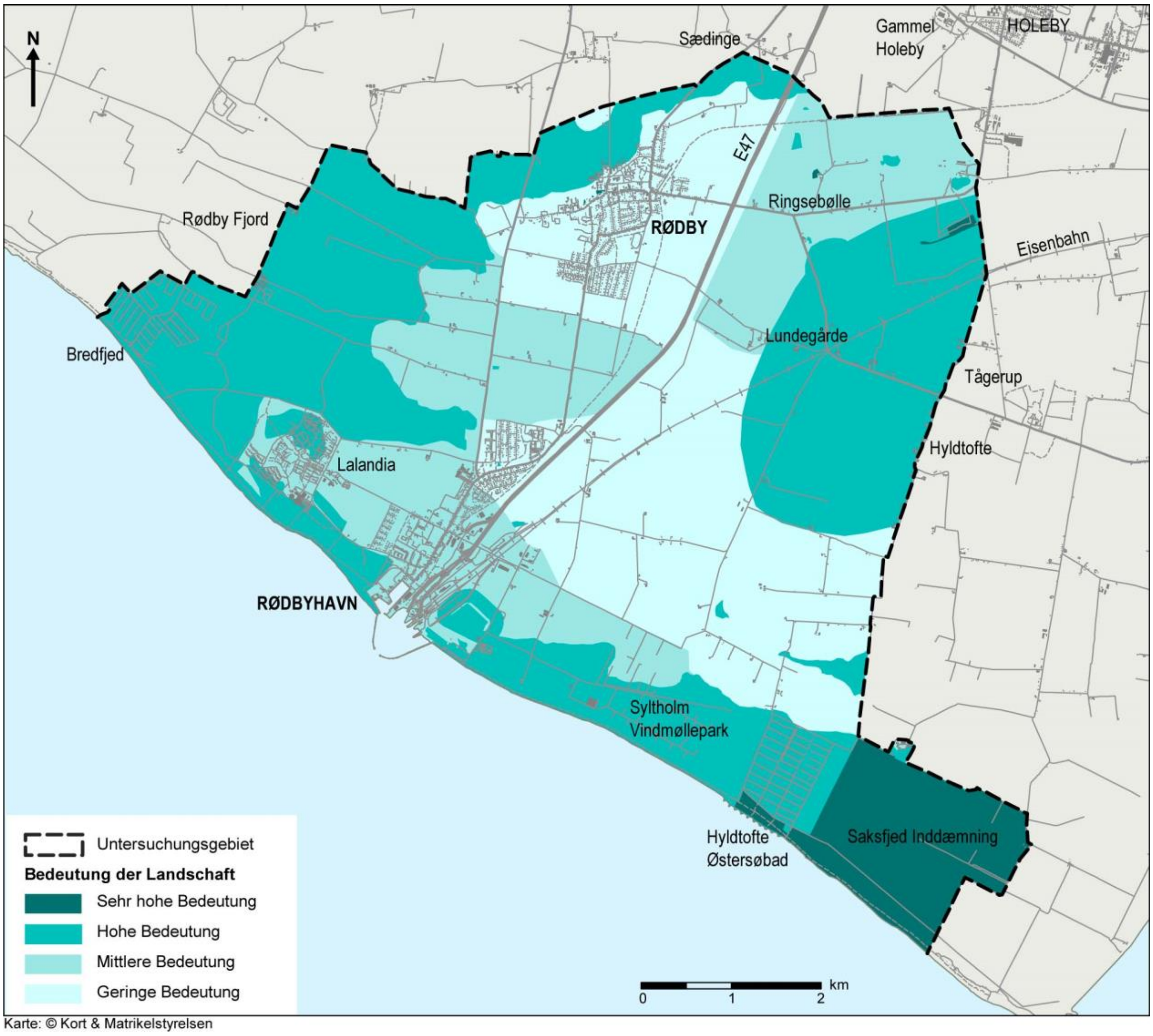



**Figure 26 Significance of the landscape areas on Lolland**

| | |
|---|---|
| Eisenbahn | Railway |
| Untersuchungsgebiet | Investigation area |
| Bedeutung der Landschaft | Significance of the landscape |
| Sehr hohe Bedeutung | Very high significance |
| Hohe Bedeutung | High significance |
| Mittlere Bedeutung | Medium significance |
| Geringe Bedeutung | Low Significance |

## 2.3.26.7. Cultural heritage and other material assets

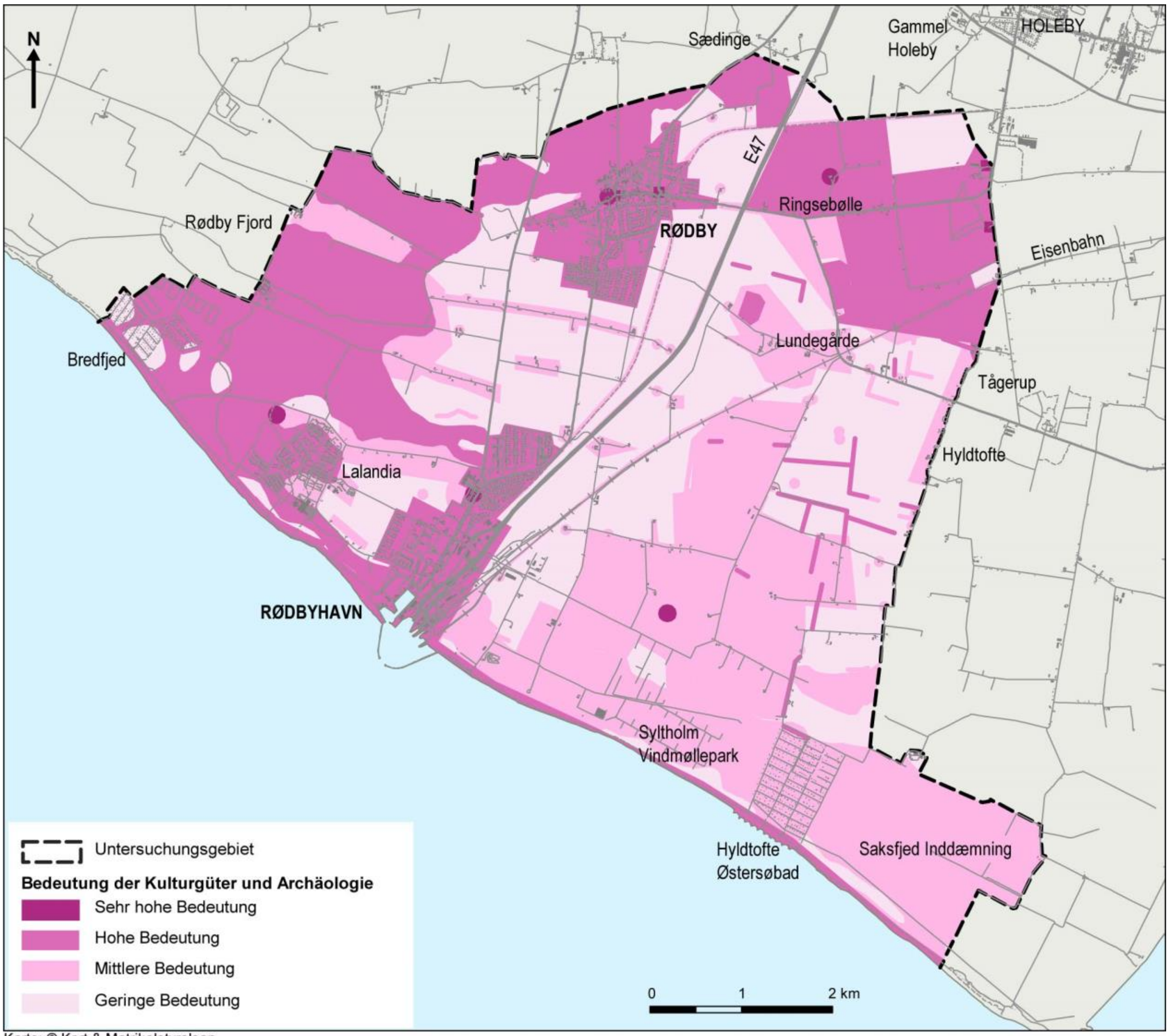
(see Section 3.26.7, Attachment 15 of the plan approval documents, Volume II C)

*Baseline investigation goals and methods*

- Information on areas and objects relevant to the conservation of monuments such as legally protected objects, historical buildings, archaeological finds, architecturally valuable objects, historical land use forms, historical cultural landscapes and cultural landscape parts in the investigation area.
- Information on existing, significant material assets such as overarching transport infrastructure, supply systems, wind farms, natural resources in the investigation area.
- Methods: analysis of documents from the authorities for the protection of historic buildings and monuments/authorities for cultural heritage and the Lolland municipality, topographic and historical maps as well as internal on-site mappings coordinated with the Lolland-Falster Museum.

*Key findings of the Baseline investigation and evaluation*

*Cultural heritage assets:* The significance of the cultural heritage assets is assessed taking into account the criteria protection status, architectural and historical value, rarity, origins, maintenance and experiential value as well as the value for education and regional relationships. Cultural heritage assets that are protected by law enjoy very high significance (legally protected historical cultural heritage assets such as protected archaeological sites, buildings and churches protected as monuments with the exception of the Rødby Kirke). Five of the six cultural landscapes are classified as having high significance (Lolland dyke, city of Rødby, former Rødby Fjord, Lindsø estate, areas with relics of the sugar industry). Protected stone and earth walls, areas with significance for cultural heritage and church surroundings are also of high significance. The other stone and earth walls are of medium significance along with the other buildings worthy of preservation, the remaining cultural landscapes ("bird migration route") and the other areas of archaeological interest (see Figure 27).



Karte: © Kort & Matrikelstyrelsen

**Figure 27 Significance of the cultural heritage assets on Lolland**

| | |
|---|---|
| Eisenbahn | Railway |
| Untersuchungsgebiet | Investigation area |
| Bedeutung der Kulturgüter und Archäologie | Significance of cultural heritage assets and archae-ology |
| Sehr hohe Bedeutung | Very high significance |
| Hohe Bedeutung | High significance |
| Mittlere Bedeutung | Medium significance |
| Geringe Bedeutung | Low Significance |

*Other material assets:* There are no material assets with very high significance in the investigation area. The pumping stations and purification plants have high significance because they depend on their locations next to the dyke. The Syltholm wind farm and the bentonite deposits east of Rødbyhavn, the transport infrastructure of the "bird migration route" and the airport near Holeby are important for the region and are classified as having medium significance (see Figure 28).

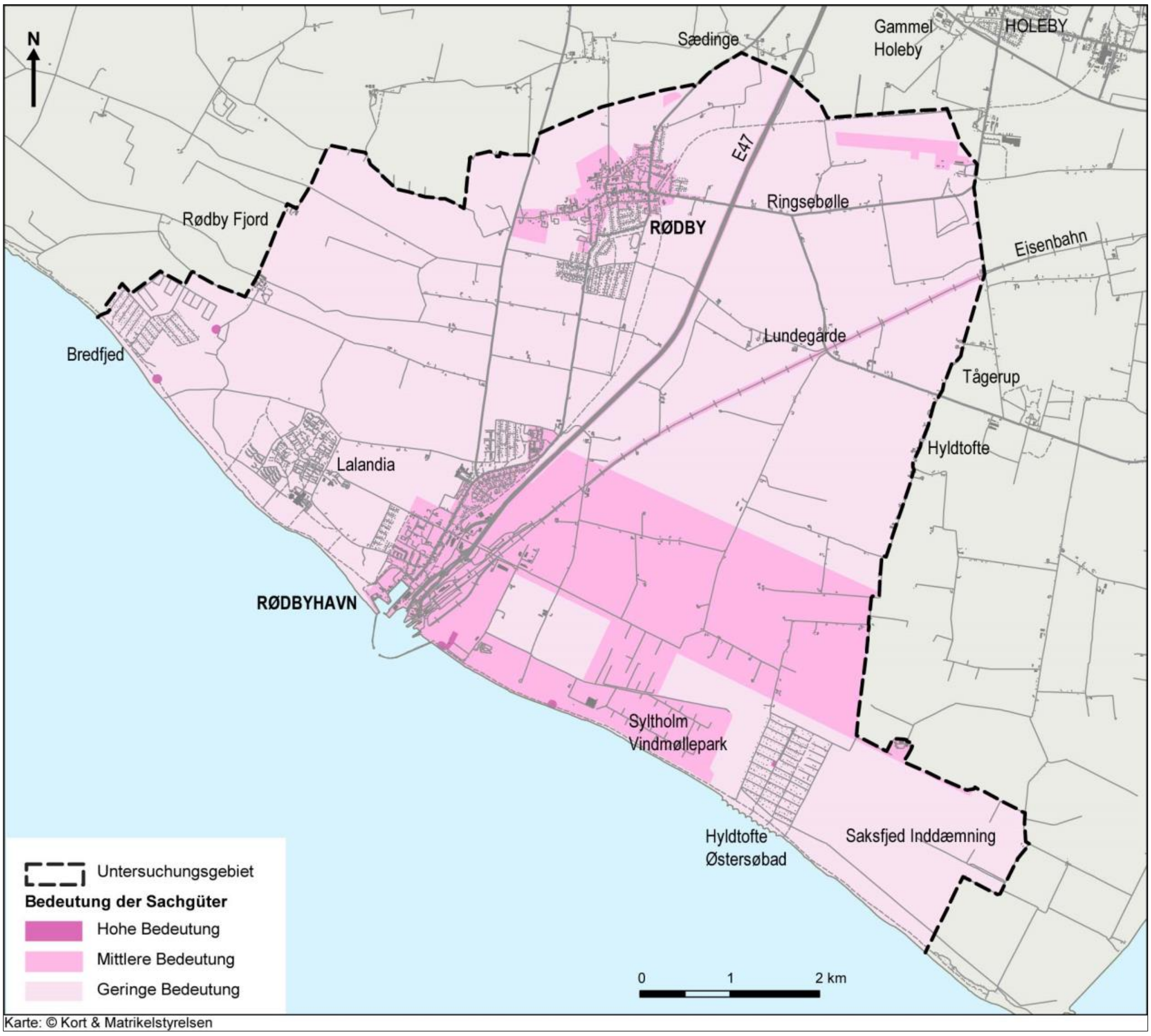



**Figure 28 Significance of the material assets on Lolland**

| | |
|---|---|
| Eisenbahn | Railway |
| Untersuchungsgebiet | Investigation area |
| Bedeutung der Sachgüter | Significance of the material assets |
| Sehr hohe Bedeutung | Very high significance |
| Hohe Bedeutung | High significance |
| Mittlere Bedeutung | Medium significance |
| Geringe Bedeutung | Low Significance |

## 2.4. Variant comparison of the Environmental Impact Assessment Report

The currency of the data was investigated using newly-obtained data and evaluating existing third-party data. No changes were determined which would influence the results of the evaluations made in the EIA-REPORT. Annex C of EIA-REPORT (Attachment 15 of the plan approval documents) shows that the impact assessment for all environmental factors contained within the main variant comparison in the EIA-REPORT is still current. Since the variants in the following preliminary variant comparison are found in the same corridor as the main variant comparison, no adaptation or update to the impact assessment of the preliminary variant comparison compiled on the basis of surveys conducted in 2009 and 2010 is required.

### 2.4.1. Preliminary comparison of variants

As a result of the assessment of the alignments of bridge and tunnel solutions in the route determination report (Attachment 18 of the plan approval documents) and Section 5.1 EIA report of the plan approval documents (Attachment 15, Volume III), the only remaining solutions are those with landing points east of the respective ferry harbour on Fehmarn and Lolland and whose rail and road connections run east of the existing transport infrastructure routes (see Figure 29 and Figure 30).

The main differences in the alignment corridor between the two bridge solutions and the tunnel variant appear in the marine area or on Lolland. On the island of Fehmarn, the almost identical route positions (see Figure 29 and Figure 30) result in almost identical impact areas and zones.

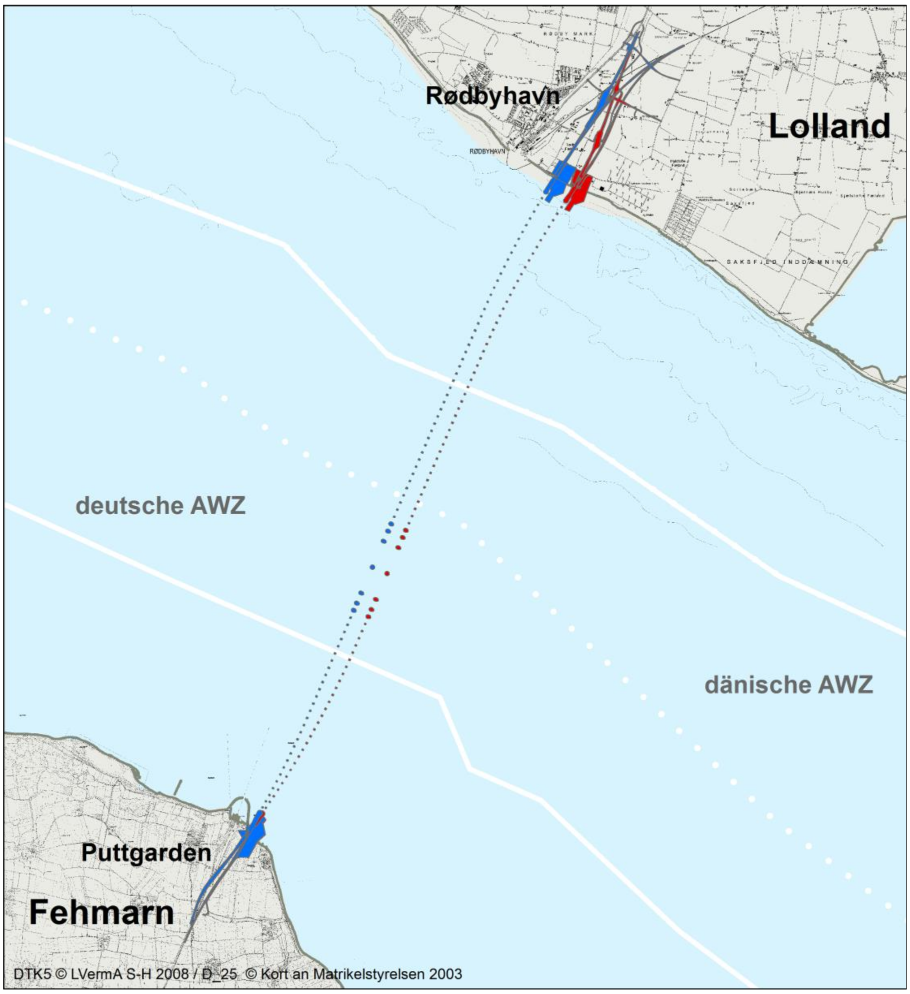



**Figure 29 Preliminary comparison of variants – location of the bridge variants**

| | |
|---|---|
| Deutsche AWZ | German EEZ |
| Dänische AWZ | Danish EEZ |


**Figure 30 Preliminary comparison of variants – location of the tunnel variants**

| | |
|---|---|
| Deutsche AWZ | German EEZ |
| Dänische AWZ | Danish EEZ |

### 2.4.1.1. Results of the preliminary comparison of bridge variants

#### Result on Fehmarn

Taking all environmental factors together, there are only slight differences between the route variants of the bridges for the onshore area on Fehmarn. The B-E-ME variant has a slight advantage in terms of the environmental factors soil and flora while the B-E-E variant has an advantage in the environmental factor landscape. With respect to all other environmental factors, there are no major differences in the two route variants relevant to the decision.

Overall the slight advantages of the B-E-ME variant in the environmental factors soil and flora compensate for the advantage of variant B-E-E in terms of the environmental factor landscape.

As a result, the cross-factor comparison of variants shows no major differences between the bridge route variants in the onshore area of Fehmarn (see. Table 22).

### Result in the marine area

Overall, variant B-E-ME has slight advantages in the environmental (sub-) factors human beings/human health, benthic fauna and benthic flora that, however, are dependent on the system and thus permanent. In terms of the environmental factor landscape, the B-E-E variant has a slight advantage in relation to installation-dependent (permanent), lower visual and sensory impairments of landscape areas of the Baltic Sea. No major differences relevant to the decision were found for any of the other environmental factors. Due to the slight advantages of the B-E-ME variant in the three environmental (sub-) factors compared to a slight advantage of the B-E-E variant, the B-E-ME variant has a slight advantage in the marine area in the cross-factor comparison of variants (see Table 22).

### Result on Lolland

There are only slight differences between the two variants in the coastal area because they cut through different biotopes. On Lolland, no clear advantages relevant to the decision can be identified for either of the two variants and both variants have similar impacts, meaning that they are neutral in comparison (see Table 22).

### Result for the whole area

The cross-factor assessment of the two bridge variants B-E-E and B-E-ME does not yield any major differences relevant to the decision for the onshore areas on Fehmarn and Lolland. The B-E-ME variant was found to have a slight advantage in the marine area due to its slight superiority in terms of the environmental factors human beings/
human health and benthic flora and fauna. For the overall assessment taking into account all environmental factors and spatial sub-results, variant B-E-ME is slightly preferable to variant B-E-E from an overall environmental standpoint.

For the overall assessment taking into account all environmental factors and spatial sub-results, variant B-E-ME is slightly preferable to variant B-E-E from an overall environmental standpoint (see Table 22).

**Table 22 Overall spatial result for the preliminary comparison of variants of the bridge variants**

| Spatial sub-areas of the investigation area | Results of the cross-factor preliminary comparison of variants | |
|---|---|---|
| | **B-E-E** | **B-E-ME** |
| Marine area | | **(+)** |
| Fehmarn onshore area | **0** | **0** |
| Lolland onshore area | **0** | **0** |
| **Overall classification** | | **(+)** |

| Classification | 0 No major difference relevant to the decision | (+) Slight advantage | + Advantage | ++ Clear advantage |
|---|---|---|---|---|

### 2.4.1.2. Results of the preliminary comparison of tunnel variants

#### Result on Fehmarn

From a general environmental standpoint, there were no major differences relevant to the decision found for the onshore area on Fehmarn for all environmental factors between the variants of the tunnel solutions because the routes of the variants on the mainland are virtually identical.

#### Result in the marine area

In terms of all environmental factors, only slight differences were found for the marine area between the two tunnel variants.

The T-E-E variant has a slight advantage in terms of the environmental factors human beings/human health, benthic flora and landscape. The slight advantages among all three environmental factors arise from differences that are found temporarily during the construction phase.

For the T-E-ME variant, on the other hand, there are slight advantages in terms of the environmental factors benthic fauna and cultural heritage and other material assets. The slight advantages arise from differences that are installation-dependent and thus permanent even though the difference in land use is only minor.

With respect to all other environmental factors, there are no major differences in the two route variants relevant to the decision.

In an overall assessment for the marine area, the T-E-E variant has three slight advantages based on temporary impairments/losses while the T-E-ME variant has two slight advantages that can be attributed to permanent losses with marginal land use. Taking into consideration that permanent losses are weighted more heavily than temporary impairments/losses during the construction phase in an environmental assessment, the slight advantages of the variants cancel each other out. A preference therefore cannot be determined for either of the two tunnel variants in the marine area because there are only minor differences from an environmental standpoint, no (see Section 7.2 EIA report, Attachment 15, Volume IV A).

### Result on Lolland

There are only slight differences between the two variants in the coastal area because they cut through different biotopes. Overall, there is also no clear advantage relevant to the decision from an environmental perspective for any of the variants so that the cross-factor result of the preliminary comparison of variants on Lolland is neutral in the overall assessment of the route variants (see Table 23).

### Result for the whole area

**Table 23 Overall spatial result for the preliminary comparison of variants of the tunnel variants**

| **Spatial sub-areas of the investigation area** | **Results of the cross-factor preliminary comparison of variants** | |
|---|---|---|
| | **T-E-E** | **T-E-ME** |
| Marine area | **0** | **0** |
| Fehmarn onshore area | **0** | **0** |
| Lolland onshore area | **0** | **0** |
| **Overall classification** | **0** | **0** |

| | | | | |
|---|---|---|---|---|
| Classification | 0 No major difference relevant to the decision | (+) Slight advantage | + Advantage | ++ Clear advantage |

The overall assessment does not yield any preference for either of the two route variants T-E-E or T-E-ME from an environmental standpoint taking into account the cross-factor and spatial sub-results. The overall assessment does not yield any preference for either of the two route variants T-E-E or
T-E-ME from an environmental standpoint taking into account the cross-factor and spatial sub-results.

## 2.4.2. Comparison of main variants

The currency of the data was investigated using newly-obtained data and evaluating existing third-party data. No changes were determined which would be relevant to the results of the evaluations made in the EIA-REPORT. The impact assessment for all environmental factors contained within the main variant comparison in the EIA-REPORT is still current. Therefore, it is not necessary to adapt the impact assessment contained in the EIA-REPORT, which was made on the basis of the results obtained in 2009 and 2010 (see EIA-REPORT, Annex C and Appendices 30.1 and 30.2 of the plan approval documents).

In the environmental comparison of the main bridge, immersed and bored tunnel variants (see Section 8.4 EIA report, Attachment 15, Volume IV C), the structural variant is derived that has the lowest environmental impact overall. The preferred alignments identified as part of route determination are used here as a basis: the T-E-ME variant for a tunnel solution and the B-E-E variant for a bridge solution.

The main variant comparison defines the following rankings:

- The variant ranked 1 is the most suitable solution compared to the other two from an environmental point of view
- The variant ranked 2 is suitable compared to the other two from an environmental point of view, and is ranked between the most suitable and the still suitable solution
- The variant ranked 3 is still a suitable solution compared to the other two from an environmental point of view

With the cross-factor comparison, it is necessary to bear in mind that the principle of rankings essentially does not make it possible to quantify the differences between the results for the various factors. Even if the differences between the rankings for the various factors/sub-factors are actually different, the principle only allows them to be described qualitatively. For this reason, for example, just adding up the rankings does not lead to the desired result. However, the quantitatively determined values do form the basis for qualitative assessment.

The preferred variant is determined not only according to the ranking established from the cross-factor variant comparison. The decisive factor is the importance of the impacts of the project on the individual factors/sub-factors in the context of all impacts identified. The weighting of the impacts on the respective environmental factors/sub-factors, which is derived from the degree, duration and range of effects identified, is incorporated in the determination of the preferred variant.

The preferred variant is chosen in several steps:

- Selection of the factors/sub-factors with very high and high weighting, which have the greatest influence on the assessment, and creation of a ranking.
- Review of the ranking for environmental factors/sub-factors with medium and low weighting
- Summary of the results

The cross-factor comparison of variants is carried out by means of verbal argumentation.

#### 2.4.2.1. Result on Fehmarn

The human beings/human health and soil factors are weighted high, taking into consideration the degree of area loss and impairment in comparison with the remaining terrestrial environmental factors. It is established that, in respect of the human beings/human health factor (broken down into the residential and recreation sub-factors), the bored tunnel has the lowest impacts, followed by the immersed tunnel in second and the bridge in third position. Broken down into the sub-factors living and recreation, it can be established that the qualitative and quantitative differences between the three main variants are relatively low both for the sub-factor living and for the sub-factor recreation. This is explained by the virtually identical landing points of the three main variants and the very similar alignments on the island of Fehmarn. For the environmental factor soil, the situation is similar, although the ranking is reversed. The bridge and the immersed tunnel have identical impacts and are both ranked as 1. At a small quantitative and qualitative distance, the bored tunnel is ranked 3. An overall view of the environmental factors human beings/human health and soil reveals that the immersed tunnel is the preferable solution here. The bridge and the bored tunnel are to be given equal ranking.

The environmental factors water, fauna, flora and biodiversity are given medium weighting, taking into consideration the degree of area loss and impairment in comparison with the remaining terrestrial environmental factors. The qualitative and quantitative differences between all three variants are minor here as well. The bridge is in first position in this category, as it is ranked 1 for the environmental factors water, fauna and flora and 3 for biodiversity, followed by the immersed tunnel, which is ranked 2 four times. The bored tunnel is ranked 3, as it is ranked 1 once, 2 once and 3 twice.

The environmental factors landscape, cultural heritage and other material assets and climate/air are weighted low, taking into consideration the degree of area loss and impairment in comparison with the remaining terrestrial environmental factors. The qualitative and quantitative differences are minor here as well. Nevertheless, the immersed tunnel is the preferred variant, as it is ranked 1 twice and 3 once. The bridge is ranked 2, as it is ranked 1 once, 2 once and 3 once. The bored tunnel is the least favourable variant in this category, as it is ranked 2 twice and 3 once. In each case the distance to the following variant is minor or not relevant to the decision.

An overall view of the factors weighted high, medium and low, respectively, reveals that the immersed tunnel is the preferred variant with high and low weighting. The bridge is clearly the preferred variant in the medium category. However, here too there are low qualitative and quantitative distances to the immersed tunnel, which is the subsequent variant. The comparison reveals a contrast between the top ranking for the bridge in the medium category with the top ranking of the immersed tunnel in the category of high and low weightings. In the area of medium weightings, the immersed tunnel is ranked 2, whereas the bridge is ranked 2 with a high weighting. Overall, therefore, the situation is a stalemate. The minor differences between the rankings do not allow for clear prioritisation of one of the two variants in this comparison so that the bridge and the immersed tunnel are jointly ranked 1, followed closely by the bored tunnel in third position.

Ranking of the main variants on Fehmarn:

Bridge 1, immersed tunnel 1, bored tunnel 3.

#### 2.4.2.2. Result in the marine area

The impacts of the bridge, immersed tunnel and bored tunnel on the sub-factors hydrography, resting birds and bird migration are assigned very high weighting. The bored tunnel is ranked

1 with regard to the environmental sub-factors of hydrography, resting birds and bird migration, followed by the immersed tunnel which is ranked 2, as it leads to higher temporary impairment of resting birds as a result of sedimentation during the construction period. However, with regard to the environmental sub-factors of hydrography and migratory birds, it ranks equally with the bored tunnel. For the sub-factors hydrography and migrating birds, however, it is ranked equal to the bored tunnel. For all three environmental factors, the bridge has the greatest permanent impact.

The impacts for the environmental factors/sub-factors benthic flora/fauna, marine mammals and landscape (marine) are assessed as high. For the sub-factor marine mammals, the bored tunnel is ranked 1 as it has the lowest degree of impairment. However, for the sub-factors benthic flora/fauna and landscape (marine), the bored tunnel is ranked 2 in each case. For the environmental sub-factor of marine mammals, the impairments caused by the bridge and immersed tunnel are ranked equally. However, for the sub-factors benthic flora/fauna, the bridge is ranked 1 in each case and the immersed tunnel is ranked 3. The situation is reversed for the sub-factor landscape (marine) (bridge 3, immersed tunnel 1). Consequently, for the sub-factors/environmental factors weighted as high, the bridge and the bored tunnel are ranked higher than the immersed tunnel, although the distance between the bridge and the two tunnel solutions is greater (fewer impacts as a result of footprint, sedimentation and suspended sediments for the bridge) than the distance between the bored tunnel and the immersed tunnel. The temporary impacts during the construction period as a result of sedimentation and suspended sediments for the sub-factors benthic flora and fauna lead to the immersed tunnel being ranked lower than the bridge and the bored tunnel.

An overall view of the environmental factors/sub-factors with impacts weighted very high and high reveals that the immersed tunnel is ranked 1 for the sub-factors hydrography and bird migration, which are weighted very high, and 2 for resting birds, while the bridge is ranked 3 for all of these three sub-factors.

Only two sub-factors/environmental factors, seabed and coastal morphology, are assigned medium weighting. The bridge takes first place here (ranked 1 once, and 2 once). The immersed tunnel (ranked 2 twice) and the bored tunnel (ranked 1 once, and 3 once) are ranked equally here. As a result, the advantage of the bored tunnel and the clear disadvantage of the bridge in the category of very high and high weightings are not influenced by the relativising figures from the category of medium weightings.

The category of impacts of environmental factors weighted low confirms the result determined from the very high, high and medium weightings.

In the main variant comparison for the marine area, the bored tunnel is ranked 1, the immersed tunnel 2 and, at some distance, the bridge is ranked at 3. Therefore, the bored tunnel is the most advantageous solution in the summary assessment, taking into consideration all weighted effects on the sub-factors in the marine area. In the comparison between the bridge and the immersed tunnel, the effects weighted very high are decisive. As the bridge has the most serious and permanent effects, it is ranked 3 below the immersed tunnel.

Ranking of the main variants in the marine area:

Bored tunnel 1, immersed tunnel 2, bridge 3.

#### 2.4.2.3. Result on Lolland

The results of the main variant comparison from the Danish EIA are included for information purposes; the environmental factors/sub-factors are therefore not weighted here. The bridge is assessed to be the most suitable variant when taking all environmental impacts into account.

The operation-related impacts of the two tunnel variants on Lolland are to be regarded as roughly equivalent.

In an overall view of the tunnel variants, the disadvantage of the bored tunnel, which causes approximately 18 months' more impairment of the coastal landscape, is therefore seen in contrast to the disadvantage of the immersed tunnel with higher land use in the construction phase. In this respect, the larger footprint for the immersed tunnel is regarded as more serious (ranked 3), resulting in the bored tunnel being the more favourable solution (ranked 2).

Taking into consideration all environmental impacts on Lolland across all factors, the bridge is the variant with the lowest environmental impacts.

Ranking: Bridge 1, bored tunnel 2, immerse tunnel 3.

### 2.4.3. Conclusion with derivation of the variant with the lowest environmental impacts

To identify the variant with the lowest environmental impacts, the overall results of the cross-factor comparisons of main variants for the marine area, Fehmarn and Lolland are combined.

In the marine area, the bored tunnel was found to be the variant with the lowest environmental impacts (ranked 1), followed by the immersed tunnel (ranked 2) and the bridge (ranked 3). The bridge is ranked 3 in particular as a result of the ranking for hydrography and the assessment of quantitative and qualitative differences between the three variants. Lower weight was assigned to the construction-related impacts on account of the short construction phase in relation to the operating phase, with the result that the permanent impacts of the bridge on the hydrography in the western Baltic Sea (over 126,000 ha) and the permanent, cross-border impacts in the central Baltic Sea (over 345,000 km$^2$), which cannot be compensated for, have much greater weight than the installation-related impacts of the immersed and bored tunnels (western Baltic Sea: approximately 1,000 ha each, central Baltic Sea: no impacts). Moreover, the permanent impacts of the bridge on internationally important bird migration, which are weighted very high, must also be taken into account. Unlike the immersed tunnel and bored tunnel, the bridge leads to permanent operation-related and installation-related barrier impacts, which lead to very high, high, medium and low impairment of migrating and resting birds and to medium and low impairment in relation to the risk of collision. In contrast, the immersed tunnel and the bored tunnel do not result in any impairments.

On Fehmarn, the bridge and the immersed tunnel were ranked equally as the variants with the lowest environmental impacts (ranked 1), although the variants differ from each other only slightly on account of the virtually identical landing points and alignments on Fehmarn but have a slight advantage over the bored tunnel (ranked 3).

On Lolland, the bridge was found to be the variant with clearly the lowest environmental impacts (ranked 1), followed by the bored tunnel (ranked 2) and the immersed tunnel (ranked 3).

The section of the alignment of the project in the marine area is roughly twice as long as that on Fehmarn and Lolland. In addition, the scope of individual environmental impacts in the marine area (in particular hydrography and bird migration) far exceeds the scope of the environmental impacts that arise from the onshore sections of the alignment. For the overall assessment of the environmental impacts of the project, its impacts on the marine area therefore have greater weight than its effects on the
mostly agricultural onshore areas. These circumstances justify greater consideration being given to the environmental impacts on the marine area than to the environmental effects on the onshore areas in the overall assessment.

The bored tunnel is the most favourable variable in respect of marine environmental impacts (ranked 1). In the onshore areas, it is ranked 2 for Lolland and 3 for Fehmarn. Its advantages in the marine area result in the bored tunnel also being the most favourable variant overall (ranked 1).

In the marine area, the immersed tunnel is the second most favourable variant (ranked 2). It is the most favourable variant (ranked 1, equal to the bridge) for Fehmarn, but the least favourable (ranked 3) for Lolland. Overall, the immersed tunnel is ranked 2, whereby its second ranking in the marine area is decisive to this ranking here as well.

In respect of Fehmarn and Lolland, the bridge is the most favourable variant in each case (ranked 1, equal to the immersed tunnel). In the marine area, however, overall it is the variant with the greatest disadvantages. On account of its permanent, cross-border impacts on water exchange in the Baltic Sea (hydrography) and its permanent impacts on internationally important bird migration, it is the least favourable variant in the marine area (ranked 3). The minor advantages of the bridge in the onshore areas do not compensate for the decisive disadvantages in the marine area so that, overall, it is also the least favourable variant (ranked 3).

Consequently, the bored tunnel is the variant with the lowest environmental impacts, followed by the immersed tunnel and by the bridge as the least favourable solution.

Final ranking of the environmental main variant comparison for the overall Fehmarnbelt Fixed Link project:

Bored tunnel 1, immersed tunnel 2, bridge 3.

## 2.5. Identification of the preferred variant

In addition to the cross-factor comparison of the three main variants with derivation of the preferred solution from an environmental standpoint, the three main variants are also evaluated based on other decisive assessment areas for the overall assessment to ultimately identify the preferred solution overall.

More details on the overall assessment can be found in the explanatory report (see Section 3.6.6, Attachment 1 of the plan approval documents) as well as the route determination report (see Section 6, Attachment 18 of the plan approval documents). The following seven assessment areas are used in the overall assessment:

- Environment
- Regional planning
- Transport
- Urban development
- Agricultural structure
- Construction procedure
- Costs/profitability

Several criteria were considered in each assessment area. Objectives were defined for the individual criteria and the achievement of the objectives was assessed. The assessments of the individual criteria in each assessment area were combined by means of verbal argumentation to create an overall classification. From this, the ranking of the main variants was determined for each assessment area. The overall result of the main variants, the preferred solution, was derived from the verbal combination of the rankings in all assessment areas (see Section 8.4.4 EIA report, Attachment 15 of the plan approval documents Volume IV C).

The table below shows the combined rankings of the assessment areas described above.

**Table 24 Overview of the rankings in the individual evaluations**

| Assessment area | Ranking of main variants | | |
|---|---|---|---|
| | Bridge | Immersed tunnel | Bored tunnel |
| Environment | 3 | 2 | 1 |
| Regional planning | 1 | 1 | 1 |
| Transport | 3 | 1 | 1 |
| Urban development | 1 | 1 | 1 |
| Agricultural structure | 1 | 1 | 3 |
| Construction procedure | 2 | 1 | 3 |
| Costs/profitability | 1 | 1 | 3 |

In the assessment area environment, none of the three main variants has such serious effects that they should be excluded as a result. Ultimately, the environmental impact in the marine area is decisive to the rankings. Taking all environmental impacts into account, the main variant bored tunnel is the most favourable solution (ranked 1), with its comparatively low impairment in the marine area, followed by the main variant immersed tunnel (ranked 2). Among other things on account of its permanent, cross-border impacts on water exchange in the Baltic Sea (hydrography) and its permanent impacts on internationally important bird migration, the cable-stayed bridge is the least favourable variant in the marine area and thus overall (ranked 3).

In the assessment areas of regional planning and urban development, all main variants are ranked equally. As a result, neither assessment area is relevant to the overall ranking.

The risk of collision between ships and bridge piers, which cannot be ruled out, and the possible negative influence of weather conditions on transport cause the cable-stayed bridge to be the least favourable main variant in the assessment area transport. However, the difference between it and the two other main variants is minor.

The difference between the main variants immersed tunnel and cable-stayed bridge in the area of agricultural structures is not relevant to the decision. On account of its larger footprint, the main variant bored tunnel is the least favourable solution.

There are clear differences in the assessment areas construction procedure and costs/profitability. On account of its considerably higher risk in relation to the construction procedure and the approximately 25% higher costs, the main variant bored tunnel is assessed as being significantly less favourable than the two other main variants. With respect to the assessment area construction procedure, the main variant cable-stayed bridge has a higher risk than the main variant immersed tunnel, partly as a result of the need to install very large prefabricated bridge parts at great heights. Therefore, the immersed tunnel is assessed as being more favourable than the cable-stayed bridge in the assessment area construction procedure. However, in the assessment area costs/profitability, there is no difference between the main variants immersed tunnel and cable-stayed bridge.

The differences in impacts in the assessment areas transport and agricultural structure are only minor. Overall, however, the main variant immersed tunnel is the most favourable solution as it is ranked 1 in both areas. Both the main variant bored tunnel and the main variant cable-stayed bridge are each ranked as the least favourable solution in one area.

Ultimately, the assessment areas environment, construction procedure and costs/profitability are decisive to the overall ranking with their clearer differences in impacts. The advantages of the main variant bored tunnel in the area environment are contrasted by considerable disadvantages in the assessment areas construction procedure and costs/profitability. These disadvantages carry more weight than the environmental advantages. This classification takes into consideration the fact that the main variants immersed tunnel and cable-stayed bridge are also feasible from an environmental perspective. Taking all impacts into consideration, the main variant bored tunnel is therefore ranked as the least suitable solution.

In a direct comparison between the main variants immersed tunnel and cable-stayed bridge, there are no differences relevant to the decision in the assessment areas regional planning, urban development, agricultural structure and costs/profitability. In all other assessment areas (environment, transport and construction procedure), there are advantages for the main variant immersed tunnel. Overall, the main variant immersed tunnel is therefore to be ranked as more favourable than the main variant cable-stayed bridge.

The final overall ranking which is based on the overall assessment of the main variants taking into account all assessment areas is shown in Table 25.

**Table 25 Overall evaluation**

| | **Immersed tunnel** | **Bored tunnel** | **Cable-stayed bridge** |
|---|---|---|---|
| **Overall ranking** | **1** | **3** | **2** |

The preferred solution to be further pursued is the main variant immersed tunnel with the preferred T-E-ME route.

# 3. Project description

## 3.1. Description of the preferred project variant and its key characteristics

In the following sections, the implementation of the immersed tunnel is described in brief. Further details are contained in Annex 1 of the plan approval documents (explanatory report), Attachment 16 (Fehmarn temporary work harbour) and Attachment 27 of the plan approval documents (site logistics).

At this stage, it should be noted that the immersed tunnel is undergoing further development as the preferred solution for the Fehmarnbelt Fixed Link and the plans have been made. Significant deviations compared with solution used in the main variant analysis in the EIA (Attachment 15 of the plan approval documents):

- The starting points for levelling the track and road sections (i.e. the connection to the road and rail landworks) were located 350 m further south than they are in the current planning approval. This is because the adjustment ranges contained in the original design of the EIA-REPORT were originally planned to be much longer.
- The roads and their ancillary facilities located in the area containing Puttgarden's marshalling yard, were optimised so that, on the one hand, they have as small a footprint as possible to the south of the point where the tracks cross. and, on the other hand, so as not to encroach on the marshalling yard's land.
- Following further technical detailing, the areas used to establish the site and complete the construction of the immersed tunnel were expanded to include areas located to the west and east of the planned roads.
- Technical equipment such as rainwater retention basins were already contained in the EIA-REPORT preliminary design but in isolated cases these were moved to other locations.
- An agricultural road in the Marienleuchte area, which was included in the preliminary design for the EIA, was considered superfluous.
- On the coast-facing reclamation area, the bay in the east which is intended as the topographic adjustment area was planned in greater detail and the area adjusted underwater.
- The ferry harbour connection (axis 961) and the K 49 district road (axis 900), including slip road 2 (axis 912) and the old K 49 tangent bending (axis 950) were replanned.
- A seawater desalination plant was expanded to ensure the water supply during the construction phase.
- A building for emergency personnel must be built on maintenance facility East. A transformer station must also be built on site to ensure electricity supply for track maintenance purposes during both the construction and operation phases.

- The following minor structural adjustments and extensions have been implemented:
  - The passage cross section was enlarged to improve ecological permeability

- Extension of an emergency train stop and fire station
- Tunnel air intake system
- Relocating the piped federal water WV 3.1.11
- Extension of Schleswig-Holstein Netz AG cable
- Re-routing the Kabel windfarm in Presen
- Extending the maintenance facility East wastewater pressure line
- Changing the planned marine construction process

The planned points are considered within the plant- and construction-related project boundaries of the landscape management plan.

### 3.1.1. Transport forecast

In the forecast plan, approx. 12,158 vehicles/24h broken down into approx. 10,321 cars and approx. 1,837 lorries and buses are expected for the year 2030.

With respect to rail transport, the forecast plan anticipates a total of 111 trains per day for the year 2030 broken down into the following train types:

- 38 passenger trains and
- 73 freight trains

Detailed information on the 2030 forecast programme can be found in Attachment 26.3 of the plan approval documents.

### 3.1.2. Overview of alignment

Figure 31 shows the alignment of the preferred solution immersed tunnel for the overall project. The details of the alignment on Danish territory are for information purposes only.

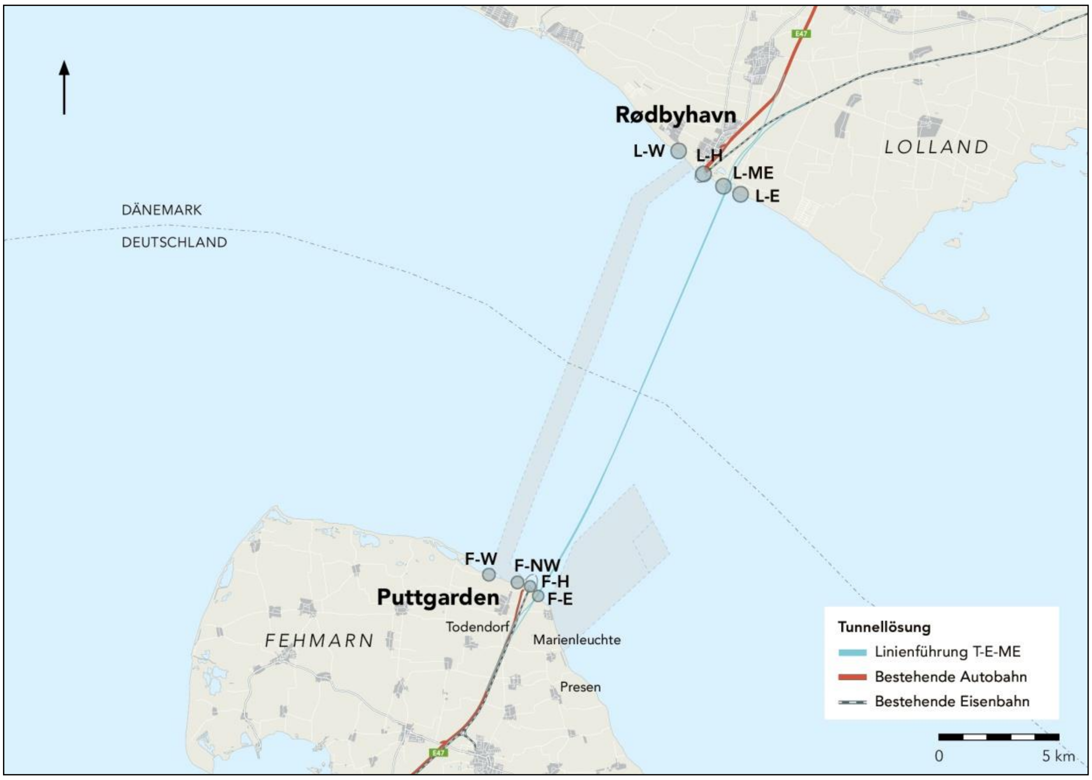



**Figure 31 Preferred solution: immersed tunnel, overview of location**

| | |
|---|---|
| DÄNEMARK | DENMARK |
| DEUTSCHLAND | GERMANY |
| Tunnellösung | Tunnel solution |
| Linienführung T-E-ME | T-E-ME alignment |
| Bestehende Autobahn | Existing motorway |
| Bestehende Eisenbahn | Existing railway |

For the planning of the FBFL, an independent chainage was introduced for both the rail and road route with the border between the German and Danish EEZ being set to chainage-km 20+000.

### 3.1.2.1. Alignment – rail

#### Start and end point

The FBFL for the railway starts on Fehmarn in the south at rail-km 85.5, which corresponds to rail-chainage-km 7+400. This point is located around 300 m south of the current overpass of the K 49 over the railway. The railway line of the FBFL ends when it connects to the existing railway line southeast of the Skovsmosevej (rail-chainage-km 33+892) on Lolland.

## Length of the line

The railway line is approximately 26.4 km long in total. Around 3.0 km is made up by the onshore connection on Fehmarn, some 18.1 km by the tunnel structure in the Fehmarnbelt and approximately 5.2 km by the onshore connection on Lolland. The length of the rail line on German territory (onshore and offshore) is approximately 12.6 km.

## Brief description of the route

*Location*

The plan on the German side is to connect the western main track of the FBFL to the existing DB Netz AG track located at the project boundary at chainage-km 7+400/current rail-km 85.497. The eastern track of the FBFL will be connected to the future second track of DB Netz AG in the direction of Rødby once this section has been twin-tracked and electrified on the island of Fehmarn and further in the hinterland.

Starting at the project boundary at chainage-km 7+400, the railway line follows the existing tracks for approx. 400 m then curves slightly to the east at a radius of R = 3,500 m and then runs straight in a northeast direction to the coast. The tunnel portal is around the same height as the current coast. A light transition and adaptation section around 150 m long is situated before the tunnel portal. A section of the current coastline around 400 m wide will be shifted approximately 500 m to the north in connection with the immersed tunnel (reclamation area). In the marine area, the line first follows a long curve to the left (R = 40,000 m) before continuing in a straight line in the area of the Exclusive Economic Zone until it reaches Lolland.

As a result of the curve of the main line to the east, the access track to the Puttgarden ferry harbour will be shifted slightly to the west on Fehmarn. The shift begins right around the start of construction of the main line and ends at the overpass of the K 49 over the rail line.

*Gradients*

The railway line is located in the cut at the beginning of the section to be approved. It reaches ground level between the road to Presen and the Monks' Trail and goes back into the cut north of the Monks' Trail (agricultural road between Marienleuchte and Marienleuchter Weg) and remains there until the beginning of the tunnel. At the beginning of the tunnel, the tracks are at 4.75 m below sea level, continuing along the seabed at a maximum incline of 12.5 ‰ . The lowest tunnel position at a depth of 38.50 m below the sea level is located at chainage-km 18+765. Starting at this point, which is located approximately at the level of the German-Danish national border, the gradient starts to rise again and continues along the seabed. The railway line reaches the flood-proof height on Lolland approx. 400 m north of today's coastline. The line is virtually at ground level until it connects to the existing route.

## Cross-section design and target route limit values

The railway line is constructed as a twin track. The second track will be positioned to the east of the existing track on Fehmarn. The distance of the centreline of track is 4.50 m and is widened to 6.90 m as it runs to the portal. There is a separate tube 6.00 m wide for each direction

of travel in the tunnel. Due to the high design speed of V = 200 km/h, the railway line has an extended alignment and does not exceed the permissible routing parameters.
The maximum permissible inclines and gradients of 12.5 ‰ are taken advantage of to lower the tunnel as quickly as possible to the required depth.

#### 3.1.2.2. Alignment – road

**Start and end point**

The road of the FBFL starts at the B 207/E47 around 480 m north of Norderweg (connection road between Hinrichsdorf and Bannesdorf). This point (road-km 7+080) is a good 300 m south of the start of railway construction. The new road section connects to the existing E 47 at the southern edge of Rødby and ends at the Ringsebøllevej (road-km 34+968).

**Length of the line**

The total length of the road construction project is approximately 27.6 km, of which around 3.3 km is made up of the connection on Fehmarn, approximately 18.1 km of the tunnel structure and approximately 6.2 km of the onshore connection on Lolland. The road route is approximately 12.9 long on German territory.

**Brief description of the route**

*Location*

In the south, the road route begins at the interface to the plan approval boundary "B 207 upgrade" of the LBV-SH, Lübeck office chainage-km (road) 7+080. The road route initially curves left to the west (R=5,000 m) to gain enough land between the E 47 and the tracks of DB AG for the eastern parallel ramps of the Puttgarden junction. The maximum distance to the old B 207 is approx. 80 m. Around the current connecting road Todendorf – K 49, the E 47 curves right (R=2,500 m, followed by R=6,500 m) and then continues to the northeast. This ensures an adequate distance to the individual farm on Marienleuchter Weg to the northwest. The E 47 crosses the tracks to the Puttgarden train station at a sharp intersection to the south of the shunting yard and continues in this direction. The position is optimised to ensure, on the one hand, that the footprint south of the intersection of the tracks is as small as possible and, on the other hand, that no impermissible intervention is made in the area of the shunting yard. However, to create the eastern abutment of the crossing, a section of the existing turnout track 71 that is 220 m long must be dismantled. At a level with Marienleuchter Weg, the E 47 completes a turn from the right (R=6,500 m) to the left (R=6,500 m) in order to join a route parallel to the railway line 300 m south of today’s coastline. This ensures that there is enough room left between the E 47 and the railway line for the East and Marienleuchter Weg maintenance facility.

The tunnel structure begins at the current coastline, runs in an elongated line to Denmark and reaches Lolland east of the Rødbyhavn ferry harbour. The road and rail alignment in the Fehmarnbelt is identical.

*Gradients*

The E 47 then goes into an embankment to cross the access track to the Puttgarden train station. The E 47 then goes into an embankment in order to cross the access track to the Puttgarden train station. To the east of the track and after the underpass of Marienleuchter Weg, the E 47 slopes downward at a gradient of 0.5% and reaches ground level at the height of the intersection of the former Rethen road. The gradient increases from 0.5% to 3.5%. when transitioning to the structure. The gradient only reaches the same level as the railway directly at the tunnel portal and is maintained for the entire length of the tunnel. The gradient follows the progression of the seabed in the Fehmarnbelt. It rises steadily to the Danish coast starting right around the border between the German and Danish EEZ. The E 47 reaches the flood-proof height on Lolland just after passing today's coastline. The line is virtually at ground level until it connects to the existing route.

#### 3.1.2.3. Constraints

The planning constraints of the specific combined railway/road planning as an immersed tunnel are:

- Development of the alignment from the existing alignments of the B 207 or E 47 and the railway; this applies to both the German the Danish sides
- Specification of the establishment of the Puttgarden junction at the E 47 south of Puttgarden
- Maintenance of the continuity of the existing network of roads and walkways
- Maintenance of the road and rail connection to the Puttgarden ferry harbour
- Avoidance of the military protection zone on German territory
- Routing of the railway line east of the E 47
- Minimisation of impairments to existing installations, e.g. to the Presen wind farm

#### 3.1.2.4. Junctions and intersections

**Rail**

The tracks to the ferry harbour as well as the shunting and passenger stations will remain connected to the main railway route via the railway siding once the FBFL goes into operation

**Road**

A junction and service exit as well as the maintenance facilities East and West are planned on Fehmarn.

The Puttgarden junction is located between the towns of Bannesdorf and Puttgarden. It links the E 47 with the K 49, which has to be relocated for this purpose. The K 49 will run in a curve to cross over the railway and road routes. "Dutch ramps" located on the eastern side of the E 47 run from the E 47 to the re-located K 49 and from the K 49 to the E 47. On the western side, it is connected to the K 49 via the loop ramps located south of the Drohngraben.

There is a "service exit" to the western carriageway (direction of Heiligenhafen) at the level of Marienleuchter Weg. It is linked to the road running parallel to the freight train station. In the southerly direction, it is possible to reach Puttgarden through the existing train underpass via Marienleuchter Weg. To the north, the road runs to the harbour site (only for operating personnel) and to the immersed tunnel (also only for operating personnel).

#### 3.1.2.5. Road network and walkways

The continuity of the public road network and walkways will be retained in full. However, it will be necessary to relocate several roads and walkways. The following roads/walkways on Fehmarn are affected.

The K 49 will be relocated in a curve north of Bannesdorf and south of Puttgarden and run via the railway line and the E 47. It swings approximately 250 m north of the east ramp of the Puttgarden junction to the northeast and leads to the old B 207 in an elongated form. It loops in to the old B 207 south of the individual farm in Marienleuchter Weg. The new road to be constructed is approximately 2,300 m in length. The relocated K 49 has three intersections:

- Connection of the eastern ramps of the Puttgarden junction
- Connection of the western ramps of the Puttgarden junction with a connection to the relocated road to Todendorf. The tracks to the ferry harbour as well as the shunting and passenger stations will remain will remain connected to the main railway route via the railway siding once the FBFL goes into operation
- Connection to the re-located road to Puttgarden

In addition, there are two access roads to the agriculturally used land planned north of the western ramps and the road to Todendorf.

The road to Puttgarden connects to the new K 49, which is currently being built, around 250 m to the north of the east ramp of the Puttgarden junction via a T-junction. Approximately 150 m of new roads need to be built for this connection.

Due to the relocation of the K 49, the municipal road to Presen will also be relocated in the section where it runs parallel to the K 49 and run on the east side of the K 49. This link road will be built on a new section of road approximately 600 m in length.

The connection of the municipal road to Todendorf will be shifted approximately 400 m to the north. To do this, it will be curved to the north approximately 100 m to the west of today's merging point with the K 49. This leads to a common point and meets with the Puttgarden junction slip road which leads to the K 49. This link road will be built on a new section of road approximately 400 m in length.

A new road to the ferry harbour will be needed. It branches off approximately 250 m north of intersection 2 to the northeast and leads to the old B 207 in an elongated form. It loops in to the old B 207 south of the individual farm in Marienleuchter Weg. The length to be constructed is approximately 840 m.

Marienleuchter Weg will be relocated as a connection between the towns of Puttgarden and Marienleuchte east of the existing underpassage below the train to the east and run between the E 47 and the railway line. Marienleuchter Weg crosses the railway on a bridge and then joins the existing line after passing under the E 47. The length to be newly constructed is approximately 800 m. The current section of the part of Marienleuchter Weg that runs parallel to the shunting yard is retained but must be adjusted to the changed constraints at a length of around 200 m (eastern base of the embankment of the E 47).

In addition, other new roads need to be built or changes made to existing roads. They constitute service roads for tunnel operation and are not available for public transport.

On Danish territory, new roads need to be built or changes made to existing ones both in the secondary road network and the walkways. This mainly concerns the area where the junction is located as well as the area containing the toll and customs station.

#### 3.1.2.6. Other technical details

The following bridge structures are necessary along the route:

- 2 Bridges on the K 49 across the railway line and the E 47
- 1 Bridge on the E 47 across the access track to the Puttgarden train station
- 1 Bridge on the E 47 across the relocated Marienleuchter Weg
- 1 Bridge on the Marienleuchter Weg across the railway line

South of the existing railway overpass across Marienleuchter Weg, a facility for the operation and maintenance of the FBFL as well as for emergencies is planned on both the west and east sides of the E 47. A new building for emergency personnel will be built on maintenance facility East. It will accommodate a temporary mission control centre for emergency services on the German side and will be equipped with additional premises, sanitary facilities, recreation areas and changing rooms, kitchens and storerooms.

An operations building (portal building) will be built to the east of the tunnel portal on the German side. During the tunnel's normal operations, the operations building on Fehmarn will not be manned by personnel. Only operational staff will be based here for maintenance purposes.

To prevent water from getting into the tunnel structure in the event of storm flooding, the area of the tunnel portal on Fehmarn will be surrounded by flood protection on a large-scale (crest level 6.35 m above sea level). The crest is approximately at ground level in the west so that flood protection in the actual sense of the word is not formed. The E 47 crosses near the site and can be routed over the object flood protection. Since this is not possible with the rail solution due to the lower permissible longitudinal incline, the rail's object flood protection must be crossed using a cut. During extreme storm surges, the cut located in the area of the tracks can be closed.

## 3.2. Cross section

### 3.2.1. Standard element

The Fehmarnbelt Fixed Link is composed of a total of 79 standard elements, of which 40 will be assembled on the German side. All standard elements (max. 220 m in length) have the same geometric shape. A standard element is 43 m wide and 9 m high. In Figure 32 the standard element can be seen.

The two road tubes in the standard elements are each approximately 11 m wide and are located on the west side of the tunnel. Each road tube has two lanes, a hard shoulder, edge strips and step barriers. A short section of the ceiling above the road tubes is higher in the centre of the element to create a niche for attaching fans or signs.

A central gallery around 2 m wide is located between the two road tubes. The corridor is broken down into three levels. The lower level houses pipes of the drainage shafts as well as water supply lines for hydrants and the fire protection system. The middle level of the central gallery is located at road level and provides room for maintenance staff, as well as serving as a temporary safety area in the event of an evacuation from one road tube to another. The upper level of the central gallery serves as a supply channel, particularly for the cabling of the special elements for the systems in the entire tunnel.

The two rail tubes, each of which is approximately 6 m in width, are located on the eastern side of the tunnel. Each tube provides space for what is known as a slab track. Escape routes are planned on both sides of the track. The tubes provide space for mechanical and electrical equipment. The clearance dimensions of the train tubes allow for the safe passage of trains at a speed of up to 200 km/h.

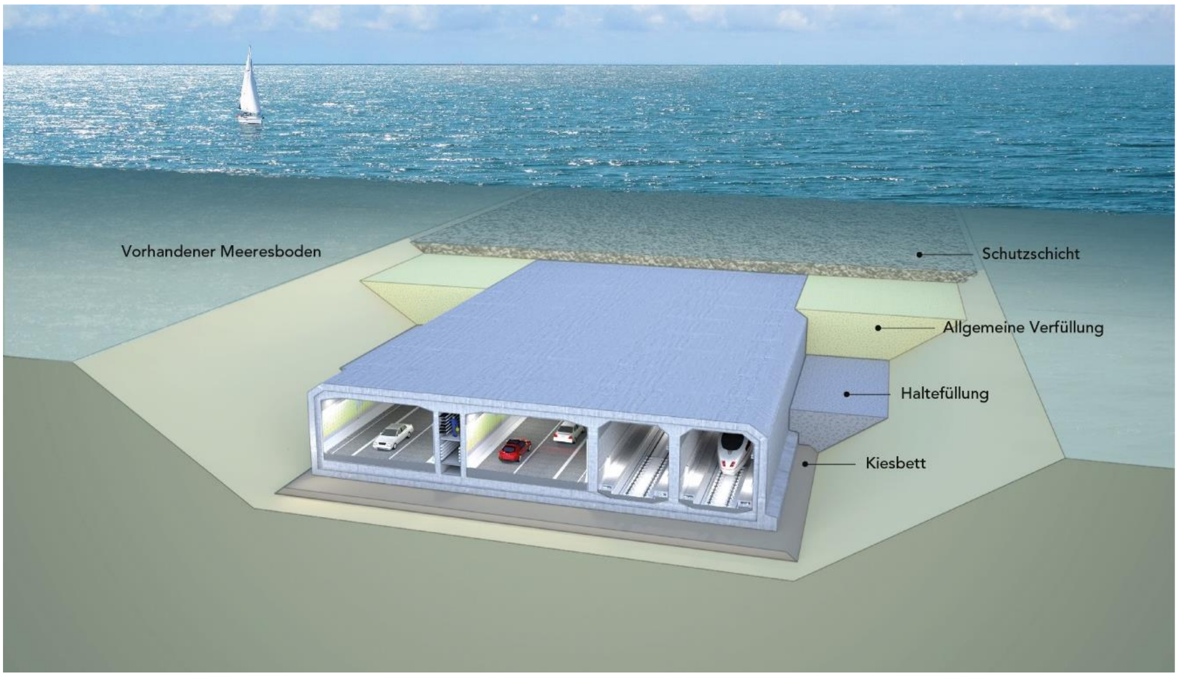



**Figure 32 Immersed tunnel cross section - standard element**

| | |
|---|---|
| Vorhandener Meeresboden | Existing seabed |
| Schutzschicht | Protection layer |
| Allgemeine Verfüllung | General fill |
| Haltefüllung | Locking fill |

| | |
|---|---|
| Kiesbett | Gravel bed |

### 3.2.2. Special element

Over the length of the immersed tunnel, a total of ten special elements are installed, five of which are on the German side. They provide space for the mechanical and electrical equipment of the tunnel's operating systems. The special elements have individual specifications and cannot be exchanged with other elements.

The special elements are 47 m in length and width and 13 m in height. The special elements are lower than the standard elements in order to offer space on a different level for equipmentrooms below the road and railway level, e.g. for transformers. The lower level can be accessed from the western road tube. An additional lay-by next to the shoulders serves there as an access point for maintenance and rescue personnel. These access facilities mean that the special elements on the western side are wider than the standard tunnel elements. Access steps to the lower level are planned on both ends of the layby.

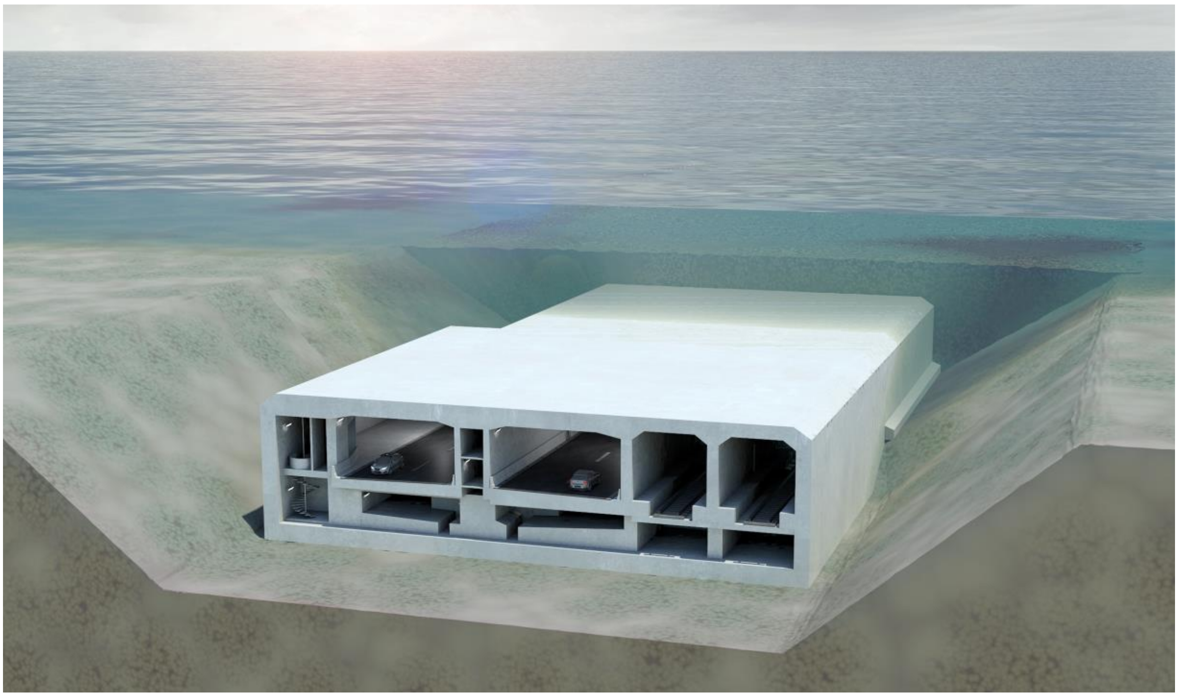


**Figure 33 Immersed tunnel cross section - special element**

## 3.3. Construction procedure

**Protection and monitoring concepts**:

In Attachment 22 (Monitoring and protection concepts), monitoring and minimisation measures are presented as framework concepts, which should minimise the impact the construction works have on the surrounding environment. These are:

- Attachment 22.1: Volume management (part 1) and soil protection concept (part 2) - (onshore and offshore)
- Attachment 22.2: Noise reduction concept (onshore)
- Attachment 22.3: Vibration monitoring concept (onshore)
- Attachment 22.4: Light management concept (onshore and offshore)
- Attachment 22.5: Noise protection concept – underwater noise (including a model of the underwater noise emissions)
- Attachment 22.6: Concept for controlling and checking sediment release (offshore)
- Attachment 22.7: General presentation of the restrictions in place at the time of construction (onshore and marine)
- Attachment 22.8: Concept for environmental supervision of construction work (onshore and offshore)
- Attachment 22.9: Marine monitoring concept

To form the content of the provided miniminsation measures, the following measures and concept sheets, which are contained in Annexes IA and IB as the LCP (Attachment 12 of the plan approval documents) were referenced.

## Description of the construction procedure

The immersed tunnel is made of prefabricated standard and special elements in production sites located on Lolland. The finished tunnel elements are floated to their installation location and immersed in a previously excavated trench. The immersed elements are then connected to the previous elements. The tunnel has a cut-and-cover design in the area where the land transitions to the sea and the water depth is inadequate to float the elements.

The excavation work for the immersed tunnel will be carried out by backhoe dredgers, grab and suction dredgers. Backhoe dredgers will likely excavate all the material down to 25m below sea level, while grab dredgers will excavate most of the seabed below this level. Tougher soil layers will be loosened using, for example, the drill bit of a suction dredger. Subsequently, this soil can be mechanically excavated using grab dredgers or suction dredgers.

The width of the trench will depend on the width of the tunnel and the slope inclination. In turn, the slope inclination will depend on the soil layers. While the marl is extremely durable and the slope angle is present for reasons related to, inter alia, occupational health legislation, it is an extremely flat slope angle in areas where sand is present. As a result, the overall width of the trench varies significantly. While excavating, the surrounding soil is taken into account in such as way as to create stable slopes which remain in place throughout the required time period without suffering from excessive erosion.

The excavated material will be transported by barge or hopper dredgers to the reclamation areas located on the coasts of Fehmarn and Lolland. The reclamation areas are located to the east of the Puttgarden harbour on the German side. On the Danish side, two areas are planned to the east and west of the Rødbyhavn harbour. Before the reclamation area takes on its final form on Fehmarn, there are three coastal working areas necessary for tunnel construction including the temporary working harbour, the temporary soil depot and the area for the cut-and-cover tunnel.

Before construction begins, care must be taken to ensure that the protected bluff section is not adversely impacted. In order to secure the current sandy beach and that it can be reused, the current beach will be excavated down to a water depth of 2 m and moved eastwards to the area where the seaward-facing temporary stockpile (structure reference no. 11.002) will be located in future. Here, the sand from the beach will be stored temporarily (see Attachment 9.4 of the plan approval documents, Sheets 1 and 2, and Attachment 12, Annex IA, Action sheet 7.3).

The areas above and the reclamation area will be set up in such a way that perimeter embankments will first be built around the fill areas off the existing coast. Part of the newly-constructed embankment will be used for a cut and cover tunnel when the excavation works have been completed. Excavation for the cut-and-cover tunnel will be carried out primarily on land. All temporary protective dams will be built using uncontaminated sand from approved sand reclamation areas in Kriegers Flak and Rønnebank and sealed with adjusted, impressed or driven sheet piles, diaphragm walls or mixed-in-place sealing walls. This will be covered up on the seaward side using a spur dyke. The routes used by the transport ships delivering sand to be used for the temporary containment embankments can be found in Attachment 27.1 of the plan approval documents, Section 3.1.5.8.

Subsequently, the material excavated from the tunnel trench will be installed in the fill areas behind the closed containment embankments. Grab dredgers and backhoe dredgers mounted on pontoons will be used for the construction of the containment embankments.

It is also planned to use part of the excavated material from the tunnel trench onshore (approximately 825,000 m³) for the portal and ramp areas. Barges will transport the material to temporary piers off the offshore stockpile and from there the where the material will be transported on by lorries to the offshore or onshore stockpiles. The excavated material is transported from the interim storage area to the individual installation sites depending on the progress of construction.

The temporarily stored sediment will be removed from the trench before the tunnel elements are immersed. This sediment has a very low density and is transported hydraulically. The quantity depends on the period between trench creation and immersion and can yield up to a total of 1,000,000 m³ of sediment-water mixture. This is done by means of a hopper dredger, which pumps the water/sediment mixture from the bottom of the trench into its hopper without any sediment-producing water removal. As soon as the hopper is full, the hopper dredger travels to the sedimentation basin located on the eastern reclamation area on Lolland. The sediment/water mixture is pumped into sedimentation basins via the station and through a pipe/hose system on land. The only sedimentation basins for the water/sediment mixture from the cleaning of the tunnel trench will be in the eastern reclamation areas on Lolland, with a controlled overflow into the open waterbody.

After the tunnel trench has been dredged and cleared of sediment, an initial underlay composed of gravel is introduced into the trench. This underlay forms the foundation for the tunnel elements. Prior to immersion the tunnel element is connected with immersion pontoons, which are positioned above the tunnel trench and moored to anchors next to the tunnel trench, at which point they are ready for the immersion. Near the coast it may be necessary to use tugboats to guide the elements.

The pontoons, barges, immersion pontoons and other floating equipment is mainly held in place by plough anchors. During the anchoring process, the anchors are pulled over the seabed where they become entrenched and provide support. Heavy backhoes and grab dredgers require anchors with a holding force of at least 50 t. Anchors with a width of up to approx. 4 m are suitable for this purpose. Under normal operating conditions, the train route typically requires approx. 10 to 15 m of sand approx. 20 m of clay.

If the equipment is relocated, the anchors are pulled in and dropped again in the new position. Assuming that the anchors are moved each time the equipment is relocated and do not temporarily remain for other equipment, approximately 2.5% of the area designated as construction-related footprint in the site plans is affected. This is shown in the site plans as "Construction-related footprint" (anchor zone 2.5%). More details on the anchors and stilts can be found in Attachment 27.1 of the plan approval documents, Section 3.1.6.1 and Attachment 30.5 of the plan approval documents.

Immersion begins by flooding the ballast tanks with water and reducing the freeboard of the floating element to zero. Then the ballast tanks are flooded further to generate the necessary weight to sink the element. During immersion, the tunnel element is held on suspension cables by two immersion pontoons. The position of the pontoons is controlled with mooring lines which are connected to anchors on the seabed. During immersion, the tunnel element is slowly lowered to a position directly adjacent to the previously immersed element. The horizontal movement of the tunnel element is controlled via positioning cables. As soon as the tunnel element gets close to the seabed, it is slowly lowered onto the gravel bed in the trench. The immersed element is pulled closer to the preceding element with the aid of hydraulic presses and wire ropes. The hydraulic presses and ropes are only attached to the elements themselves, not anchored to the seabed. A gap remains between the steel bulkheads on the two elements. At this point, the gap is evacuated and sealed by a pre-fitted rubber gasket (GINA gasket) which is pressed together by the water pressure on the opposite, free end of the element. Now the ballast tanks take on more water until the required minimum weight to hold the element in position is reached. The volume of water to be flooded varies as a result of weight discrepancies caused by spreading material parameters and structural tolerances and is around 5,000 m³/element for standard elements and around 3,500 m³/element for special elements.

Subsequently the alignment of the element is adjusted if needed, e.g. by tugboats or immersion pontoons. Once the tunnel element is correctly positioned, the locking fill (via a drainpipe) is attached next to the element. The locking fill secures the position of the tunnel element in the trench and prevents movements caused by hydraulic loads or adding the remaining fill. The rest of the fill is introduced using drainpipes. A protection layer made of larger stones is added on top of and to the side of the elements. The protection layer is installed laterally from the edge of the barge using a grab dredger. The protection layer is generally around 1.2 m thick and protects the element from any sinking ships or ship anchors that are dragged across the seabed. The routes used by the transport ships delivering sand and stones to be used for the temporary containment embankments can be found in Attachment 27.1 of the plan approval documents, Section 3.1.5.8.

The depth of the tunnel was selected to ensure that, with the exception of the coastal area, the stone protection layer and the lateral fill with sand is always located beneath the level of the existing seabed. This thereby guarantees a subsequent natural re-filling, and thus the reproduction of a seabed which is comparable to its current situation. Model calculations and the assumptions derived from these with regard to sedimentation rates, which are derived from the knowledge of existing sediments and flows, and an assumption of the average depth of the trench have shown that the remaining tunnel trench will be re-filled by natural sedimentation within at most 28 years.

The initial depth of the tunnel trench after the end of the construction phase will vary as a result of the natural unevenness of the seabed (including local terrain slopes and seabed geometries) and the geometrically linear course of the immersed tunnel. In order to promote a timely restoration of the seabed conditions in all areas of the tunnel trench, further calculations will be made regarding the duration of the natural refilling time on the basis of the local terrain slopes and seabed geometries. The calculations are based on a conservative assumption of sedimentation rates and a concrete, segment-by-segment (200m) representation of the depth of the tunnel trench which is to be refilled. The calculations show that due to the natural unevenness of the seabed in particular parts of the tunnel route, a targeted refilling should be undertaken using sand, so as to keep up with the timescale of the natural refilling (Attachment 9.1, Sheet 1). Both the sand material and the lateral backfilling used will come from approved sand reclamation areas (see also LCP, Attachment 12 of the plan approval documents, Annex IA, Action Sheet 8.6).

Verification of the natural refill of the tunnel trench and the reproduction of the prior habitat is a part of the planned monitoring programme in the marine area (plan approval documents 22.9).

A cut-and-cover tunnel section approximately 600 m in length connects with the light transition zone on Fehmarn before the immersed tunnel. The areas are created in an open, dry trench on-site. After the cut-and-cover tunnel and the light transition zone are completed, the construction trench is filled again up to the planned upper level and the final reclamation area on Fehmarn created.

Based on the findings in Appendices 24 and 25 of the plan approval documents and the resulting settlement and elevation calculations, it can generally be stated that soil improvement measures are necessary in the areas of the light transition zone, the cut-and-cover tunnel and the immersed tunnel to minimise the shifts to be expected there in the long term. The section of soil improvement thus extends from chainage-km (road) 10+375 to 10+967. The soil is improved by introducing drilled cement piles (or driven steel pipes) down to a depth of approximately 20 m below the erosion level. The pile spacing has a centre-to-centre distance of 2-5m. A load-distributing gravel layer (approx. 1 m thick) will be added above the bored piles to which the backfill is then added and the flat-rounded structures erected. Soil improvement is carried out on both sides of the tunnel up to a maximum of 40 m.

In accordance with Attachment 25 of the plan approval documents , the ramp construction trench will penetrate an approximately 2.0 m thick layer made of post-glacial sands. The soil is improved by introducing drilled cement piles (or driven steel pipes) down to a depth of approximately 20 m below the erosion level. This is to ensure that the soil improvement measures will have no impact on the groundwater regime.

No groundwater will be lowered to create over- and underpasses on Fehmarn.

## 3.4. Construction site establishment, working harbours and production site

### 3.4.1. Site establishment on Fehmarn

Several independent sites must be established on Fehmarn to create the immersed tunnel. These sites will be used partly to supply the sea-based works and tunnel facilities through the portals as well as the onshore construction activities.

Attachment 27.1, Section 3.3 graphically depicts the individual construction site areas required on Fehmarn as well as the temporary allocation. They are used in part to supply the offshore work and the tunnel equipment via the portals and in part to support the onshore construction measures.

### General site locations on Fehmarn

General construction site areas on Fehmarn A range of general work is necessary for the entire onshore construction area and can thus not be assigned to individual activities. This includes, for example, areas used to store top soil, areas used for accommodation and road construction etc. Construction vehicles will be refuelled in areas approved and suitable for handling fuel. These areas will be paved in accordance with statutory regulations and drained using light material separators.

### Construction site area on Fehmarn used for storing top soil

A storage area is required for the temporary storage of the removed topsoil (approx. 260,000 $m^3$). The topsoil is removed from the areas in which the permanent structures are constructed as well as the areas where the various temporary construction sites and storage areas are situated. Except in the areas for the permanent structures, the topsoil will be replaced. The space for temporary storage will preferably be situated close to the area where the topsoil will be reused, but not in the area of the permanent structures. The amount of space required for storing topsoil depends on the area from which the topsoil is removed. The space for storing the topsoil requires an average erosion strength of 30 cm and must be around 2 m high i.e. around 130,000 $m^2$. The ground tenancies are built with a maximum width of 5 m and a maximum height of 2 m (cf. Attachment 12 of the plan approval documents, Annex IA, Action Sheet 0.8).

### Construction site areas for dredging work and land reclamation on Fehmarn

For the first dredging and reclamation work, a smaller construction site area is required on Fehmarn to provide office and storage areas for monitoring and providing supplies for the offshore work. An area of approximately 1,000 $m^2$ will be needed and kept available until the final construction site area has been created in the area of the working harbour. After the working harbour has been created, the final construction site to supply the dredging work will be created in the area of the working harbour. It will cover a total area of approximately 5,000 $m^2$ and apart from offices for site supervision will include sanitary facilities for harbour personnel and storage areas for equipment and spare parts.

The contractor engaged to carry out the dredging and reclamation areas will supply the fill material for the embankments which are constructed by the contractor for the onshore portal, trough structure and roads. The excavated material is supplied with barges and unloaded east of the new alignment or of the cut-and-cover tunnel section to be created. Floating cranes will load the excavated material from the barges onto trucks on land.

The trucks will transport the excavated material to an interim storage area, where it will be heaped to a height of up to approximately 8 m. The soil is deposited in such a way as to ensure safe storage. The embankments are constructed on an inclination which corresponds to the soil's geotechnical parameters. For transport, an access road will be constructed to the east of the alignment from the reclamation area to the interim storage area.

The amount of space required for the interim storage of the delivered material (approximately 850,000 m³) is approximately 110,000 m² and is planned to the east of the new rail line. From the interim storage area, the soil material will be taken to the individual installation sites as needed etc.

### Construction site areas for the cut-and-cover tunnel on Fehmarn

To create the cut-and-cover tunnel and the portals and trough structures, work is necessary such as drainage and excavation of the construction trench, ground improvement measures through boring, driven piles, construction of all structures including the technical equipment and refilling of the working spaces as well as the landscape design measures.

The following construction site areas are necessary for this work:

*General construction site areas for the construction of the cut-and-cover tunnel and for the portals and trough structures*

The space requirement for the general construction site is approximately 40,000 m². This area is situated close to the construction site and includes areas for offices, parking spaces, storage of building materials for the completion, workshops, storage of equipment, etc.

Access to the construction site is generally by vehicle via the public road. A construction road is planned between the construction site and the trench.

*Construction site areas for cement production*

The space required for producing the concrete used in constructing the cut-and-cover tunnel section and engineering works on Fehmarn (TPR = Tunnel Portal Ramps) amounts to around 25,000 m². This includes the area for the batching plants and the storage of concrete aggregates.

The cement production is located close to the working harbour in order to keep the transport routes for the aggregate, which is supplied by ship, short. The hold-off time for the concrete mixing plant (TPR) must not exceed 52 months. This time includes (dis)assembly and trial operations. In addition to the cut-and-cover tunnel section, the mixing plant will also supply concrete to the engineering works. The site location can be found in Attachment 9.4 of the plan approval documents.

Additionally, ballast concrete will be manufactured in a second site (TUS = Tunnel South) on Fehmarn. The space requirement for ballast concrete production (TUS) is approximately 15,000 m². This includes the area for the batching plant and the storage of concrete aggregates. The site location can be found in Attachment 9.4 of the plan approval documents. The construction site is accessed by vehicle from the public road and by vehicle from the temporary work harbour. A construction road is provided between the concrete production facility and each tunnel cross-section. The concrete plant (TUS) will provide ballast concrete in accordance with the lowering process and will be present for a maximum of 48 months, of which 31 months will see intensive use. For a period of around 8 months, this intensive operation will run in parallel with the operation of the intensive concrete mixing plant used for the cut-and-cover tunnel.

The accumulated water from the concrete processes or for the concrete processes is recirculated, treated again if necessary and used several times. The possibility that water with concrete additives is discharged into the discharge systems is ruled out. This waste water will be treated accordingly before being discharged to the existing, public waste water drainage and/or the drainage system with regard for the waste water Ordinance (AbwV) and in compliance with the discharge limit values.

*Supplying water to construction sites on Fehmarn*

The water required for the FBFL construction site located on Fehmarn over a period of around 60 months has been calculated at around 100,000 $m^3$. At peak times, the construction site on Fehmarn will require up to 14 $m^3$/h of water. A commitment in principle has already been obtained from the local water supplier on Fehmarn ensuring that, –until the months of July and August, – the water supply for the construction site can be obtained from the existing pipeline network for manufacturing purposes. However, the same provider could not provide a supply guarantee for the required quantities of water. In order to ensure the water supplies required for manufacturing purposes, it is therefore considered that the water needed during construction will need to reclaimed from a seawater desalination plant. Two alternative solutions for "water desalination over the whole construction period" will be shown hereinafter.

Seawater desalination must take place during the whole of the FBFL project's construction phase. Desalinated water can then be employed for manufacturing purposes. Installation of the seawater desalination plant with sufficient capacity for the aforementioned use will require an area of approximately 80–100 $m^2$. The total space used is located within the boundaries of the construction footprint shown on the plan approval documents (cf. Attachment 9.4 of the plan approval documents). The plant is made up of two, approx.12 $m^3$-tanks and two 10 $m^3$storage tanks and will be situated in the same area as the concrete mixing works.

The seawater desalination plant uses a well-known process called reverse osmosis to process the water. The water is pressed through semi-permeable membranes using high pressure pumps. The choice of membrane is based on the quality of the water source and the desired properties of the water being prepared. This process produces desalinated water (permeate) and residual water (concentrate) which, when compared with the untreated water, contains an increased concentration of mineral substances. When using water drawn from the Fehmarnbelt in the Baltic Sea, the relationship between the desalinated and untreated water can fluctuate by between 40:60 and 50:50. The power consumption amounts to approximately 3.2 kW per$^3$ of desalinated water.

Before undergoing reverse osmosis, the untreated water drawn from the Fehmarnbelt is fed through a sand filter which removes larger microbiological impurities and prevents the osmosis membranes from becoming clogged. The sand filter is rinsed on a regular basis both for maintenance reasons as and when required and depending on the biological content of the incoming water.

The untreated water is pumped from the Fehmarnbelt using pumps and a supply pipeline. The inflow is located in the harbour basis of the temporary work harbour. Arake situated in front of the supply pipe prevents fish from being sucked in. The rake will have be placed at a distance of around 1 cm. The opening will have an overall dimension which will ensure an inflow speed of ≤ 0.3 m/s over the surface of the rake. After desalination has been carried out, the resulting water will be fed into a storage tank which is connected to the water supply for the concrete works, inter alia. The residual water is stored in another storage tank from which it is fed back into the Fehmarnbelt through an outlet pipe (to the area where the east pier of the temporary work harbour is located). The location of the concrete works and the seawater desalination plant, including the inflow/outlet route, can be found in Attachment 9.4 of the plan approval documents.

The content of different ions in the Baltic Sea water drawn from the Fehmarnbelt fluctuates between +50 % to -33 % with regard to average salinity.

**Table 26 Content of various compounds in Fehmarnbelt water in permeate and in concentrate**

| Ion | Unit | Baltic Sea feed water at 18 psu salinity | Desalinated water (permeate quality) | Residual water (concentrate quality) |
|---|---|---|---|---|
| Chloride | $Cl^-$ | 9.900 | 18 | 18.322 |
| Sodium | $Na^+$ | 5.580 | 11 | 10.137 |
| Sulphate | $SO_4^{2-}$ | 1.386 | 0,24 | 2.520 |
| Magnesium | $Mg^{2+}$ | 666 | 0,29 | 1.211 |
| Calcium | $Ca^{2+}$ | 216 | 0,09 | 393 |
| Potassium | $K^+$ | 198 | 0,43 | 360 |
| pH | (-) | 8,1 | 8,1 | 8,1 |
| Dissolved solids (total) | TDS | 17.946 | 29,3 | 32.942 |

Estimated daily accruing volume at peak production times:
Untreated Fehmarnbelt water 336–420 $m^3$
Desalinated water (permeate) 168 $m^3$ (default = 14 $m^3$/h over 12 hours)
Residual water (concentrate) 168–252 $m^3$

Estimated total volumes over total length of the FBFL project:
Untreated Fehmarnbelt water 200,000–250,000 $m^3$
Desalinated water (permeate) 100,000 $m^3$
Residual water 100.000–150.000 $m^3$

### Construction site areas for the immersed tunnel on Fehmarn

The following offshore work requires onshore activities:

*Removal of immersion aids (water ballast tanks, bulkheads etc.)*

The sealing bulkheads and ballast tanks will be removed from inside the tunnel elements and transported through the tunnel in the direction of the mainland and in an area close to the working harbour. From the working harbour, the immersion equipment will be taken by sea to the element production site to Lolland. A total area of approximately 7,500 m² is required for the inspection, repair and temporary storage of the sealing bulkheads and ballast tanks.

*Completion of joints*

Material needs to be provided and prepared for the completion of the joints between the tunnel segments. Space for workshops, storage of equipment, storage of construction products etc. is therefore provided on the construction site. The space requirement for this construction site area is approximately 15,000 m².

### Construction site areas for engineering structures, earthworks and road construction on Fehmarn

A primary construction site area 15,000 m² in size and construction site areas of approximately 3,000 to 5,000 m² in size for every individual structure are required for the construction of the bridges and other engineering structures (e.g. retaining walls), and to carry out earthworks south of the portal and trough structures. These are used to load and unload material, to cut and form reinforced steel, to produce the formwork and concrete and prepare the rail and road substructure including all earthworks and drainage work.

### Construction site areas for railway equipment on Fehmarn

The railway equipment includes the installation of the track superstructure (ballast, cross-ties, track), the catenary systems and signalling, and all the rail maintenance facilities, as well as putting the rail line into service. The space required for site establishment comprises around 10,000 m² and has space for storing and preparing the track sleepers, tracks and cable pits. An additional approximately 1.500 m² are required for storing the catenary system and cable material.

### Construction site area for tunnel technical equipment on Fehmarn

The work on the technical tunnel equipment includes:

- Installation of the permanent mechanical and electrical systems in the tunnel structure and the portal building and outside the tunnel along the road (for example cameras, height detection system, lighting, etc.). For these activities, construction area sites are necessary for the temporary storage and preassembly of mechanical and electrical installations on the construction site before they are installed in the

tunnel. Approximately 7,000 m² of space is required for the mechanical and electrical works.
- Operation and monitoring of the installations in the tunnel and testing the installations before the tunnel goes into service. The tests will generally be carried out in the portal building. Before the portal building is available, functional tests will be performed after the first installations are fitted in the tunnel. Approximately 1,500 m² of space is required for the mechanical and electrical works. The planned location of the construction site is therefore directly adjacent to the future portal building.

The land used for the temporary construction site areas will be restored after construction work is completed and the original use resumed.

### 3.4.2. Temporary working harbours

To build the immersed tunnel, two temporary working harbours are planned: one on the German side at Puttgarden and one on the Danish side at Rødbyhavn. The following information on the Danish working harbour is included for informational purposes only.

The temporary working harbours are to be used for landing tugboats, passenger and supply ships for offshore activities to construct the Fehmarn Fixed Link and to supply the onshore construction site on Fehmarn and Lolland. The harbours can be used both during normal operations and during bad weather conditions and storms.

The Danish temporary working harbour on Lolland (for informational purposes only) will be located to the east of the landing point of the immersed tunnel and integrated into the production site to produce the tunnel elements. The working harbour on Lolland will then be re-filled and become part of the planned permanent reclamation areas. As on Lolland, the working harbour on Fehmarn will be disassembled after the tunnel has been completed.

**Fehmarn temporary working harbour**

The temporary harbour on Fehmarn is not a public harbour and its sole use is to supply the FBFL construction site for onshore and offshore work. The temporary working harbour on Fehmarn is partly inside and partly outside of the subsequently planned reclamation area northwest of the area for the cut-and-cover tunnel and northeast of the existing ferry harbour (see Attachment 9.4 of the plan approval documents). This location was chosen because a large part of it uses land which is required anyway later on (reclamation area). The harbour basin of the temporary working harbour also has the necessary water depth of -5.5 m below sea level so that it is not necessary to dredge a channel. The breakwater of the temporary working harbour will not extend to the north beyond the existing breakwater of the Puttgarden ferry harbour (cf. Attachment 9.4 of the plan approval documents).

The trench for the cut-and-cover tunnel including the respective construction site facilities will connect southeast of the temporary working harbour. The trench for the cut-and-cover tunnel will be surrounded by a temporary internal embankment in the east and west, by a temporary containment embankment in the north and by the existing coastline of Fehmarn in the south.

The temporary soil depot is located to the east of the trench for the cut-and-cover tunnel. On Fehmarn, the offshore excavated material will be unloaded and temporarily stored in these areas until it is brought to the construction areas. The area is surrounded by the trench for the cut-and-cover section of the tunnel in the west, its own temporary perimeter embankment in the north and east and the existing coastline of Fehmarn in the south. The temporary working harbour on Fehmarn will be constructed as part of the coastal construction activities together with preparation of the area for the cut-and-cover tunnel and the temporary soil depot shortly after the entire project starts.

It is estimated that it will take around 8 months to build the working harbour and can be broken down into roughly four construction phases.

Construction phase 1:
Dams will be built in the Fehmarnbelt to the east of the Puttgarden ferry harbour as rear and lateral protection. The lateral protection will be formed using the ferry harbour's existing breakwater. Part of the newly-constructed embankment will be used for a cut and cover tunnel when the excavation works have been completed. The rear dam represents the first part of the future construction site areas used for the harbour. It will be reinforced on the seaward-facing side using a spur dyke as a sea defence (Figure 34). The hatches are used for the following purposes:

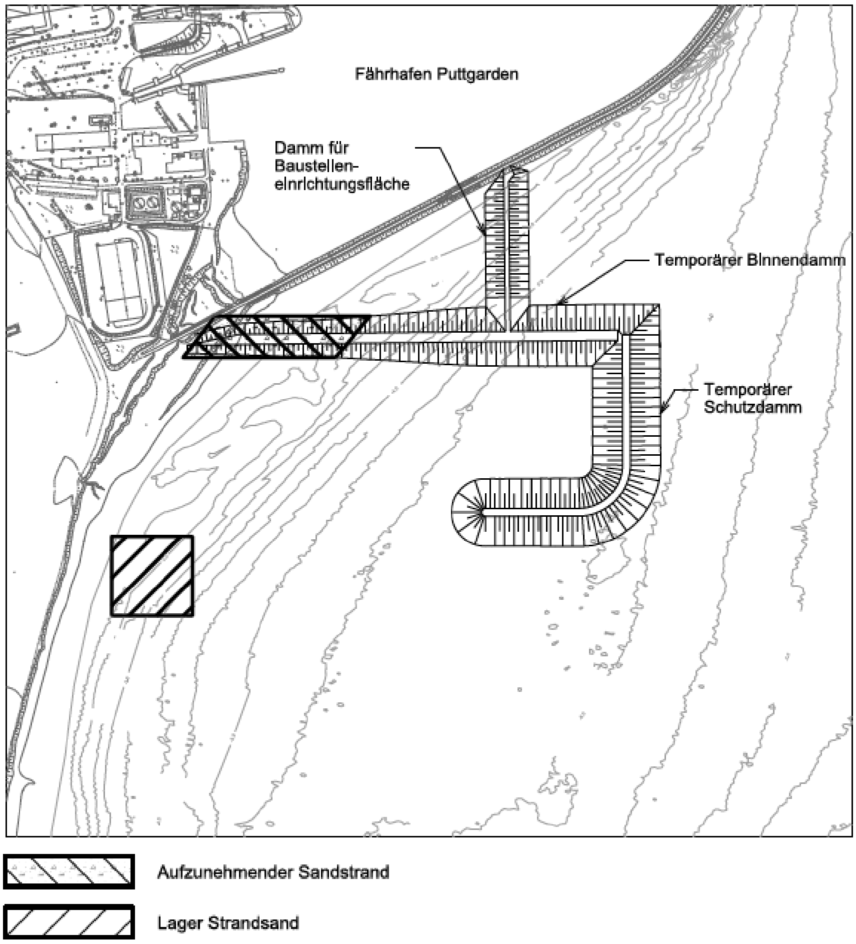



**Figure 34 Construction phase 1 (month 0–1): Building a temporary protection embankment, inner dyke and embankment for construction site areas, including areas used for storing and depositing sand.**

| | |
|---|---|
| Damm für Baustelleneinrichtungsfläche | Embankment for site facilities areas |
| Temporärer Binnendamm | Temporary inner dyke |
| Temporärer Schutzdamm | Temporary protection embankment |
| Aufzunehmender Sandstrand | Receiving beach |
| Lager Strandsand | Beach stockpiles |

Construction phase 2:
At the same time as dredging is being carried out in the area where the cut-and-cover tunnel is being excavated, the sheet piles for the quay wall and working harbour will be brought in within four weeks. A total of around 190 m of quay walls with approximately 330 sheet piles must be attached for the working harbour on Fehmarn (Figure 35).

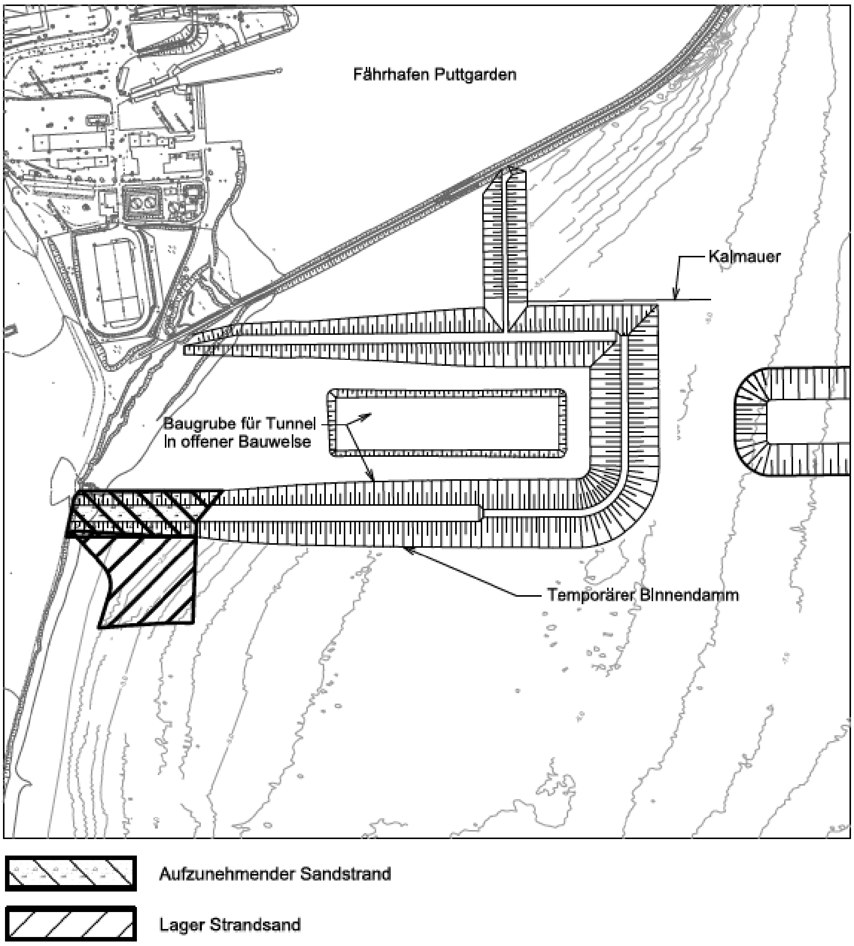



**Figure 35 Construction phase 2 (months 1–3): Completing excavation work for the cut-and-cover tunnel, including areas used for storing and depositing sand**

| | |
|---|---|
| Kaimauer | Quay wall |
| Baugrube für Tunnel in offener Bauweise | Excavation for cut-and-cover tunnel |
| Temporärer Binnendamm | Temporary inner dyke |
| Aufzunehmender Sandstrand | Receiving beach |
| Lager Strandsand | Beach stockpiles |

## Construction phase 3:

After all the embankments have been constructed, the breakwaters for the temporary working harbour will be built with a central core made of sand and marl and a spur dyke used as a sea defence. For scour protection purposes, the spur dyke is integrated roughly 1 m into the in-situ ground. To protect this embankment, the breakwater and the temporary inner dyke used for the excavation of the cut-and-cover tunnel, the construction site areas will be filled with re-claimed excavation material. After the sheet piles have been backfilled with fill material, an-chored and the quay has been built, the pontoon is attached approx. +2.50 m above sea level and drainage and electricity supply are connected. At the same time the working harbour is being built, the containment embankment located to the east of the trench for the cut-and-cover site will be built to store the material for the temporary stockpile. The trench for the cut and cover tunnel is excavated after the excavated earth has been drained at the target depth (Figure 36).

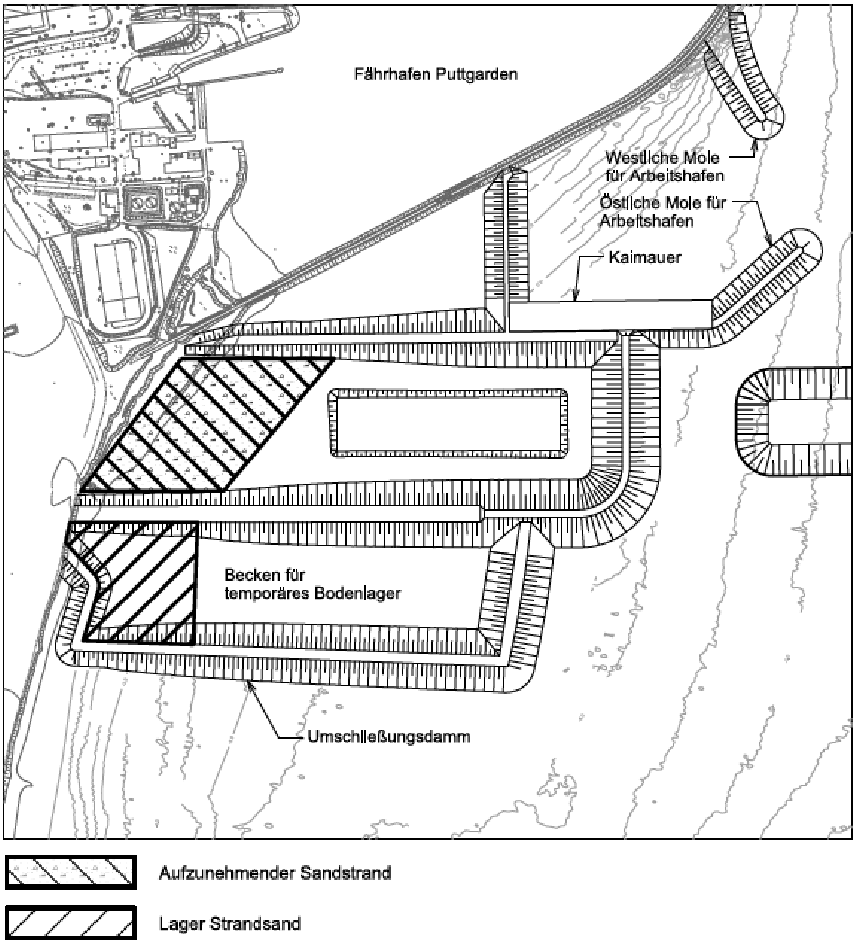



**Figure 36 Construction phase 3 (months 3-4): Building a working harbour, including areas used for storing and depositing sand**

| | |
|---|---|
| Fährhafen Puttgarden | Puttgarden ferry harbour |
| Westliche Mole für Arbeitshafen | Western breakwater for working harbour |
| Östliche Mole für Arbeitshafen | Eastern breakwater for working harbour |
| Kaimauer | Quay wall |
| Becken für temporäres Bodenlager | Pool for temporary soil depot |
| Umschliessungsdamm | Enclosure embankment |
| Aufzunehmender Sandstrand | Receiving beach |
| Lager Strandsand | Beach stockpiles |

Construction phase 4:
After the filling of the harbour's construction site area has been carried out, these areas will also be raised to +2.5 m above sea level, drainage and electrical supply connected and the

access road for the construction site built. After the western counterpart to the eastern break-water has been completed, the harbour will be ready to commence operations roughly 8 months after the onshore construction activities have begun (Figure 37).

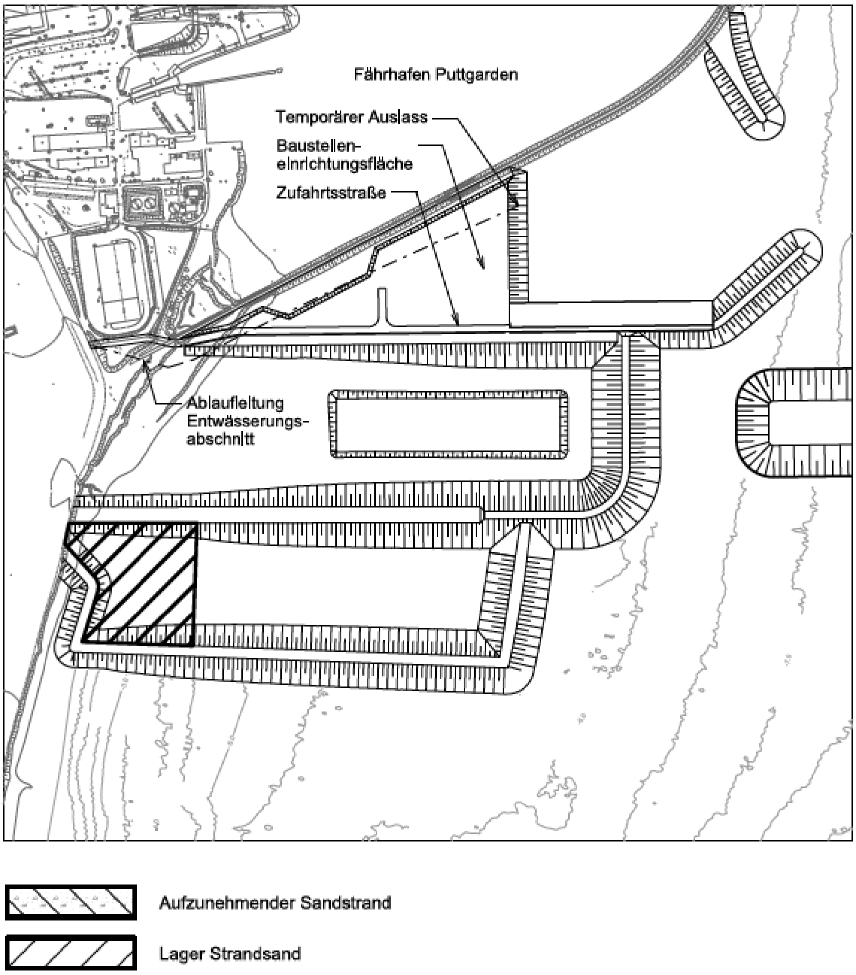



**Figure 37** **Construction phase 4 (months 4-8): Completing a working harbour and commencing a dredging trench, including areas used for storing and depositing sand**

| | |
|---|---|
| Fährhafen Puttgarden | Puttgarden ferry harbour |
| Temporärer Auslass | Temporary outlet |
| Baustelleneinrichtungsfläche | Site facilities area |
| Zufahrtstrasse | Access road |
| Ablaufleitung<br>Entwässerungsabschnitt | Discharge pipe<br>Drainage zone |
| Aufzunehmender Sandstrand | Receiving beach |
| Lager Strandsand | Beach stockpiles |

Dismantling the working harbour and building a reclamation area on Fehmarn:

After the tunnel elements have been immersed, ballast concrete has been introduced into the tunnel and while the tunnel is outfitted and the final design for the reclamation area drawn up, the temporary working harbour on Fehmarn and the temporary stockpile will be dismantled and the cut-and-cover tunnel will be filled. This means that the working harbour will have a useful life of 54 months. As part of the dismantling process, which will last around 12 months, the quay wall and breakwaters, the structures. surface attachments and supply cables will be removed and disposed of properly.

Subsequently, the harbour area and breakwaters along with their spur dykes located above water level will be removed using land-based equipment and the soil taken to the reclamation area. This is carried out using dredgers positioned at the end of the breakwater which pick up the soil and load it onto a tipper. The submersed soil and the western pier are removed via dredging, mainly carried out using shovel excavators, up to the elevation of the natural seabed. This process will release a maximum of 400 tons (approx. 250 $m^3$) of sediment. While planning the construction phase, care is taken to ensure that these works are only carried out between October and February.

Dismantling the working harbour on Fehmarn is considered in the numerical simulation on sediment drifting and to evaluate the potential environmental impacts, even when the working harbour has not been dismantled within a period of marine construction activity lasting 4.5 years. It has been guaranteed that the dismantling of the working harbour and the creation of the new embankment line for the reclamation area will be an integral part of the onshore sediment release rates.

The sheet piles and poles will be removed using a floating installation on stilt-mounted pontoons. If the sheet piles and poles are not steeped, they will be cut off at 1.0 m below the seabed.

The reclamation area will then be formed as specified in the plan approval documents (cf. Figure 38 and Attachment 12.2, Sheet 8, 9).

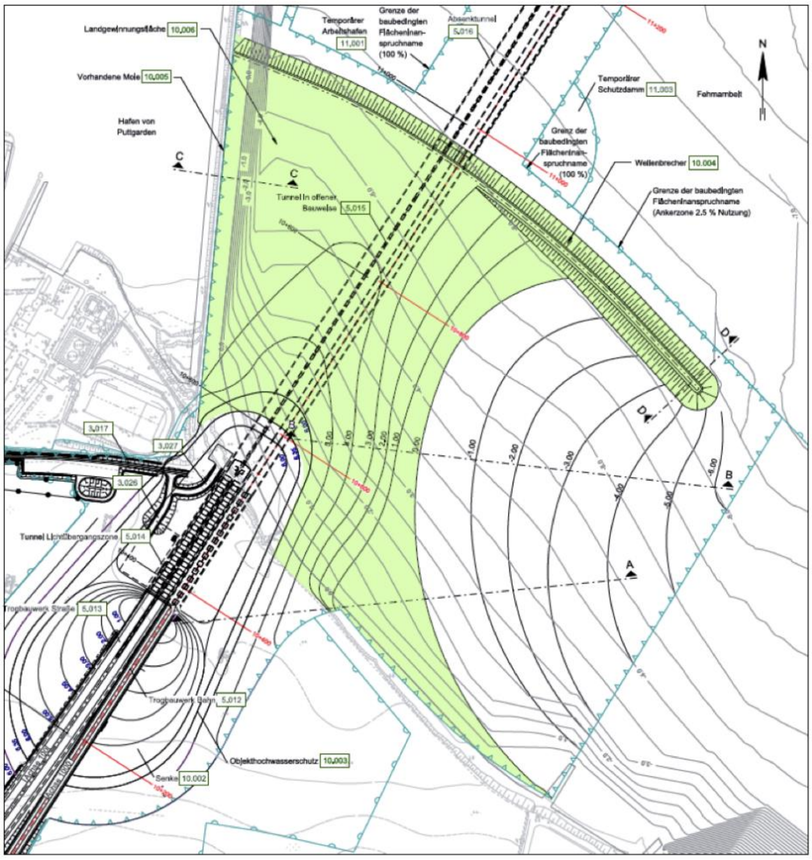



**Figure 38 Representation of the completed reclamation area (green) directly to the east of the Puttgarden ferry harbour (top left of the figure)**

| | |
|---|---|
| Landgewinnungsfläche | Reclamation areas |
| Vorhandene Mole | Existing breakwaters |
| Hafen von Puttgarden | Puttgarden harbour |
| Temporärer Arbeitshafen | Temporary working harbour |
| Grenze der baubedingten Flächeninanspruchnahme (100%) | Boundary of project-related footprint (100%) |
| Absenktunnel | Immersed tunnel |
| Temporärer Schutzdamm | Temporary protection embankment |
| Grenze der baubedingten Flächeninanspruchnahme (100%) | Boundary of project-related footprint (100%) |
| Wellenbrecher | Wave breaker |
| Grenze der baubedingten Flächeninanspruchnahme (Ankerzone 2,5% Nutzung) | Boundary of project-related footprint (anchor zone 2.5% use) |
| Fehmarnbelt | Fehmarnbelt |
| Tunnel in offener Bauweise | Cut-and-cover tunnel |
| Tunnel Linienübergangsgrenze | Light transition area, tunnel |
| Trogbauwerk Strasse | Trough structure road |
| Trogbauwerk Bahn | Trough structure railway |
| Objekthochwasserschutz | Object flood protection |
| Senke | Sink |

### 3.4.3. Production facility for tunnel elements to the east of the Rødbyhavn harbour (for information only)

The plan is for the tunnel elements to be manufactured in a production site established specially for this purpose to the east of the Rødbyhavn harbour. The production site will be located partly on land and partly off the current coast in the reclamation area.

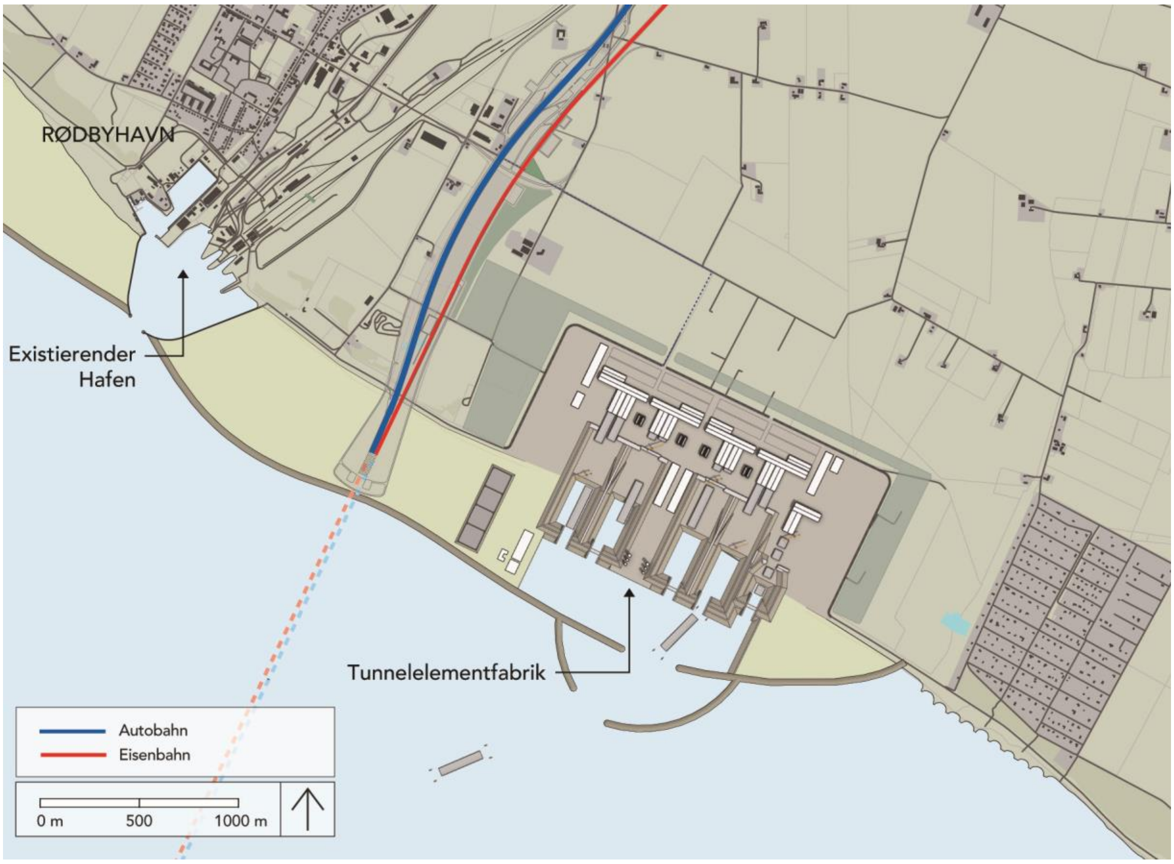



**Figure 39 Production facility for tunnel elements on Lolland**

| | |
|---|---|
| Existierender Hafen | Existing harbour |
| Tunnelelementfabrik | Tunnel element factory |
| Autobahn | Motorway |
| Eisenbahn | Railway |

As already described, the immersed tunnel comprises a total of 89 tunnel elements, of which 79 are standard and 10 are special elements. The reinforcement is prefabricated and the concrete is poured under controlled conditions in a factory building. Situated directly in front of the plant's production building is an adjoining flotation basin, which is partly shallow and partly deep and from which there is access to the Fehmarnbelt via a floating gate.

Each element will be concreted in short sections, referred to as segments. The plant is expected to produce one segment per production line every seven to eight days. Each segment

will be concreted in formwork on a solid bed.
Once it reaches a minimum strength, the segment will be released from the formwork with the aid of hydraulic presses and slid into the shallow flotation basin so that the next segment can be concreted. Once all the segments of a tunnel element have been manufactured, they are joined together using tendons to form a complete tunnel element.

Once a tunnel element is finished, the last piece is slid into the shallow part of the flotation basin where it is equipped to the fullest extent, fitted with ballast tanks and provided with a watertight bulkhead at each end. The flotation basin, which is surrounded by embankments and gates, will then be separated from the sea using a sliding door from the manufacturing area and a floating gate and then flooded with water in a controlled process until the tunnel elements float. Then the tunnel elements are pulled into the deep part of the basin and moored, at which point the water is pumped out of the basin to reduce the water level back down to the level of Fehmarnbelt. The sliding gate and floating gate can then be opened. Now the upper shallow basin will once again be dry and will be ready for the next tunnel elements.

From the deep basin, the elements are then towed to a predetermined holding area near the tunnel trench in the Fehmarnbelt, where they are ready for immersion in the tunnel trench. When the element reaches the holding area, it is connected with the pontoons necessary for the immersion process.

## 3.5. Significant impact factors and effects of the project (due to construction, facilities and operations)

The following tables show significant potential impact factors due to construction, facilities and operations for the onshore and marine area (see Table 27 and Table 28).

**Table 27 Overview of the potential project impacts in the onshore area (Fehmarn)**

| | **Construction-related (temporary) project impacts through the construction field, construction area facilities and construction operations** | **Installation-related (permanent) project impacts through the construction of transport routes, structures and permanent maintenance facilities** | **Operation-related (permanent) project impacts through installation operation, rail and road transport** |
|---|---|---|---|
| Mainland (Fehmarn) | Footprint | Footprint | |
| | Fragmentation/barrier effect | Fragmentation/barrier effect | Fragmentation/barrier effect |
| | Visual and sensory disturbances | Visual and sensory disturbances | Visual and sensory disturbances |
| | Lowering of groundwater level during construction | Permanently necessary lowering of groundwater level and groundwater aquiclude | |
| | Noise and air pollution, light emissions caused by construction site operation | | Noise and air pollution, light emissions |

| | Construction-related (temporary) project impacts through the construction field, construction area facilities and construction operations | Installation-related (permanent) project impacts through the construction of transport routes, structures and permanent maintenance facilities | Operation-related (permanent) project impacts through installation operation, rail and road transport |
|---|---|---|---|
| | Risk of collision due to construction site operation | Risk of collision with the structures | Transport-related risk of collision |
| | Vibrations due to construction site operation | | Transport-related vibrations |
| | | | Electromagnetic fields through overhead electrification of railway |

**Table 28 Overview of the potential project impacts in the marine area (Fehmarn)**

| | Construction-related (temporary) project impacts within the construction area, construction area facilities and construction operations | Installation-related (permanent) project impacts through the structures with permanent maintenance facilities (e.g. rockfill, land reclamation) | Operation-related (permanent) project impacts through installation operation, rail and road transport |
|---|---|---|---|
| Marine area | Footprint of the seabed | Footprint of the seabed through superstructures and underwater structural components | |
| | Barrier effect | | |
| | Suspended sediments | | |
| | Sedimentation | | |
| | Hazardous substances | | |
| | Nutrients | | |
| | Introduced construction materials and transporting construction materials | | |
| | | Hard substrate (spur dykes) | |
| | | Change in the seabed and/or coast morphology | |
| | | Change in the hydrography and/or water quality | |
| | Visual disturbances | | |
| | Collision (e.g. birds) | | |
| | Drainage | | Drainage |
| | Noise | | |
| | Light | | |
| | Electromagnetic fields | | Electromagnetic fields |

Bird migration and bat migration are to be given superordinate consideration for the marine and onshore area ("superordinate area"). The potential project impacts are identified below.

### Bird migration

- construction-dependent barrier effects
- collisions with construction ships

### Bat migration

- construction-, installation- and operation-dependent habitat loss and change
- construction-, installation- and operation-dependent barrier effects
- installation- and operation-dependent collisions
- construction-, installation- and operation-dependent disruptions (noise and light and working ships)

## 3.6. Timeline

The plan is to conclude contracts with the future construction companies with a runtime of 8.5 years. The "active" construction work involved in the immersed tunnel will still be completed in the marine area offshore within approximately 4.5 years. The time estimated for the onshore "active" construction work on Fehmarn remains unchanged at 6.5 years. The individual construction activities in some cases are interdependent and in other cases will also run independently in parallel. Before the construction activities on Fehmarn and the in the Fehmarnbelt can begin, a planning and mobilisation time is envisaged. After completion, a period is also required to clear and restore the site.

The tables below (see Table 29 and Table 30) show the activities required with their duration in relation to the offshore work in the Fehmarnbelt and the onshore work on Fehmarn. More detailed information on this schedule can be found in Attachment 27.1, Section 2.

**Table 29 Offshore activities related to the construction project in the Fehmarnbelt**

| No. | Activity | Duration |
|---|---|---|
| 0. | Final review and clearance of the detailed design and clearance of the offshore mobilisation/installation work on the German side | approx. 17 months |
| 1. | Construction of temp. working harbour | approx. 8 months |
| 2. | Construction of temp. soil depot and the area for the cut-and-cover tunnel (perimeter embankments) | approx. 6 months |
| 3. | Provision of working harbour | approx. 56 months |
| 4. | Creation of tunnel trench | approx. 18 months |
| 5. | Immersion and trench backfill | approx. 38 months |
| 6. | Dismantling temp. working harbour and temp. soil depot and final formation of the reclamation area | approx. 12 months |

**Table 30 Offshore activities related to the construction project on Fehmarn**

| No. | Activity | Duration |
|---|---|---|
| 0. | Review and clearance of the detailed design and mobilisation work on Fehmarn | approx. 28 months |
| 1. | Cut-and-cover tunnel, trough structures and portals including portal buildings | approx. 52 months |
| 2. | Completion of tunnel via the portals (removal of immersion equipment, ballast concrete, joints) | approx. 35 months |
| 3. | Engineering structures (duration per structure) | approx. 6-18 months within 38 months |
| 4. | Earthworks and road construction | approx. 74 months |
| 5. | Railway equipment | approx. 35 months |
| 6. | Tunnel technical equipment | approx. 49 months |
| 7. | Monitoring, inspection, testing tunnel fixed equipment | approx. 58 months |

## 3.7. Onshore land and soil requirements

### Earthworks

The excavated soil volumes already included in the "B 207 upgrade" in the plan approval procedure are listed separately in the plan approval for better clarity.

The extracted soil is used for the necessary fill and backfill work. A total of approximately 670,000 m³ of excavated material and approximately 260,000 m³ of removed topsoil will accumulate during the onshore excavation work on Fehmarn.

**Table 31 Onshore excavation volumes by origin (volumes in situ)**

| Excavation area | Volume (m³) |
|---|---|
| Topsoil (of which approx. 65,000 m³ is from the plan modifications "B 207 upgrade") | 260.000 |
| Excavation (suitable for reintegration into the road area - of which approx. 72,000 m³ is from the plan modifications "B 207 upgrade") | 603.000 |
| Excavation (not suitable for reintegration into the road area because it cannot be adequately compacted – of which approx. 8,000 m³ is from the plan modifications "B 207 upgrade") | 67.000 |
| **Total** | **930.000** |

**Table 32 Reuse of onshore excavation material (volumes in situ)**

| Type of reuse | Volume (m³) |
|---|---|
| Topsoil | 260.000 |
| Road and railway system | 603.000 |
| Terrain modelling | 67.000 |
| **Total** | **930.000** |

However, approximately 1,614,000 m³ of soil is needed for the different construction measures on Fehmarn (without reclamation area). In addition to the reuse of the excavated material extracted onshore of 670,000 m³, an additional approximately 850,000 m³ of soil is therefore needed from the offshore construction area.

Already approximately 94,000 m³ of excavated material has already been included in the "B 207 upgrade" mass balance for the plan modifications. This will be retained in the FBFL plan approval procedure. The topsoil requirement will be completely covered by the topsoil accumulated in the project.

**Table 33 Total soil requirement on Fehmarn and origin**

| **Soil requirement for backfill work on Fehmarn (without topsoil)** | **1,614,000 m³** |
|---|---|
| Is covered by: | |
| Reuse of the material excavated onshore | 670,000 m³ |
| Supplied from the offshore excavation area | 850,000 m³ |
| Use of the onshore excavation from "B 207 upgrade" (was already included in the modification plan) | 94,000 m³ |

The excavated material accumulated onshore will be completely supplied for reuse (see Table 31 and Table 32).

### Offshore earthworks

The bulk of the accumulated excavated material will stem from the creation of the trench for the immersed tunnel. In addition, soil will accumulate from the creation of the temporary working harbour on Lolland and from the ramp areas created offshore.

**Table 34 Offshore excavation volumes by origin (volumes in situ)**

| **Excavation area** | **Volume (m³)** |
|---|---|
| Trench area Fehmarnbelt German coastal waters | 3.800.000 |
| Removing sediment from the Fehmarnbelt trench area in German coastal waters | 54.000 |
| Trench area Fehmarnbelt German EEZ | 4.200.000 |
| Removing sediment from the Fehmarnbelt trench area in the German EEZ | 50.000 |
| Fehmarnbelt excavated area in Danish sovereign territory (for information only) | 6.400.000 |
| Removing sediment from the Fehmarnbelt excavated area in Danish sovereign territory (for information only) | 98.000 |
| Access channel, production facility and temporary working harbour on Lolland (for information only) | 4.585.000 |
| Portal and ramp area on Lolland (for information only) | 67.000 |
| Portal and ramp area on Fehmarn | 84.000 |
| **Total** | **19.338.000** |

The gravel fill that is accumulated can also be used for backfilling the ramp areas and the reclamation areas.

The volumes anticipated for the various reuse options are shown in the following table (see Table 35).

**Table 35 Reuse of offshore excavation material (volumes in situ)**

| Type of reuse | Volume ($m^3$) |
|---|---|
| Road and railway systems, backfilling the ramp areas on Fehmarn | 850.000 |
| Road and railway systems, backfilling the ramp areas and ponds on Lolland (for information only) | 1.335.000 |
| Reclamation area on Fehmarn | 1.040.000 |
| Reclamation areas on Lolland | 16.113.000 |
| **Total** | **19.338.000** |

The excavated material accumulated offshore will therefore be completely reused. Before the excavated material supplied offshore on Fehmarn is integrated into the areas above, the excavated material is temporarily stored on different areas in the construction area. The temporary storage plan can be found in Attachment 27, Section 3.2.2.1.

### Space required

A total of 121.5072 ha of land will be utilised by the construction project on Fehmarn, of which 62.0092 ha will have permanent structures (road transport areas, rail areas, maintenance facilities, etc.) and 59.4980 ha temporary structures (e.g. construction site areas).

# 4. Description of the environment

## 4.1. Investigation area

The investigation area for the project can be split into an onshore area and a marine area.

### Fehmarn onshore area

The onshore investigation area of the FBFL covers the northeast of the island of Fehmarn. The island of Fehmarn forms the north-eastern limit of the "Schleswig-Holstein Uplands" area of unspoiled nature. Fehmarn has a flat terrain with very fertile soils and a sunny climate with relatively little rain which favours intensive agriculture. The present-day boulder-clay soils, rich in lime, developed from the ground moraine deposited by glaciers. Their productivity is measured as 60 to 85, making them highly suited to agriculture. This applies especially to the dominating pseudogley to chernozem pseudogley (the so-called "Fehmarn black earth").

The limit of the onshore investigation area is determined by constraints resulting from the route of the bored tunnel variant for the plan approval (e.g. the connection point to the road/rail hinterland infrastructure on Fehmarn). It is also determined by the most far-reaching impacts or impact zones starting from the bored tunnel (see state of knowledge in EIA report, main comparison/bored tunnel variant [Attachment 15]):

- Noise levels of 49 dB(A) (daytime), which is the equivalent of the isophone for impairments which are to be assumed for landscape-linked recovery according to the orientation framework (MWAV & MUNF 2004)
- Noise levels of 49 dB(A) at night, which is the limit value for noise impact on residential areas according to the 16th Federal Immission Control Ordinance (BimSchV)
- The 500 m distance from the planned road edge and/or from the land used temporarily for construction because up to this distance the area has been used in the EIA as an impact zone affected by noise and other interferences (based on the effect distances of Garniel & Mierwald 2010) in the sense of the precautionary principle for breeding and resting birds.

By way of precaution, the investigation area also covers all the settlement areas of the districts of Puttgarden and Marienleuchte. The start of the plan approval segment on Fehmarn overlaps in part with the plan approval segment of the B 207 hinterland road connection. To cover this overlap, the investigation area of the LCP is therefore extended inwards 100 m into the plan approval segment of the B 207.

The border between the onshore and marine parts of the investigation area is only of importance for balancing impact and compensation. It runs along the coast to the north of Puttgarden to a point southwest of Marienleuchte. The harbour basin is included in the onshore area.

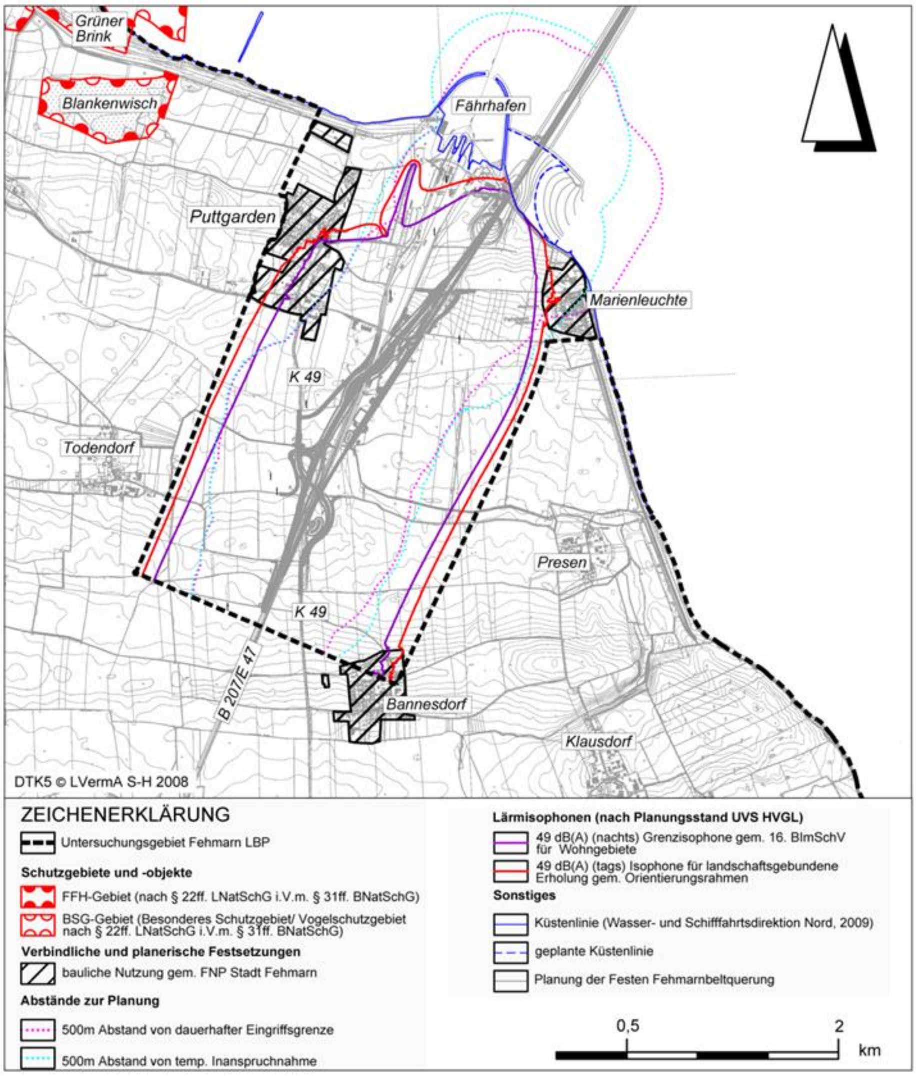



**Figure 40 Onshore LCP investigation area on Fehmarn**

| ZEICHENERKLÄRUNG | KEY |
|---|---|
| Untersuchungsgebiet Fehmarn LBP | Fehmarn investigation area LCP |
| Schutzgebiete und –objekte | Conservation areas and objects |
| FFH-Gebiet (nach § 22ff. LNatSchG i. V. m. § 31ff. BNatSchG) | SCI (according to § 22 et seq. LNatSchG in conjunction with § 31 et seq. BNatSchG) |
| BSG-Gebiet (Besonders Schutzgebiet/Vogelschutzgebiet nach § 22ff. LNatSchG i. V. m. § 31ff. BNatSchG) | Special conservation area/bird conservation area in accordance with § 22 et seq. LNatSchG in conjunction with § 31 et seq. BNatSchG) |
| Verbindliche und planerische Festsetzungen | Binding and planning definitions |
| Bauliche Nutzung gem. FNP Stadt Fehmarn | Structural use in acc. with FNP Municipality of Fehmarn |
| Abstände zur Planung | Planning distances |
| 500m Abstand von dauerhafter Eingriffsgrenze | 500m from permanent impact limit |
| 500m Abstand von temp. Inanspruchnahme | 500m from temp. use |

| | |
|---|---|
| Lärmisophonen (nach Planungsstand UVS HVGL) | Noise levels (based on planning status EIA HVGL) |
| 49 dB(A) (nachts) Grenzisophone gem. 16 BlmSchV für Wohngebiete | 49 dB (A) (night-time) noise limit for residential areas according to the 16th Federal Immission Control Ordinance |
| 49 db(A) (tags) Isophone für landschaftsgebundene Erholung gem. Orientierungsrahmen | 49 db (A) (day-time) noise limit for landscape-linked recovery according to the orientation framework |
| Sonstiges | Miscellaneous |
| Küstenlinie (Wasser- und Schifffahrtsdirektion Nord. 2009) | Coastline (Water and Navigation Command North. 2009) |
| Geplante Küstenlinie | Planned coastline |
| Planung der Festen Fehmarnbeltquerung | Planned Fehmarnbelt Fixed Link |

## Marine area

The marine investigation area is shaped by the Fehmarnbelt, which is a strait in the Baltic Sea between Lolland (Denmark) and Fehmarn (Germany). Along with the Bay of Kiel and Bay of Mecklenburg, it forms the southern edge of the Belt Sea, which includes not only the Fehmarnbelt but also the Little Belt, the Great Belt, Øresund and a series of smaller belts (e.g. Alsenbelt, Langelandbelt, Samsøbelt). The Belt Sea is the passage between the Kattegat in the north and the Baltic Sea itself. Around 70% of the water passing between the Arkonasee and the Kattegat comes through the Fehmarnbelt because it is the deepest and widest of the passages (compared with Fehmarnsund and Øresund).

Very particular living conditions have arisen in the Fehmarnbelt area due to the natural location of the Baltic Sea as an intracontinental sea with a narrow link to the North Sea and the world's oceans. Salt-rich bodies of water from the Kattegat and low-salt water from the inner Baltic Sea mix and produce layers of ever changing sizes. These shape the special dynamics of this area as a transition zone between a marine and fresh water habitat.

The northern boundary of the section to be approved in German territory at the German-Danish border in the Fehmarnbelt is produced for reasons of national responsibility. In terms of aspects relating to the environment and impact, in some cases the marine Fehmarnbelt area can only be split by national responsibility with limitations. This results in the following consequences for defining the marine investigation area of the LCP:

- Environmental factors or function elements, which can be mapped in a mobile or cross-border manner only (e.g. marine mammals, hydrography, bird migration) are described accordingly. With regard to the impact assessment, wherever possible attempts are made to relate details to the German territory, including the EEZ, but limiting this exclusively to the German territory is not always possible.
- For all environmental factors or function elements linked mainly to location, such as benthic habitats and seabed etc., the limit of the investigation area depends on the release of suspended materials/sedimentation (due to construction) as the most far-reaching impact of the project and/or on the range of the significant impairments on the biotic and abiotic environmental factors resulting from this. Any impairments classed as more severe than low are considered to be significant.

This is determined from the impacts already considered in the EIA report (Attachment 15). Given their insignificance, such minimal impairments are not important to defining the investigation area.

- The impacts for the environmental factors of human beings (recreation aspect), landscape (open sea) and cultural heritage and other material assets in the marine area are not expected to be as far-reaching as those just mentioned for benthic habitats. The marine investigation area for these environmental factors is limited to a corridor running parallel to the route of the tunnel for 5 km on each side where e.g. interference and visual impairments may be present during the construction phase (see Figure 41).

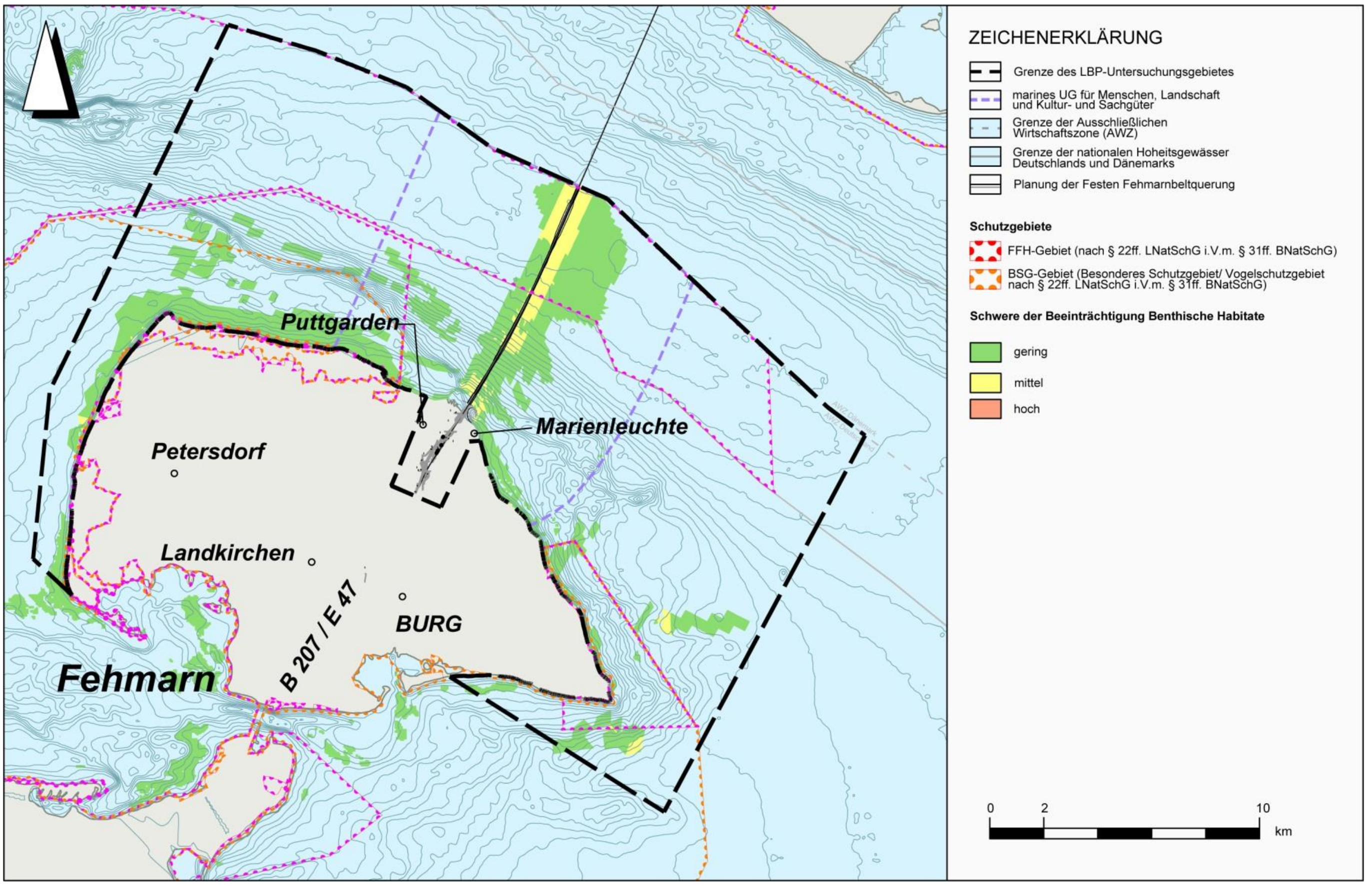



**Figure 41 Borders of marine and onshore LCP investigation area (see Figure 40)**

| ZEICHENERKLÄRUNG | KEY |
|---|---|
| Grenze des LBP-Untersuchungsgebietes | Border of the LCP investigation area |
| Marines UG für Menschen, Landschaft und Kultur- und Sachgüter | Marine investigation area for human beings, land-scape, cultural heritage and material assets |
| Grenze der Ausschliesslichen Wirtschaftszone (AWZ) | Border of the Exclusive Economic Zone (EEZ) |
| Grenze der nationalen Hoheitsgewässer Deutsch-lands und Dänemarks | Border for the national territorial waters of Germany and Denmark |
| Planung der Festen Fehmarnbeltquerung | Planned Fehmarnbelt Fixed Link |
| Schutzgebiete | Conservation areas |
| FFH-Gebiet (nach § 22ff. LNatSchG i. V. m. § 31ff. BNatSchG) | SCI (according to § 22 et seq. LNatSchG in con-junction with § 31 et seq. BNatSchG) |
| BSG-Gebiet (Besonders Schutzgebiet/Vogelschutz-gebiet nach § 22ff. LNatSchG i. V. m. § 31ff. BNatSchG) | Special conservation area/bird conservation area in accordance with § 22 et seq. LNatSchG in conjunc-tion with § 31 et seq. BNatSchG) |
| Schwere der Beeinträchttigung Benthische Habitate | Severity of adverse effect on benthic habitats |
| Gering | Low |
| Mittel | Medium |
| Hoch | High |

## 4.2. Description of the environment and its components

The following details relate to the Baseline investigation and evaluation in the LCP investigation area. The methodical backgrounds can mostly be found in Attachment 15 (EIA report). This Attachment also contains a detailed description of the baseline and its significance.

Furthermore, based on the duration of the current procedure, the data gathered from the baseline survey is now more than five years old, meaning that an update and plausibility study is required. In order to carry out the plausibility check, up-to-date mappings for the terrestrial area on Fehmarn, new analyses and third-party assessments of available data for the marine investigation area are required. The results of this current status check are shown in Attachment 30.1 (for the marine area) and 30.2 (for the terrestrial area) of the plan approval documents. Further explanations on the plausibility check and update mappings can be found in Section 2.3.

### 4.2.1. Human beings, including human health

No new analyses have been carried out on either the land area on Fehmarn or the marine area with regard to the human/human health environmental factor. There have been no known significant short-term changes to the partial environmental factors of residential areas and recreation in recent years, nor are any expected. Therefore, the data basis for the human environmental factor described hereinafter in the EIA is still current and thus no alteration is required.

#### 4.2.1.1. Island of Fehmarn

**Residential**

*Baseline investigation*

The settlement pattern in the LCP investigation area is shaped mainly by villages. To the west of the B 207/E 47 are the districts of Puttgarden and Todendorf; Todendorf only borders the investigation area. To the east of the railway/B 207, Marienleuchte and the western part of Bannesdorf lie within the LCP investigation area. The built-up areas are mainly mixed village areas comprising detached homes and farmsteads, forming closed settlement structures (some historic Fortadorf structures with village squares; see Section 4.2.9). Marienleuchte contains two special areas with a residential function in the form of a weekend/holiday home area and a military facility. Hotel "Dania" to the east of Puttgarden is another specific residential function. Facilities with general social functions include a school with sports complex and child daycare centre in Puttgarden and a church in Bannesdorf.

The area up to 500 m away from cohesive settlements is defined as residential and, given its potential for use for recreation, enhances the residential function.

*Existing impairments*

- Noise and pollution levels from rail and road traffic volume, especially the B 207/E 47
- Visual impairments and barrier effects from existing traffic
- Commercial areas in Puttgarden and Bannesdorf
- Odours from fattening units for poultry or pigs in the countryside

*Baseline evaluation*

The table below provides an overview of the assignment of levels of importance to the residential sub-factor.

**Table 36 Overview of the assignment of levels of importance to the sub-factor of living**

| **Very high significance** |
|---|
| - Areas used mainly for residential purposes in Puttgarden and Marienleuchte (e.g. general and purely residential areas and mixed areas)<br>- Settlements built on open land, individual farmsteads on the Marienleuchter Weg<br>- Facilities with general social functions/public amenities such as the school/nursery in Puttgarden (including cultural facilities and churches) |
| **High significance** |
| - Green spaces (e.g. sports grounds and playing fields) in the direct vicinity of settlements<br>- Weekend and holiday home areas in Marienleuchte |
| **Medium significance** |
| - Hotel "Dania" in the open land<br>- Military facilities in Marienleuchte<br>- Protected green space<br>- Areas surrounding the residential areas of Marienleuchte, Bannesdorf, Todendorf and Puttgarden (spaces within a 500 m radius of settlements) |
| **Low significance** |
| - Commercial area in Puttgarden |

## Recreation

*Baseline investigation*

The recreation infrastructure in the investigation area consists mainly of weekend and holiday homes or private guesthouses within the settlements, as can be found in other areas on Fehmarn. There is a special area for holiday homes in Marienleuchte on the eastern edge of the built-up area.

The campsite to the north of Puttgarden has a car park from which the coast can be accessed as a recreation area.

There are no designated bathing beaches in the investigation area on either side of the ferry harbour. The areas of beach on the north coast with coastal defence dykes, to the west of the ferry harbour, are frequented by large numbers of people seeking recreation because of their proximity to the ferry harbour and Puttgarden and their developed recreation infrastructure (cycle paths and hiking trails, car parks). The extensive path network (for bikes/walking/horse riding) in the investigation area includes all built-up areas. Most paths run through fields on agricultural roads, regional roads or the dykes along the coast. Part of the cross-regional Baltic Sea coastal cycle path (same as the Monks' Trail in the investigation area) runs through the investigation area along the eastern coast to Marienleuchte and then heads west after crossing under the railway and the B 207/E 47. The Via Scandinavica (a continuation of the Scandinavian Way of St. James) runs west along a similar route from Puttgarden.

Large areas along the north coast are identified in the landscape programme as being very suited to recreation use. However, only small parts of these near Puttgarden and Marienleuchte fall within the LCP investigation area.

There is a lEIA-reporture time facility linked to the landscape in the form of a viewpoint on the western harbour breakwater in Puttgarden.

*Existing impairments*

- Noise and pollution levels from rail and road traffic volume, especially the B 207/E 47
- Visual disturbances (e.g. from wind farms)
- Commercial areas in Puttgarden and Bannesdorf
- Odours from fattening units for poultry or pigs in the countryside
- Coastal defence systems limit the extent to which beaches can be used for recreation

*Baseline evaluation*

The importance of the recreation areas is assessed depending on how effective the landscape is for recreation, primarily due to its natural attractiveness. When considering recreation areas, however, accessibility, infrastructure of relevance to recreation and proximity to settlements also play a major role in the evaluation. The table below provides an overview of the assignment of levels of importance to the sub-factor of recreation.

**Table 37 Overview of the assignment of levels of importance to the sub-factor of recreation**

| **Very high significance** |
|---|
| - Because there are no bathing beaches (sandy beaches) in the investigation area, this level of importance is not present. |
| **High significance** |
| - Beach highly suited to recreation without primary use for bathing to the west of the ferry harbour and to the east of Marienleuchte<br>- Viewpoint on the ferry harbour's breakwater |
| **Medium significance** |
| - Areas particularly well suited to recreation (according to landscape programme) near Puttgarden and Marienleuchte<br>- Baltic Sea coastal cycle path |
| **Low significance** |
| - Beach with limited accessibility/use for recreation (natural beach between ferry harbour and Marienleuchte)<br>- Cycle, bridle and hiking paths between Marienleuchte and Puttgarden<br>- Car parks linked to lEIA-reporture time use (access to recreation areas linked to the landscape) |

#### 4.2.1.2. Marine area

In the marine area, the environmental factor human beings includes the sub-factor of recreation.

**Recreation**

*Baseline investigation*

The entire coast of Fehmarn, up to one kilometre inland, and therefore the marine area is identified as "a key region for tourism and lEIA-reporture" according to the state development plan (2010). Particular attention should be paid to tourism within this area (e.g. improving opportunities for water sports).

Along the coast of Fehmarn, bathing areas have been identified by the Ministry for Labour, Health and Social Affairs of Schleswig-Holstein (2012) and bathing beaches have been identified in the land use plan (town of Fehmarn 2009) (east coast at Presen and on the north coast to the east of the "Grüner Brink"). Generally speaking, the bathing water quality on all of Fehmarn's beaches, outside the investigation area, was classified by the state of Schleswig-Holstein as "very good" in 2010.

There are no harbours for sports boats in the LCP investigation area on the island of Fehmarn. People including water sports enthusiasts flock to the Fehmarn estuary because, as well as offering bathing opportunities, it can also be used for surfing, kite surfing and numerous other hobbies such as cycling or walking the paths around the harbour (Planco Consulting GmbH 2008 and v. Rohr & Heinisch 2008).

Given the ideal wind conditions on the beaches and bays of Fehmarn, the island is a popular destination for wind surfers and kite surfers. There are numerous points along the coast suited to wind surfing, kite surfing and surfing. In the LCP investigation area itself, the designated area outside the nature conservation area at Grüner Brink is frequently used for all kinds of surfing. There is also access to the sea and parking close by near Presen, making this area popular for water sports.

The island of Fehmarn is one of the most interesting destinations for anglers along the German Baltic Sea coast (Schroeter 2010) and the entire Fehmarn region is very important for amateur fishing in Schleswig-Holstein. With the corresponding fishing licence, coastal fishing and surf casting are possible all along the coast of Fehmarn with the exceptions of the nature conservation area and the ferry harbour. Apart from the months of January and February, when the fishing quota for the main fish species is lower, anglers can be found along the north coast of the island all year round.

What's more, commercial offshore fishing has been practised from Heiligenhafen since 1960. The most concentrated fishing in the Fehmarnbelt takes place in areas where cod and herring are common. This is mainly in a zone within 5 nautical miles of the island of Fehmarn and thus extends across the Fehmarnbelt.

*Existing impairments*

- Intensive ferry traffic between the ferry harbours of Puttgarden and Rødbyhavn
- Shipping (freight and container ships) on the T route

*Baseline evaluation*

The evaluation is basically undertaken following expert objectives for retaining the recreation areas and their usability and/or suitability for recreation purposes.

**Table 38 Overview of the assignment of levels of importance to the sub-factor of recreation in the marine area**

| **Very high significance** |
|---|
| Identified "Grüner Brink" and "Presen" bathing zones on the north coast of Fehmarn |
| **High significance** |
| - Areas with high concentrations of fishing grounds, frequently used for offshore fishing off the German coast<br>- Fishing areas along the coast (entire coastline, particularly hotspots on Fehmarn: Grüner Brink, Puttgarden, eastern ferry harbour at Puttgarden, Marienleuchte and Presen)<br>- Surfing and kite surfing area at Grüner Brink |
| **Medium significance** |
| - Main area for tourism and recreation (1 km wide strip along the German coast according to 2010 state development plan, with the exception of areas assigned greater value)<br>- Surfing and kite surfing area near Presen |
| **Low significance** |
| - Areas with low concentrations of fishing grounds, less frequently used for offshore fishing off the German coast. Not shown in plan no. 5 (LCP, Attachment 12) because only areas with high concentrations are shown and the rest is of low significance. |

## 4.2.2. Geology and soil

### 4.2.2.1. Island of Fehmarn

No new surveys have not been carried out on Fehmarn with regard to the soil environmental factor. There have been no events which have caused significant short-term changes to these parameters in recent years. Therefore, the data basis for the EIA-REPORT is still current.

#### Soil

*Baseline investigation*

During the most recent ice age, glaciers flowing from the north and east transported huge amounts of moraine and stones into the investigation area, which were left behind after the ice melted (see Hydrogeology, Attachment 25). These deposits (ground moraine) form the geological basis for the soil in the area. The flat terrain on the island of Fehmarn was also produced by geomorphological processes during the last ice age.

Along the north and west coast, the main structures formed after the last ice age are the topogenous fens, consisting of peat, gyttja and alluvial mud. Areas of alluvial deposits containing marine gravel and sands can also be found. Off the west, northwest and east coast of Fehmarn, there are abrasion areas in the Belt Sea. Material is being continually eroded from the active cliffs, such as those in Marienleuchte. This active cliff is an object/geotope worthy of protection from a geomorphological standpoint, but which is not protected by law (see State Geological Department of Schleswig-Holstein 1991).

In terms of its soils, Fehmarn is very special. The LCP investigation area contains mainly **pseudogley to chernozem pseudogley** from glacial loams, known as "Fehmarn black earth".

This soil type is peculiar to Fehmarn and covers virtually the entire investigation area with the exceptions of the coastal areas and the areas around Bannesdorf. The "Fehmarn black earth" is one of the highest quality soils in Schleswig-Holstein because of its high natural productivity. This productivity is down to the large natural nutrient reserves, the high lime content and the presence of large amounts of loam. The soil is particularly important for agriculture.

In the southern investigation area around Bannesdorf, grey brown podzolic soils can be found of the form **pseudogley grey brown podzolic soils** to **chernozem grey brown podzolic soils**.

**Immature soils on emerged beach deposits** can be found in the northern coastal area, sometimes together with bog soils. Given the prevalence of sand and gravel soil types, these soils are very permeable to water and are very influenced by the salt water of the Baltic Sea.

The bog soils are mainly **fens**, which can be found in the LCP investigation area directly behind the north coast. However, most of the bog soils are drained and used intensively for agriculture so these areas have been modified greatly from their natural state.

*Existing impairments*

- Ground sealing around the existing roads, built-on areas at the ferry harbour and railways
- Settlement areas and areas where soil has been added or removed and other major anthropogenic changes and areas of inherited waste
- In accordance with FNP draft (dated: 15.12.2011) one area of the car park to the east of the Puttgarden campsite is polluted with substances detrimental to the environment
- Soil compaction in agricultural areas
- Drainage of soils with a naturally high water table
- Extensive existing impairments in the form of airborne harmful substances or nutrients
- Pollution in the form of harmful substances from traffic near the B 207/E 47

*Baseline evaluation*

The evaluation uses a scale of two. Assignment in relation to soil on Fehmarn is shown in the table below.

**Table 39 Overview of soil types and geological formations and their importance**

| **Special significance** |
|---|
| - Fens due to their rarity and pristine nature<br>- Pseudogley to chernozem pseudogley ("Fehmarn black earth") due to its rarity and productivity<br>- Immature soils on emerged beach deposits as evidence of geological trends<br>- Geotopes (cliff at Marienleuchte) |
| **General significance** |
| - Pseudogley grey brown podzolic soils to chernozem grey brown podzolic soils given their unexceptional location factors and widespread occurrence |

#### 4.2.2.2. Marine area

**Seabed**

No new surveys have not been carried out in the marine area with regard to the morphology and sediments environmental sub-factor.

The environmental sub-factor of morphology and sediments concerns soil at a water depth of more than 6 m and the data basis for the baseline survey is made up of the following parameters: Hydrographic dimensions such as flow rates, flow directions and wave dynamics, all of which have a profound influence on morphology and sediments, data concerning sediment structure, including bottom substrate and grain size distribution, measurements of the chemical properties of seabed substrates, calculations for near-bed sediment transport and bed geometry measurements in the Fehmarnbelt Fixed Link (EIA-REPORT, Attachment 15 of the plan approval documents, Volume II, Section 2.1.3 and EIA-REPORT, Annex C). There have been no events which have caused significant short-term changes to these parameters in recent years. Therefore, the data basis for the EIA-REPORT is still current.

*Baseline investigation*

Along the coast of Fehmarn, the seabed to the west of Puttgarden consists mainly of sandy material, whereas that to the southeast of Puttgarden is coarser. Where the sea is over 20 m deep, there are fine-grained sandy sediments on the seabed, sometimes in the form of thin covering layers.

Along the course of the FBFL, the concentrations of organic matter are typical for marine areas. Lower concentrations exist in the sandy material (0.04% – 1.55% C or loss on ignition: 0.32% LOI to 7.89% LOI) with the lower lying samples (30 cm to 100 cm) displaying the higher values.

The transport of sediment close to the seabed in the Fehmarnbelt is closely linked to local currents and wave conditions. For extended periods during the year, currents in the deeper parts of the Fehmarnbelt flow too slowly for large volumes of sediment on the seabed to be moved. The transport of sediment close to the seabed in these deep parts of the belt mainly takes place during periods when current speeds exceed 0.2 m/s. In the parts of the Fehmarnbelt where the water is less than 6 m deep (coastal areas), where the dynamics of the waves can mobilise sediment on the seabed, even slight wave-induced currents can transport this sediment on the seabed. Most sediment transport in the Fehmarnbelt takes place in shallow areas under the influence of wave dynamics. Sediment transport close to the seabed is greatest in the German coast area (transport rates of approx. 1.5 $m^3$/m in 12 hours). Most of the sediment transported near the coast follows the primarily eastwards flow of water close to the seabed.

As a result of the interaction between sediments and current, different seabed geometries have formed in different parts of the Fehmarnbelt. The two most common seabed geometries are dunes (also known as megaripple/wave shape) and sickle-shaped geometries. Dunes are the most common seabed geometries in the Fehmarnbelt with a maximum height of 4 m. The sickle-shaped geometries occur in the deeper parts (> -25 m NN) of the Fehmarnbelt and feature one main section and two arms (length and width 100-150 m).

In addition to the two geometries described above, other seabed shapes, which are not characteristic but are clearly visible, can be found in the Fehmarnbelt ("other active seabed geometries"). These include isolated dunes, sand baths and ripples. Ripples are the smallest of seabed geometries with a maximum height of 5-6 cm and a maximum length of 50 cm.

*Existing impairments*

- Sand excavation and dumping of excavated material (no sand excavation currently on the German side)

*Baseline evaluation*

**Table 40 Importance of the seabed**

| Importance according to orientation framework | Description |
|---|---|
| Special | - Dune areas in Natura 2000 areas with conservation objectives, relating especially to seabed formations<br>- Other parts of the seabed with seabed geometries (sickle-shaped dunes, dunes/megaripple and other active seabed geometries) |
| General | - All other seabeds, which have not been significantly altered by human activities.<br>- Seabeds which are greatly affected by human activities, including the maintenance area of shipping channels and harbours, dumping and extraction and harbours |

## Coastal morphology

*Baseline investigation*

The coast of Fehmarn is a typical simplified coast with alternating areas of erosion and sedimentation. It consists of beaches, bars/spits, lagoons/coastal lagoons, dunes, meadows, salt marshes and coastal defences. The Grüner Brink, which extends along the coast west of Puttgarden harbour, is a special morphological object. The prevailing wind and wave conditions result in the formation of bay bars and spits, and as they bend back towards the coast, they produce lagoons/coastal lagoons.

The harbour in Puttgarden was constructed in 1962/63, at the same time as the harbour in Rødby, and it protrudes 520 m out of the coastline. The access channel is around -8.5 m NN. A breakwater was built to the west at the same time as the harbour. At the current time there is no sedimentation in the harbour access channel.

The only significant changes that have occurred recently on the northern coastline are at Grüner Brink and the defence structure for the drainage runout to the west of the long free-standing breakwater. Only very minor changes to the coastline can be seen at the Puttgarden harbour and along the coast southeast of the harbour.

The coastline to the southeast of Puttgarden is generally characterised by low cliff formations. The Marienleuchte district is around 700 m southeast of Puttgarden directly to the south of the Ohlenborgs Huk headland, a 5 m high bed load formation. The strip of coast off Ohlenborgs Huk and Marienleuchte is protected from erosion by small breakwaters, coastal defence walls and stone embankments.

Outside the morphologically active and complex area of Grüner Brink just to the west of Puttgarden, the coastal profiles quickly fall away to a depth of around 2 m. However, the profile incline between 2 and 7 m of water is shallow. To the east of the ferry harbour, the coast profile rapidly drops to depths of 3 to 4 m. Next to this is an area with a shallower incline that increases again further out to sea. With the exception of the Grüner Brink, no significant changes to the coastal profiles took place between 1998 and 2009.

To the west of Puttgarden, the net rate of sediment transport eastwards off the Gammendorfer beach is around 41,000 $m^3$/per year. Most of this sediment is deposited in the Grüner Brink area at the eastern end of the formation in sandbanks below sea level.

In contrast, the annual net rates of sediment transport near the coast in the area between Grüner Brink and Puttgarden are low (less than 5,000 $m^3$/year). No changes to the coastline have been observed here. Just to the west of Puttgarden, the net rate of transport is close to zero.

To the east of Puttgarden, around 500 – 2,500 $m^3$/year of sediment is transported northwards.

*Existing impairments*

Coasts in built-up areas are rarely left to nature and this is the case on Fehmarn, where there is a long tradition of coastal defence work and use of the coast. It should be noted that these manmade impacts have affected the current state of the coastal morphology sub-factor. The coastal defence work and use of the coast are, however, important elements of the coast and, as function elements, therefore form part of the Baseline investigation.

- Existing sea dykes near the Grüner Brink and Markelsdorfer Huk areas (following construction of the sea dykes in 1872, there were major changes to the coast, resulting in the loss of coastal lagoons and lowland)
- Influence of the transport of sediment along the coast by coastal defence structures

*Baseline evaluation*

**Table 41 Evaluation parameters for the coastal morphology**

| Importance according to orientation framework | Explanation |
|---|---|
| Special | - Coastal areas (beaches and unprotected parts of the coast and special coastal morphological formations including coastal defence measures, as well as coastal defence structures or singular structures, in these areas) with a natural or semi-natural appearance, in particular: Natura 2000 areas with conservation objectives, which relate in particular to coastal morphological formations and processes,<br>- coastal areas which are protected by German law as nature conservation areas,<br>- singular marine structures (not including coastal defences) |
| General | - All sections of the coast (beaches and unprotected parts of the coast and special coastal morphological formations including coastal defence structures or singular structures in these areas) which have not been significantly altered by human activity.<br>- Sections of coast which are subject to serious reshaping caused by human activities |

## 4.2.3. Water

### 4.2.3.1. Island of Fehmarn

No new surveys have not been carried out on Fehmarn with regard to the water environmental factor. There have been no events which have caused significant short-term changes to these parameters in recent years. Therefore, the data basis for the LCP is still current.

#### Surface waters

In the paper written on water law, (cf. Attachment 20 of the plan approval documents), the condition, management conditions and the actions pertaining to surface waters located within the LCP investigation area are described and explained in accordance with the management plan and action programme for the Schlei/ Trave Fließgewässereinheit (Running Waters Unit - FGE).

*Baseline investigation*

Most of the surface water on the island of Fehmarn is discharged via the extensive system of ditches in place. These ditches are mainly used to drain areas used for agricultural purposes. In the LCP investigation area the ditches drain into the surrounding coastal waters and are the only form of waterways (Nieland and Drohn ditches).

The paper on water law (cf. Attachment 20 of the plan approval documents) contains a description of the condition of the Drohengraben (Todendorf/ Bannesdorf ditches – DESH_og_05) which is based on the provided in the management plan for the Schlei/ Trave Flussgebietsgemeinschaft (River Basin District FGG). The ecological potential is assessed as "moderate" (Attachment 20 of the plan approval documents, page 196). The body of water is in poor chemical condition (Attachment 20 of the plan approval documents, Section 5.3.1).

There are numerous bodies of standing water in the investigation area's farmland and near the proposed route. These take the form of small bodies of water protected by law (§ 30 BNatSchG in conjunction with § 21 LNatSchG). They are spread relatively evenly across the agricultural landscape and were formerly clay pits from which calcium-rich clay till was extracted for soil improvement.

The strip protected by law for waterways in the investigation area only applies for coastal waters. In accordance with § 61 BNatSchG in conjunction with § 35 LNatSchG, the protective strips runs inland 100 m from the coast with the exception of the existing ferry harbour.

Basically all parts of Fehmarn below a level of 3.5 m above sea level are at risk of flooding. . Within the investigation area, this includes e.g. areas in and around the districts of Puttgarden and Marienleuchte.

*Existing impairments*

- Materials deposited from agriculture and traffic (rail and road)
- Obstruction of banks and waterway construction
- Piping of waterways crossing roads

*Baseline evaluation*

The evaluation uses a scale of two. Assignment in relation to the surface water sub-factor is shown in the table below.

**Table 42 Overview of surface waters and their importance**

| **Special significance** |
|---|
| - Strip along waterways protected by law (100 m inland from the Baltic Sea coast in accordance with § 61 BNatSchG in conjunction with § 35 LNatSchG)<br>- Small bodies of water protected due to their pristine nature<br>- Surface waters such as brooks and ditches (the only waterways in the investigation area) |
| **General significance** |
| - Areas at risk of flooding up to 3.5 m above sea level .<br>- Artificial/non-natural standing water, such as rainwater retention basins due to their low importance for nature conservation |

### Groundwater

*Baseline investigation*

The low elevation above sea level, the flat surface form and the accumulation of water in and on the water-retaining boulder-clay and/or tertiary clay (backwater and subterranean water) near layers/lenses of melt water sand produce a high water table and mean that the soil is sometimes waterlogged with groundwater over large parts of the island.

The only areas waterlogged with standing groundwater in the investigation area are the fen soils along the north coast and to the north of Puttgarden.

Fehmarn has no major groundwater reservoirs in the ice age stratification. Smaller Quaternary layers of sand in isolated locations are the only strata with the potential to carry water.

The water-carrying strata in the planned landing area for the FBFL can be considered as isolated instances and occur in limited numbers in the adjoining area, where they can be seen in the form of local horizons of strata water. There is no continuous groundwater horizon.

A continuous groundwater horizon also does not exist further inland. There are individual, local horizons of backwater and/or groundwater held in the boulder clay and sands. In some cases, the backwater may occur up to ground level height. There are no drinking water protection areas on the island of Fehmarn.

*Existing impairments*

- Materials deposited from agriculture.
- Inherited waste is a potential threat to the groundwater (car park to the east of the campsite near Puttgarden where soils are heavily contaminated with substances detrimental to the environment).
- Influence on water supply by groundwater extraction (groundwater lowering) – potential private or commercial water extraction on Fehmarn (e.g. for agriculture).

*Baseline evaluation*

The evaluation uses a scale of two. Assignment in relation to groundwater is shown in the table below.

**Table 43 Overview of groundwater and its importance**

| **Special significance** |
| --- |
| - (Drained) fens on the north coast of Fehmarn where the groundwater level is continuously high (<2 m depth to water table) |
| **General significance** |
| - Remaining areas (without settlements, traffic, dykes and other built-up/sealed areas) due to the small supply of groundwater and without any continuous groundwater conduits (in some sections local backwater and subterranean water) |

### 4.2.3.2. Marine area

The data on marine status parameters underwent an update check in 2015. As part of this, data on subjects such as wind, salinity, water temperature, turbidity, water quality and phytoplankton was requested and was partially carried out by project proponents. The currency update check confirms that the basic description from the years 2009/10 is, to a high level, representative of the whole period covering 2009 to 2014 (see also Attachment 30.1 of the plan approval documents). The aspects of hydrography and water quality described below are current and valid.

In addition to the following description, Section 4.2.3.3 provides a summary status overview and assessment of the aspects of hydrography and water quality as these are presented in the article on water law. The article on water law describes the Sea Strategy Directive for sea water (see article on water law, Attachment 20 of the plan approval documents, for more details).

In order to describe **hydrography** the impacts and components shown in the table below are taken into account and briefly summarised for the Fehmarnbelt (see Section 3.2, EIA-REPORT, Attachment 15, Volume II A for more details).

**Table 44 Overview of hydrography – impacts and components**

| Impacts and hydrographic components | Baseline investigation |
|---|---|
| Driving forces | The Fehmarnbelt is part of the Belt Sea, i.e. the transition zone between the North Sea and Baltic Sea. The current through the Fehmarnbelt is shaped by the estuarine exchange of water and the local topographic structure between the Great Belt and Darss Sill. The driving forces for hydrography in the Fehmarnbelt are predominantly the meteorological conditions in the North Sea and Baltic Sea. Areas of low pressure over Scandinavia and the associated westward wind fields produce higher water levels in the Kattegat and drive a current through the Fehmarnbelt into the Baltic Sea.<br>Areas of high pressure and anticyclonic wind directions on the other hand result in lower water levels in the Kattegat, causing a current running in the opposite direction in the Fehmarnbelt, i.e. from east to west. Local meteorological events have only a minor impact on currents in the Fehmarnbelt, although local wind conditions affect the wave climate in the belt.<br>The salty Atlantic water flowing out of the North Sea into the Baltic Sea meets the freshwater flowing out of the Baltic Sea's catchment area, resulting in estuarine stratification and mixing. These bodies of water with variable properties determine the hydrography in the Fehmarnbelt. The dispersion of the current flowing out of the Fehmarnbelt towards the Darss Sill is shaped by the fact that highly dense North Sea water with a high salt content and rich in oxygen periodically flows along the seabed and into the Baltic Sea through deep channels. Water only enters the Baltic Sea when the saltwater has filled the buffer zone in the Bay of Mecklenburg such that the Darss Sill is covered to a depth of 18 m. Similarly, saltwater from the Great Belt first has to fill the Bay of Kiel, during which some of the inflow is diverted 90 degrees straight into the Fehmarnbelt by the topography. At the surface, it is mainly brackish water with a low salt content that flows out of the Baltic Sea. When the water levels between the Kattegat and the Baltic Sea are very different, there can sometimes be one single direction of flow throughout the Fehmarnbelt, i.e. either an inflow or outflow. |

| **Impacts and hydrographic components** | **Baseline investigation** |
|---|---|
| Meteorology | Areas of high and low pressure pass over Scandinavia virtually every week and raise or lower the water level in the North Sea and Baltic Sea accordingly. The resulting difference in water levels in the North Sea and central Baltic Sea produces the biggest exchange of water between the two. This either results in water low in salt flowing from the central Baltic Sea into the North Sea or very salty bodies of water flowing in the other direction. The exchange is made yet more pronounced by differences in air pressure and the resultant air movements. |
| Sea state | The waves in the Fehmarnbelt are mainly produced by local wind. The surrounding land masses do however impede wind-induced waves from being produced because they limit the fetch of the wind blowing over the water surface.<br>The sea state in the Fehmarnbelt tends to be light, the average significant wave height for the period between May 2009 and May 2010 being 0.57 m and 0.52 m at the MS01 and MS02 measurement stations respectively with an average wave period of less than 4 seconds. The corresponding maximum significant wave heights are 2.37 and 2.49 m and the peak wave period 6.5 s. Overall, 25% of waves are less than 0.5 m in height and 98% less than 2 m. The maximum absolute wave heights in the Fehmarnbelt are up to 4 m near the coast and up to 5 m in the centre of the belt at wind speeds of 24-28 m/s (Schmager G., 1979).<br>Some of the wave energy is lost through friction on the seabed. In calm waters the waves produce oscillating movements on the seabed which can stir up loose sediments. As the depth of water decreases, the waves refract towards the coast and wave crests become steeper until they break against the shore or in shallow water. The wave energy is then converted into mixing and the transport of sediment. |
| Fresh water entering the Baltic sea | The addition of freshwater from rivers, such as the Oder, and non-point sources into the Baltic Sea produces a low-salt body of water in the upper part of the water column. As a result, the bodies of water in the Baltic Sea usually comprise several layers. Input from rivers is very important to the environmental conditions in the Baltic Sea. |
| Salinity and temperature in the Fehmarnbelt | The drop in temperature in the autumn and stronger winds in the winter produce greater mixing in the bodies of water, while the thermocline in the spring and summer stabilises the water column.<br>The distribution of salinity throughout the Fehmarnbelt region shows decreasing salt content as you move towards the Darss Sill in layers of water both near the surface and seabed.<br>In terms of average water temperatures, it should be noted that the annual cycle of air temperature and solar irradiation produces an annual water temperature range of 0-20 °C (95% of measured values) especially in the upper layers of water. Lower down at around 30 m the annual cycle is just 1-14 °C and there is a phase shift: The maximum monthly averages here occur in September-October (around 11.5 °C) yet on the surface the figure is 17 °C in August. |
| Currents | The differences in water levels between the Kattegat and the Baltic Sea and the regional meteorological conditions are important as forces driving the currents in the Fehmarnbelt.<br>The main current flows through the Fehmarnbelt and Great Belt. As it flows out, water with a low salt content is transported out of the Baltic Sea area through the Great Belt and Öresund at the surface, while near the seabed water from the North Sea with a high salt content flows in and fills the basins until it can cover the Darss Sill and/or Drogden Sill. On the surface, the prevailing outflow moves northwest. In contrast, near the seabed in the Fehmarnbelt, the inflowing current moves mainly eastwards at a low average speed. Most of the currents in the Fehmarnbelt are driven by the different water levels in the Arkona Basin and the Kattegat. The tides in the Kattegat also have a small influence on this. The influence of tides is more pronounced in the lower layers of water and can sometimes be seen in the form of alternating current directions lasting a few hours. While the large-scale inflow and outflow of water is determined by the difference in water level between the Kattegat and Baltic |

| Impacts and hydrographic components | Baseline investigation |
|---|---|
| | Sea, the current profiles in the Fehmarnbelt are mainly shaped by local meteorological conditions (differences in air pressure, temperature, wind etc.) and the differences in density between layers of water near the surface and the seabed.<br>Given the lower salt content in the Baltic Sea, an outflow near the surface always creates stratification, whereas the powerful inflow tends to mix the entire water column. Increased mixing of water with a high and low salt content has been found during the autumn and winter in particular. The differences in density between the surface and seabed are much smaller than in the summer. |

The parameters of visible depth of seawater, suspended materials, nutrients, oxygen and bacteria, which are briefly described in the paragraph below, are important for the **water quality** Baseline investigation.

Compared with other sea areas, the Baltic Sea is characterised by high concentrations of chlorophyll and tannins. As a result, the depth of penetration of sunlight is limited to a relatively shallow surface layer flooded with light (euphotic layer), which also impacts on the depth of the thermocline (change in temperature layer). The seasonal fluctuations in the visible depth are much more pronounced than the spatial fluctuations and are between 4.5 and 8 m. Over the entire baseline period, the visible depth in the Fehmarnbelt investigation area was 7.05 m on average.

Only low values were recorded for the concentration of suspended materials over long periods (mostly below 3 mg/l). The figures were only higher during brief periods when suspended materials were stirred up from the seabed (resuspending) and then deposited on the seabed again. The high concentrations of suspended materials often occur when there are strong currents near the seabed. High concentrations of suspended materials occur during storms with high wave heights which stir up the sediments in the shallow waters. At the near-shore stations the concentrations of suspended materials are seen to be significantly higher in autumn and winter than in spring and summer due to the weather and wave conditions.

The distribution of nutrients in the surface layer of the Baltic Sea is characterised by a distinct seasonal fluctuation. Concentrations are high in the winter when biological activity is at its lowest. During the period of high biological productivity, which starts in the spring and ends in late summer, concentrations fall to the detection level. Averaged over 2009 and 2010, the concentration of all inorganic nutrients is at its highest in January and February. This is a result of accumulated mineralisation during late autumn-winter and land run-off, combined with low insolation preventing phototrophic production and uptake of nutrients by algae.

Changes in the oxygen content are caused primarily by the annual stratification cycles (especially water temperature) and the different production and consumption processes which occur throughout the year. In the layer of water near the seabed, physical forces and especially the advection of oxygen rich water and the intensity of vertical mixing during summer and autumn are the most important factors affecting oxygen levels. The Belt Sea has a natural propensity for oxygen problems because of weak tidal currents in the Belt Sea and estuarine circulation giving rise to seasonal stratification separating the denser bottom water from the surface water and thus also from the atmospheric oxygen. Oxygen concentration in bottom water decreased significantly between 1960 and 1990 in the Fehmarnbelt which is linked with an increase in nutrient loads in the Belt Sea.

The bathing water quality in coastal waters off Fehmarn and Lolland, gauged according to the concentration of the two bacteria *E. coli,* and *Enterococcus* is sufficient to very good.

*Existing impairments*

- Nutrient input (anthropogenic or atmospheric input)
- Harmful substances deposited by point sources (industrial plants, purification plants), non-point sources (agriculture/forestry), activities at sea (shipping, operation of oil platforms, excavations) and atmospheric deposits of pollutants (combustion sources, volatile chemicals)

*Baseline evaluation*

The areas where the **hydrography** is of importance are defined by two criteria. Firstly, they are below the mean high water line and secondly, they are important to the exchange of water between the North Sea and Baltic Sea. There is a belt of general importance around the coast of Fehmarn. Along the north coast up to the Grüner Brink and on the northeast coast there are narrow strips of particular importance. Given their proximity to harbours and bathing zones, they are in areas where currents and waves may be affected by projects.

According to the bathing waters ordinance, bathing beaches (sandy beaches, up to a water depth of 3 m) are of particular importance to the sub-factor of **water quality**. All other areas are of general importance.

#### 4.2.3.3. Status description and assessment of hydrography and water quality in the article on water law

The article on water law (Attachment 20 of the plan approval documents) contains a description of hydrography and the water quality of marine waters in the Fehmarn area. The description focuses on the quality components which are provided by the surface water regulations to describe the ecological condition of the coastal waters and the chemical condition of the coastal waters and territorial waters.

**Coastal waters**

In the case of coastal waters - bodies of water, i.e. the marine area extending up to one nautical mile outwards from the basis line and for hydromorphology, the article describes the quality components of depth variation, the structure and substrate of the soil, structure of the intertidal zone, the swell load and the direction of the prevailing waterflow. To do this, for the chemical and general physical-chemical quality components, there is a description of the pollutant levels, visibility depth, temperature conditions, oxygen budget, salinity and nutrient ratio. The chemical condition is also described.

Based on the FGG Schlei/Trave management plan, the article identifies significant burdens to coastal waters as the diffuse inputs of the nutrients nitrogen and phosphorus, hydromorphological changes caused by historic stone fishing and water flow regulation and morphological changes (cf. Attachment 20 of the plan approval documents, Section 5.2.3).

The description adds to the representation of an overwhelming part of the functional elements which, as stated previously, are used in the Baseline investigation and assessment of the environmental factor of water in the marine area. Below, the sections are specified in which the article on water law (Attachment 20 of the plan approval documents), ordered according to coastal waters - bodies of water, which contain notes on hydrography and water quality:

**Table 45 Coastal waters - bodies of water and their description in the article on water law**

| Coastal waters - bodies of water | Hydromorphology | chemical and general physical-chemical quality components | Chemical condition |
|---|---|---|---|
| Fehmarnbelt B3.9610.09.08 | p. 207 et seq. | page 215 f. | page 217 |
| Orth Bay B2.9610.09.02 | page 219 et seq. | page 224 f. | page 226 |
| Putlos B3.9610.09.06 | page 227 et seq. | page 232 f. | page 233 |
| Fehmarnsund B3.9610.09.07 | page 235 et seq. | page 242 f. | page 244 |
| Hohwacht Bay B3.9610.09.11 | page 245 et seq. | page 249 f. | page 250 |
| Fehmarnsund East B4.9610.09.08 | page 251 et seq. | page 256 f. | page 257 |

The results of the status description and assessment of coastal waters show that the coastal waters are in a moderate ecological condition and a poor chemical condition.

### coastal waters:

With regard to coastal waters i.e. the marine water area located between the coastal waters - bodies of waters and the EEZ, the article on water law only describes the chemical condition. The article contains this status description and assessment on page 257 et seq., the results of which show that the chemical condition is "not good".

### Coastal waters

The article on water law also contains a description of the fundamental properties and characteristics of the coastal waters in the German section of the Baltic Sea, which is based on the initial assessment of the German section of the Baltic Sea in the sense of the Marine Strategy Framework Directive (MRSL). As part of this, the physical and chemical properties (page 451), biotope types (age 452) and biological features (page 452 et seq.) are described. This gives an illustration of the physical burdens, which contains information on

- physical loss (page 455),
- physical damage (page 456),
- other physical disturbances (page 457 et seq.),
- interference to hydrological processes (page 459),
- contamination caused by hazardous substances (page 459 et seq.),
- the systematic and/or intentional release of substances (page 462) and
- enrichment with nutrients and organic material (page 463) in addition to
- biological disturbances (page 464)

.

These descriptions consider some of the aforementioned functional elements which are used to specify the environmental sub-factors of hydrography and water quality. The description of fundamental properties and characteristics shows that the waters of the German section of the Baltic Sea are not in a good environmental condition.

### 4.2.4. Animals

The biological surveys contained in the Fehmarnbelt Fixed Link EIA-REPORT to determine the preferred variants were carried out in 2009 (by FEBI and leguan gmbh) and those carried out in the area of the B 207 highway were conducted in 2008 by the BIOPLAN office. Additional investigations were also carried out by leguan gmbh on bats and moths in 2010.

After the preferred variants were determined, the data gathered formed the basis for the landscape conservation plan (LCP) arising from them. The majority of this data is now 5 years old or older and must therefore be updated as the procedure has not yet been completed. A plausibility check was carried out in the marine area (Attachment 30.1 of the plan approval documents) and up-to-date mappings were made of the Fehmarn onshore area (Attachment 30.2 of the plan approval documents).

#### 4.2.4.1. Superordinate area

**Bird migration**

When putting together the EIA-REPORT, extensive investigations were conducted on bird migration in the Fehmarnbelt and a highly detailed data basis was produced. Because of this, the EIA-REPORT is based on the best data basis available with regard to bird migration in the Fehmarnbelt. Since the impairments to bird migration one would expect to be caused by the construction and use of a tunnel have been classified as being low, bird migrations are not considered further in this update investigation. In this respect, the following Baseline investigation and assessment are still fully valid following the evaluation (see Attachment 30.1 of the plan approval documents and EIA-REPORT, Attachment 15 of the plan approval documents, Annex C).

*Baseline investigation*

Studies have found that a total of 230 bird species migrate over the Fehmarnbelt.

Visual observations have found very high levels of migration intensity of water birds in the spring near Rødbyhavn along the coast and in the autumn near both Rødbyhavn and Puttgarden along the coast. Depending on the direction of migration (northwards in the spring and southwards in the autumn), there are relatively large concentrations of birds on the departure coast. But once the birds have left the coast, the concentration gradually falls and the birds are recorded at the offshore station and arrival coast in a slightly wider group and a lower concentration.

Visual observations have found that the migration of song birds is virtually the opposite to that of water birds, i.e. in the two investigation years, there was a high level of migration intensity in Puttgarden in the spring and in Rødbyhavn in the autumn.

In the Fehmarnbelt, both the long-distance migration of land and water birds and local movements of water birds have been observed. Long-distance migratory birds include large populations of ducks, Arctic geese, song birds, pigeons and birds of prey. Shorter distances are covered by roosting, moulting, overwintering and breeding water birds, which move about between different areas.

*Existing impairments*

- Fishing (reduction in food web, change to food web,
  direct losses from intensive static net fishing and gillnets)
- Hunting (however, pressure from hunting is low in the Fehmarnbelt: boat-based hunting at sea is prohibited in Germany, there are large conservation areas with bans on hunting)
- Eutrophication (eutrophication status of Fehmarnbelt region: inadequate to poor (HELCOM 2009a, HELCOM 2009b)),
- Shipping (shipping traffic as disturbance sources, species-specific flight distances and avoidance zones)
- Environmental pollution (danger to sea birds from pollution, various toxic chemicals, heavy metals and oil pollution)
- Offshore wind farms (in operation: Nysted, Rødsand II; to west of Fehmarnbelt planning underway: Belt Sea, Beta Baltic, GEOFReE; greatest risks to sea birds during operation)
- Barrier effects (obstruction due to ships, wind farms, other barriers to long-distance migration, roosting or feeding flights; change to migration or flight paths/migration or flight heights and change to energy costs for birds)
- Collisions (due to increasing number of offshore wind farms)
- Other structures (onshore wind farms near the sea, moderate rates of collisions with breeding and resting birds in wind farms/on Fehmarn)

- Climate change (change in geographic distribution; forecast: northeast shift in possible breeding grounds of many European bird species by several hundred km).

*Baseline evaluation*

Of the 230 species recorded in total, more than ten individuals were recorded for 149 species.

The results of the Baseline investigations prove (see Section 4.4 LCP, Attachment 12) that the Fehmarnbelt region is of very high to high importance for a number of species from various ecological groups with different migration strategies. The area is very important to land birds which migrate during the day, especially birds of prey, pigeons and also song birds which migrate during the day, crossing the Fehmarnbelt between Lolland and Fehmarn at the shortest point. For some of these species, including some with a very high at-risk status, a large to very large proportion of the Scandinavian breeding population migrates along the so-called bird migration route. Furthermore, very large to large proportions of the populations of a number of water bird species migrate through the Fehmarnbelt. The Fehmarnbelt is a migratory corridor for these species, which clearly tend to migrate over the sea, crossing as little landmass as possible (especially divers, sea ducks, terns and little gulls).
Furthermore, a number of water bird species with mixed migratory strategies, like geese and waders, were recorded in numbers which mean that the area is classified as being of very high or high importance. The Fehmarnbelt is on the most important flight path for these species between their roosting sites at the mudflats and their breeding grounds in the north. For land birds that migrate at night – the group of birds migrating through the region with the largest number of individual species – no species-specific quantitative data is available. It is assumed that these species fly over the region in a broad front. If we consider the rates of migration identified over the planned route against the very large populations, the figures are only of little importance. Because this data is still highly uncertain, medium importance is assumed by way of precaution (see Section 2.3.22).

**Bat migration**

According to the mapping results of 2014/2015, migration in the area of the investigation area of the Fehmarnbelt Fixed Link on Fehmarn should be classified as conservative. Investigations carried out as part of the EIA-REPORT showed massive migration over the Grüner Brink and Katharinenhof. This would indicate either a broad-front migration over the Fehmarnbelt or a stronger migration along the coastline. Bat migration over the Fehmarn island body and, in particular, the area of the FBFL, is significantly lower, which means that there is nothing of significance here (Attachment 30.2 of the plan approval documents, Section 4.7.1.4).

During the 2015 spring migration, serotine bats, soprano pipistrelles, nathusius pipistrelles and common pipistrelles were detected. A more uniform distribution of the contacts of different automatic bat detection systems can be seen here. During the spring migration of 2014, the bat detection systems in 5 locations were in continuous operation, which meant that there was a near-continuous series of data from 06/04 – 18/05/15.

In contrast, the autumn migration of 2014 was recorded sporadically at 4 locations and 6 terminals. The results showed that the autumn migration within the surgical site was of greater importance than the spring migration. On the one hand, Natterer's and Daubenton's bat, 2 species of genus myotis, were detected which would not have been detected using conventional recording methods. However, this was a case of 1 to 3 contacts which means that there is no evidence of a regular migration. On the other hand, the numbers of individuals recorded during the autumn migration were significantly higher than those observed during the spring migration. In particular, on the small number of nights on which the investigation was carried out during the autumn migration, more contacts were registered for the common pipistrelle than in the whole spring migration.

Overall, migration in the intervention area should be classified as conservative. Investigations carried out as part of the EIA-REPORT showed massive migration over the Grüner Brink and Katharinenhof. This would indicate either a broad-front migration or a stronger migration along the coastline. In contrast, migration over the island body and, in particular, the area of the FBFL is significantly more limited which means that there is nothing of significance here.

*Conclusion*

In terms of bat fauna, the investigation area should be considered average because there are virtually no areas of particular relevance to bats, such as old woodland and grove structures. Evidence was found on Fehmarn of seven of the eleven potential indigenous bat species (see Table 4-10), of which however only five species were native to the area. The following species were included: serotine bat, common noctule, soprano pipistrelle, Nathusius' pipistrelle, pond bat and common pipistrelle. No significant hunting habitats, roosts or flight routes were found within the investigation area.

#### 4.2.4.2. Island of Fehmarn

**Medium-sized and large mammals**

While the update surveys were being carried out, there were no new surveys carried out on what are called here organism groups. Since, while the biotope types were being re-surveyed in 2014/2015, there was no indication of fundamental changes to the habitat structures of medium- and large-sized mammals, no independent, updated survey was necessary.

*Baseline investigation*

The following species were found in the investigation area:

- Hare
- Roe deer
- Wild boar
- Wild rabbit

Of these, hare and roe deer are being studied in greater detail. The hare is at risk throughout Germany and is included on the endangered species list for Schleswig-Holstein. Given this situation, the species is being considered in more depth. Of the species found regularly in the planning area, the roe deer needs the greatest space and is highly relevant to safety (traffic accidents) because of its size.

*Existing impairments*

- Existing dissection of habitat by the close-running railway and B 207/E 47
- Above-average non-hunting related deaths from traffic accidents
- Low water quality due to artificial system of ditches and intensive land use

*Baseline evaluation*

The planning area has a relatively homogenous landscape structure, characterised by individual small settlement areas of little significance to medium-sized and large mammals and large semi-open and open spaces, most of which are used intensively for agriculture. There are no large areas of woodland. Since the habitat in the investigation area is homogeneous, distinctions cannot be made between preferred spaces or therefore landscapes of different importance to certain species. There are no long-distance migration routes for mammals in the investigation area. In terms of medium-sized and large mammals, dense populations of roe deer and hares are found in the investigation area. With regard to the hare, the Fehmarn planning area is important to this species, which is at risk throughout the country and included on the endangered species list in Schleswig-Holstein, because it is found here in such dense and above-average populations. Hot spots cannot be seen for either hares or roe deer because both species are distributed throughout the area relatively evenly.

**Bats**

(see Attachment 30.2 of the plan approval documents, Section 4.7).

7 species were definitively identified during the course of the investigations:

- Serotine bat (*Eptesicus serotinus*)
- Common noctule (*Nyctalus noctula*)
- Nathusius' pipistrelle (*Pipistrellus nathusii*)
- Natterer's bat (*Myotis natteri*)
- Soprano pipistrelle (*Pipistrellus pygmaeus*)
- Common pipistrelle (*Pipistrellus pipistrellus*)
- Daubenton's bat ((*Myotis daubentonii*)

Although the serotine bat, common long-eared bat, soprano pipistrelle, nathusisus' pipistrelle and common pipistrelle were recorded by the detector inspections carried out on hunting activities and therefore were counted as part of Fehmarn's local population, very few (1 to 3) contacts were made with natterer's and daubenton's bats during the autumn migration.

*Existing impairments*

- Risk of collision with existing offshore wind turbines

*Baseline evaluation*

The seven species recorded thus far represent around 2/3 of the species composition of Fehmarn of which, as previously mentioned, five species belong to the local population. By contrast, the other species only passed through the LCP plan area during migrations.

### Roosts

No bat roosts could be found within the intervention area and its surroundings. The wooded areas of the B 207's junction with the K 49 represent the largest woodland stockpile located within the intervention area and its immediate surroundings. These could potentially be used as daytime hiding places in hunting areas or temporary roosts and restricted to use as nursery roosts for bats. The detector inspections on hunting activities, however, showed no social calls which might indicate the presence of roosts. The numerous automatic bat detection systems' observations of flight routes (HBFL02 and HBFL03) for the autumn migration (location 01) and for the spring migration (locations 04 and 05), showed no indications of a standing stock of roosts in this area. The wooded areas showed no hollows or cracks which could serve as roosts.

Isolated observations of common pipistrelles were made on the K 49 in the wooded areas running alongside the road from the settlement area of Puttgarden southwards, along the road heading to Todendorf and the eastern side of the wooded area near the B 207 and K 49 junction. This would indicate social calls. It cannot be determined at present where the reproduction sites for common pipistrelles were located. The mating areas themselves, at least in the case of the common pipistrelle, should not be seen as being essential, as they are largely non-specific and mating can also take place outside the hiding area.

### Flight routes

While the flight route investigations were being carried out, the serotine bat, soprano pipistrelle, nathusisus' pipistrelle and common pipistrelle were recorded by the detector inspections and therefore were counted as part of Fehmarn's local population.

Over the course of these investigations, the threshold of ≥ 10 general bat contacts or ≥ 3 call sequences for myotis species within a 120 minute time interval allotted to data capture by at least one deadline, which is provided in the working guide (LBV-SH 2011), was not reached for seven potential flight route locations by any of the three investigation deadlines. Thus, none of the structures investigated in the intervention area of the Fehmarnbelt Fixed Link could serve as a flight route.

### Hunting habitats

The overwhelming number of bats recorded were classified as "hunters". Puttgarden and the harbour and railway premises, as well as the wooded areas near the junction between the B 207 and K 49, represented focal areas for recording bats.

In the case of the latter area, 24 bat contacts were made of which 16 were "hunting". In view of the high occupancy rate over the course of the year, it is to be expected that there would be no essential feeding areas in the wooded area.

**Table 46 Bat species found in the LCP investigation area and risk category**

| Species name (English) | Species name (Latin) | RL SH | RL BRD | Proof |
|---|---|---|---|---|
| Serotine bat | Eptesicus serotinus | 3 | G | D, HBFL, HBHZ, HBFZ |
| Natterer's bat | Myotis natteri | V | + | HBHZ |
| Common noctule | Nyctalus noctula | 3 | V | D |
| Soprano pipistrelle | Pipistrellus pygmaeus | V | D | D, HBFL, HBHZ, HBFZ |
| Nathusius' pipistrelle | Pipistrellus nathusii | 3 | + | D, HBFL, HBHZ, HBFZ |
| Daubenton's bat | Myotis daubentonii | + | + | HBHZ |
| Common pipistrelle | Pipistrellus pipistrellus | + | + | D, HBFL, HBHZ, HBFZ |

V = pre-warning list; G = Presumed endangered; + = not endangered; D = data situation limited. It also gives details in the context of which investigation the evidence was found. D = detector inspection, HBFL = Bat detector system flight routes, HBHZ = Bat detector system autumn migration, HBFZ = Bat detector system spring migration

The brown long-eared bat, (*Plecotus auritus*), which was recorded once by BIOPLAN (2009), could not be observed in either the EIA-REPORT investigations or in the current investigations. The investigations conducted on bat migrations for the purposes of the EIA-REPORT also showed no brown long-eared bats (*Plecotus sp.*) on Fehmarn. This quiet-calling species of bat could only be found a long distance from the detector. During additional investigations conducted by leguan GmbH, the species was recorded regularly. This means it is to be expected that the species is not a regular element of the fauna on Fehmarn.

The seven species recorded thus far represent around 2/3 of the species composition of Fehmarn of which, as previously mentioned, five species belong to the local population. By contrast, the other species only passed through the LCP plan area during migrations.

### Bat migration in the investigation area on Fehmarn

While mappings of bat fauna were being carried out during the autumn migration of 2014, the serotine bat, natterer's bat, soprano pipistrelle, nathusius bat, daubenton's bat and common pipistrelle were recorded, During the spring 2015 migration, the serotine bat, natterer's bat, soprano pipistrelle and common pipistrelle were recorded.

Overall, migration in the area of the planned Fehmarnbelt Fixed Link should be classified as conservative. Investigations carried out as part of the EIA-REPORT showed massive migration over the Grüner Brink and Katharinenhof (EIA-REPORT Attachment 15 of the plan approval documents, Volume II C, Section 3.23). This would indicate either a broad-front migration or a stronger migration along the coastline. In contrast, migration over the island body and, in particular, the area of the FBFL is significantly more limited which means that there is nothing of significance here.

### Conclusion

In terms of bat fauna, the investigation area should be considered average because there are virtually no areas of particular relevance to bats, such as old woodland and grove structures. Evidence was found on Fehmarn of seven of the eleven potential indigenous bat species, of which however only five species were native to the area. The following species were included: serotine bat, common noctule, soprano pipistrelle, Nathusius' pipistrelle, pond bat and common pipistrelle. No significant hunting habitats, roosts or flight routes were found within the investigation area.

## Breeding birds

*Baseline investigation*

Within the LCP investigation area, 60 species of breeding birds with a total of 1,348 areas were recorded (see Attachment 30.2 of the plan approval documents, Section 4.5.1, and Figures 4-2 to 4-10 ibidem).

Five species which are endangered nationwide were recorded (Knief et al. 2010):

- Red list S-H 1 (threatened with extinction): Wheatear;
- Red list S-H 2 (critically endangered): Ringed plover
- Red list S-H 3 (endangered): Lapwing, skylarks, whinchats,

and three species on the early warning list (V): Cuckoo, common gull, Eurasian jackdaw.

Six species which are endangered nationwide were recorded (Südbeck et al. 2009):

- Red list FRG (Federal Republic of Germany) 1 (threatened with extinction): Wheatear, ringed plover;
- Red list FRG 2 (critically endangered): Lapwing
- Red list FRG 3 (endangered): Northern shovelers, skylarks, whinchats

and seven species on the early warning list (V): Tree sparrow, house sparrow, cuckoo, house martin, swallow, moorhen, linnet.

The marsh harrier, as listed in Annex I of the EU Birds Directive. The following are strictly protected species according to the BNatSchG: Eurasian kestrel, lapwing, long-eared owl, marsh harrier, moorhen and ringed plover (see Table 47).

## Table 47 Species and number of pairs of breeding birds in the LCP investigation area, their risk category and protection status

| Species (English) | Species (Latin) | Number RP | Proportion % | Red list SH | Red list FRG | EU-VSch-RL | special (§)/strict (§§) protection status (BNatSchG) |
|---|---|---|---|---|---|---|---|
| Blackbird | *Turdus merula* | 49 | 3,6 | | | | § |
| Oystercatcher | *Haematopus ostralegus* | 2 | 0,1 | | | | § |
| White wagtail | *Motacilla alba* | 26 | 1,9 | | | | § |
| Common redpoll | *Carduelis flammea* | 3 | 0,2 | | | | § |
| Eurasian coot | *Fulica atra* | 3 | 0,2 | | | | § |
| Blue tit | *Parus caeruleus* | 13 | 1,0 | | | | § |
| Linnet | *Carduelis cannabina* | 30 | 2,2 | | V | | § |
| Winchat | *Saxicola rubetra* | 1 | 0,1 | 3 | 3 | | § |
| Chaffinch | *Fringilla coelebs* | 19 | 1,4 | | | | § |
| Eurasian jackdaw | *Corvus monedula* | 1 | 0,1 | V | | | § |
| Whitethroat | *Sylvia communis* | 37 | 2,7 | | | | § |
| Black-billed magpie | *Pica pica* | 5 | 0,4 | | | | § |
| Pheasant | *Phasianus colchicus* | 16 | 1,2 | | | | § |
| Skylark | *Alauda arvensis* | 27 | 2,0 | 3 | 3 | | § |
| Tree sparrow | *Passer montanus* | 6 | 0,4 | | V | | § |
| Willow warbler | *Phylloscopus trochilus* | 7 | 0,5 | | | | § |
| Garden warbler | *Sylvia borin* | 13 | 1,0 | | | | § |
| Redstart | *Phoenicurus phoenicurus* | 5 | 0,4 | | | | § |
| Icterine warbler | *Hippolais icterina* | 10 | 0,7 | | | | § |
| European serin | *Serinus serinus:* | 1 | 0,1 | | | | § |
| Yellowhammer | *Emberiza citrinella* | 2 | 0,1 | | | | § |
| Spotted flycatcher | *Muscicapa striata* | 15 | 1,1 | | | | § |
| Green finch | *Carduelis chloris* | 24 | 1,8 | | | | § |
| Black redstart | *Phoenicurus ochruros* | 7 | 0,5 | | | | § |
| House sparrow | *Passer domesticus* | 193 | 14,3 | | V | | § |
| Dunnock | *Prunella modularis* | 22 | 1,6 | | | | § |
| Stock dove | *Columba oenas* | 9 | 0,7 | | | | § |
| Common rosefinch | *Carpodacus erythrinus* | 1 | 0,1 | | | | §§ |
| Hawfinch | *Coccothraustes coccothraustes* | 1 | 0,1 | | | | § |
| Lapwing | *Vanellus vanellus* | 10 | 0,7 | 3 | 2 | | §§ |
| Lesser whitethroat | *Sylvia curruca* | 20 | 1,5 | | | | § |
| Great tit | *Parus major* | 21 | 1,6 | | | | § |
| Cuckoo | *Cuculus canorus* | 1 | 0,1 | V | V | | § |

| **Species (English)** | **Species (Latin)** | **Number RP** | **Proportion %** | **Red list SH** | **Red list FRG** | **EU-VSch-RL** | **special (§)/strict (§§) protection status (BNatSchG)** |
|---|---|---|---|---|---|---|---|
| Northern shovller | *Anas clypeata* | 1 | 0,1 | | 3 | | § |
| Swift | *Apus apus* | 22 | 1,6 | | | | § |
| House martin | *Delichon urbicum* | 46 | 3,4 | | V | | § |
| Blackcap | *Sylvia atricapilla* | 17 | 1,3 | | | | § |
| Carrion crow | *Corvus corone corone* | 2 | 0,1 | | | | § |
| Swallow | *Hirundo rustica* | 33 | 2,4 | | V | | § |
| Wood pigeon | *Columba palumbus* | 71 | 5,3 | | | | § |
| Reed bunting | *Emberiza schoeniclus* | 3 | 0,2 | | | | § |
| Marsh harrier | *Circus aeruginosus* | 1 | 0,1 | | | Annex I | §§ |
| Robin | *Erithacus rubecula* | 17 | 1,3 | | | | § |
| Rook | *Corvus frugilegus* | 312 | 23,1 | | | | § |
| Ringed plover | *Charadrius hiaticula* | 1 | 0,1 | 2 | 1 | | §§ |
| Yellow wagtail | *Motacilla flava* | 42 | 3,1 | | | | § |
| Herring gull | *Larus argentatus* | 35 | 2,6 | | | | § |
| Song thrush | *Turdus philomelos* | 4 | 0,3 | | | | § |
| Common starling | *Sturnus vulgaris* | 9 | 0,7 | | | | § |
| Wheatear; | *Oenanthe oenanthe* | 1 | 0,1 | 1 | 1 | | § |
| Goldfinch | *Carduelis carduelis* | 7 | 0,5 | | | | § |
| Mallard | *Anas platyrhynchos* | 14 | 1,0 | | | | § |
| Common gull | *Larus canus* | 29 | 2,2 | V | | | § |
| Moorhen | *Gallinula chloropus* | 3 | 0,2 | | V | | §§ |
| Reed warbler | *Acrocephalus scirpaceus* | 8 | 0,6 | | | | § |
| Collared dove | *Streptopelia decaocto* | 29 | 2,2 | | | | § |
| Eurasian kestrel | *Falco tinnunculus* | 3 | 0,2 | | | | §§ |
| Long-eared owl | *Asio otus* | 2 | 0,1 | | | | §§ |
| Winter wren | *Troglodytes troglodytes* | 12 | 0,9 | | | | § |
| Chiffchaff | *Phylloscopus collybita* | 30 | 2,2 | | | | § |
| **Total breeding pairs** | | **1.348** | | | | | |

The LCP investigation area is home to six breeding bird habitats (according to Flade 1994) (see Table 48). The majority of the LCP investigation area consists of the "Fields with little woodland" breeding bird habitat (D4). This habitat runs along both sides of the railway/B 207 and is characterised by extensive farmland with few structures used intensively for agricultural purposes. The percentage of woodland is below 3%. A large number of small bodies of water (pools, ponds, marl pits) is characteristic for the farmland on Fehmarn. This habitat type has an area of 585.3 ha. 43 breeding bird species with 294 territories were found here. The overall density was 5.0 pairs/ 10 ha.

**Table 48 Habitat types in the investigation area according to Flade (1994)**

| Code | Habitat type |
|---|---|
| A3 | Beaches (east/west of the ferry harbour) |
| D4 | Fields with little woodland (east/west of the B 207/railway) |
| D5 | Highly-structured fields (west of the B 207) |
| F5 | Park-like developments (Puttgarden) |
| F6 | Villages (Puttgarden, Marienleuchte, Bannesdorf) |
| F9 | Industrial areas/railway facilities (Puttgarden, Marienleuchte) |

The habitat type "Beaches" can be found in two partial areas in the north and northeast of the investigation area. It is comprised of, at least in part, flat areas with little or vegetation and sand, gravel and shells. Most are around 10–30 m wide. Dunes or cliffs are either not formed or only minimally formed. This habitat type has an area of 10.25 ha. Seven breeding bird species with ten territories were found here. The overall density was 10.2 pairs/ 10 ha.

The majority of the LCP investigation area consists of the "Fields with little woodland" breeding bird habitat (D4). This habitat is located on both sides of the railway/B 207, the largest partial area, however, is to the east of the transport infrastructure. The habitat is characterised by extensive farmland with few structures that is used intensively for agricultural purposes. The percentage of woodland is below 3%. A large number of small bodies of water (pools, ponds, marl pits) is characteristic for the farmland on Fehmarn. This habitat type has an area of 585.3 ha. 43 breeding bird species with 294 territories were found here. The overall density was 5.0 pairs/ 10 ha.

The habitat "Highly-structured fields, hedgerows" is situated on a subarea in the southwestern part of the investigation area. It is characterised by intensively farmed fields but has a higher percentage or woodland and smaller fields for agriculture than the habitat "Fields with little woodland" (D4). There are also small bodies of water in this habitat. This habitat type has an area of 100 ha. 22 breeding bird species with 36 territories were found here. The overall density was 3.6 pairs/ 10 ha.

The habitat "park-like developments" is located on a sub-area near Puttgarden in the LCP investigation area. Park-like developments are characterised by a vegetation percentage of at least 40% (Flade 1994). In addition to the typical, one- to three-storey buildings of different ages, they are characterised by gardens separated by hedges and bushes with lawns, fruit trees and ornamental plants. Hedges, fruit trees and birdhouse are important structural elements for breeding bird fauna. The main differences to villages are the absence of larger barns and stables, the prevalence of ornamental gardens over productive gardens and the dominance of pine trees over fruit trees (Flade 1994). This habitat type has an area of 15.6 ha. 25 breeding bird species with 131 territories were found here. The overall density was 84.0 pairs/ 10 ha.

There are three sub-areas of the breeding bird habitat "Villages" (F6) in the investigation area: Puttgarden, Marienleuchte and Bannesdorf. In addition to single-family house settlements that comprise up to 50% of the habitat type, farms or agricultural production operations with stables, barns and paved or unsealed farmyards are important components of villages. Fruit and vegetable gardens, small public parks, ponds, hedges and older deciduous trees are very common here. Villages are usually surrounded by open landscape. This habitat type has an area of 31.6 ha. 39 breeding bird species with 358 territories were found here. The overall density was 113.3 pairs/ 10 ha.

The most important area of the habitat F9 in the LCP investigation area, on the other hand, is the area "Puttgarden/freight train station". Almost 90% of the area consists of parking lots and train facilities. Woodland growth is mainly in the form of rows of poplar trees of different ages. There are several old sheds with flat roofs and concrete pillars in the extensively used eastern part. The potential disturbance is therefore classified as high due to the regular car and freight traffic. In addition to the area Puttgarden/freight train station, there is another area of the breeding bird habitat "Industrial areas and railway facilities" (F9) in the LCP investigation area: the depot of the German Armed Forces in Marienleuchte. A colony of seagulls with 29 pairs of common gulls and more than 30 pairs of herring gulls was detected in the area surrounding the freight depot as well as a colony of rooks with 299 breeding pairs. This habitat type has an area of 43.0 ha. 22 breeding bird species with 441 territories were found here. The overall density was 102.6 pairs/ 10 ha.

The habitat type "Transportation areas" is comprised in part of wooded embankments along the B 207/E 47 and the railway tracks. This habitat type has an area of 14.8 ha. Twenty breeding bird species with 45 territories were found here. The overall density was 30.4 pairs/ 10 ha.

*Comparison with 2009 mappings*

There are barely any differences in the numbers of the most common species between the breeding pair mappings of 2009 and 2015 In both years, the five most common species were the house sparrow, rook, woodpigeon, blackbird and house martin. Throughout 2009, 75 different species were found in a significantly larger EIA-REPORT investigation area (EIA-REPORT, Attachment 15 of the plan approval documents, Volume 2c, Section 3.17.3.4) and 48 species of breeding birds were found in the LCP investigation area, whereas 60 species were found in the LCP investigation area in 2015. In 2009, however, only endangered/ protected species and breeding pairs were recorded in the villages. In 2015, all the species were recorded there.

In 2015, using the standing stock of a breeding pair of wheatears and a breeding pair of whinchats, more species included on the SH Red List were recorded than in 2009. The wheatear, lapwings and skylark, all red list SH species, were detected in both investigation years. In both years, six species which are endangered nationwide were recorded. However, in 2009 the common teal and grey partridge were included in these species whereas in 2015, the wheatear and whinchat were found. The other four species included on the German Red List (ringed plover, lapwing, northern shoveller and skylark) showed no differences in either year.

The distribution of the aforementioned species over the investigation area is also comparable; in both years, lapwings bred in the area surrounding the Presen windfarm, with skylarks being widely spread over farmland areas (cf. Attachment 30.2, Section 4.5.1).

***Existing impairments***

- Noise and car traffic: along the B 207/ E 47, rail traffic on the railways, ferry harbour at Puttgarden and the ferry operations there
- Wind turbines in the Presen wind farm
- Intensive agricultural use
- Tourist use in beach area (cyclists, walkers, bathers)

*Baseline evaluation*

The habitats located in the LCP investigation area according to Flade (1994) as part of the update mappings were assigned the following importance (the level and importance were derived in Attachment 30.2 of the plan approval documents, Section 4.5.2):

**Table 49 Evaluation of habitat types according to Flade (1994) within the LCP investigation area**

| Habitat type according to Flade (1994) | | Assessment |
|---|---|---|
| A3 | Beaches (east/west of the ferry harbour) | Average (level III) |
| A3 | Beaches (ferry terminal to Presen) | Moderate (level II) |
| D4 | Fields with little woodland | Average (level III) |
| D5 | Highly-structured fields, hedgerows | Moderate (level II) |
| F5 | Park-like developments (Puttgarden) | Moderate (level II) |
| F6 | Villages (Puttgarden, Marienleuchte, Bannesdorf) | Average (level III) |
| F9 | Industrial areas and railway facilities | Average (level III) |
| | Traffic areas | Moderate (level II) |

Overall therefore, the update mapping showed only moderate and average levels, whereas the largest proportion, geographically speaking, was attributed average importance. Only garden cities, traffic areas and richly structured fields were classed as being of moderate importance.

The assessment of habitat types according to Flade (1994) is broadly consistent in both years (2009 mapping and update mapping 2015). In 2009, the section of beach located to the west of Puttgarden was assessed as being of high importance. In 2015, the same area was only assessed as being of average importance.

**Resting birds**

(cf. Attachment 30.2 of the plan approval documents, Section 4.6)

*Baseline investigation*

Between the nine mapping exercises conducted for resting birds on Fehmarn, 40 species with a total of 18,413 individuals were recorded in the LCP investigation area between September 2014 and April 2015. The three most common species were the great cormorant, herring gull and common gull. The great cormorant was only recorded at the facilities of Puttgarden harbour. Regionally significant stocks of bean geese and common gulls were recorded. In Rasttrupp, 102 individuals of bean geese were found to the east of the B 207 in the Nieland ditch.

A representation of the standing stock of resting birds can be found in Attachment 30.2 of the plan approval documents, Section 4.6, as well as figures 4-13 to 4-19 (ibidem).

*Existing impairments*

- Disturbances from noise and visual distractions: along the B 207/ E 47 and railway, near the Puttgarden ferry harbour and by ferry operations
- Wind turbines in the Presen wind farm
- Intensively used beach areas outside the Grüner Brink nature conservation area

*Baseline evaluation*

While the update mapping was carried out, significant stocks were found only for the cormorant on a national level. The great cormorant was only recorded at the facilities of Puttgarden harbour. It was therefore assessed as being an area of high importance for resting birds (Puttgarden breakwater).

Regionally significant stocks were recorded for the bean goose (Nieland ditch) and the common gull. Not a single flock of regional significance was found for the common gull in the investigation area. However, the total number of common gulls in the investigation area as of 23.09.2014 did indeed represent a population of regional significance. The largest individual flock (350 individuals) was recorded on the same day and was established as having local significance (northwest of Bannensdorf in the Nieland ditch). Those areas assessed as having stocks of regional or local significance were classified as being of high significance, in accordance with the criteria.

Locally significant stocks were recorded for the greater white-fronted goose (to the east of Todendorf and northwest of Puttgarden), whooper swan (south of Puttgarden) and bean goose (to the south of Puttgarden). These areas were therefore assessed as being of high importance to resting birds in accordance with the assessment criteria.

When comparing the 2009/2010 mappings to those carried out in 2014/2015 it can be determined that there is hardly any difference between the distribution and use of these areas in either investigation year. Large sections of the investigation area are not used by resting birds; they are found more frequently in the north-westerly areas next to the Grüner Brink.

## Amphibians

During the course of the update mapping, observations were made for amphibians in August 2014 and from April to July 2015. Detailed information on the recording methods used can be found in Attachment 30.2 of the plan approval documents, Section 3.1.4.

*Baseline investigation*

(cf. Attachment 30.2 of the plan approval documents, Section 4.4.1)

A total of three amphibian species were found in the 43 bodies of water studied (cf. Table 50). Of these, the great crested newt (triturus cristatus) was found on the early warning list nation-wide, whereas the data situation for the edible frog was classified as being insufficient on count of the hybridisation of the 3 species of green frog *Pelophylax lessonae, P. ridibunda* and *P. kl. esculentus* for the whole country. The smooth newt (*Lissotriton vulgaris*) is not endangered. At a national level, the edible frog and smooth newt are not endangered, the great crested newt however is included on the early warning list, as in the state of Schleswig-Holstein.

The adult animal specimens mapped are distributed over individual bodies of water as shown in Table 50.

**Table 50 Overall list of the amphibian species recorded, with information on the degree of risk on the Red List for the State of Schleswig-Holstein (Klinge 2003) and the Federal Republic of Germany (Kühnel et al. 2009a)**

| Species name (English) | Species name (Latin) | RL SH | RL BRD | Annex IV | Presence | Continuity |
|---|---|---|---|---|---|---|
| Great crested newt | *Triturus cristatus* | V | V | X | 18 | 43,90 % |
| Edible frog | *Pelophylax kl. esculentus* | D | + | | 40 | 97,56 % |
| Common newt | *Lissotriton vulgaris* | + | + | | 35 | 85,37 % |

V = included on the early warning list, D = data situation insufficient, + = note endangered, Annex IV = species listed in Annex IV of the FFH-RL, Presence = standing stock in all 41 bodies of water with evidence, Consistency = percentage ratio of the standing stock in all 41 bodies of water with evidence.

The amphibian presence shows extreme differences in distribution. With an extremely high consistency of nearly 100% and 85%, the edible frog and common newt are the key species in the investigation area. These are ectothermic species which inhabit waters of varying degrees of quality. Furthermore, the great crested newt has been recorded in great numbers. It inhabits around 44%, nearly half of the bodies of water studied in the investigation area.

The results reflect the typical rations found on Fehmarn. However, the frog and toad species that are otherwise commonly found in Schleswig-Holstein such as the common toad, grass frog and moor frog are only found now and again and then only outside the LCP plan area. Other species which are typical of Fehmarn, such as the natterjack toad, European green toad or fire-bellied toad, are restricted to the waters found in conservation areas belonging to the Naturschutzvereins Nördliche Seeniederung (Northern Lake Lowlands Organisation) and coastal lagoons, including Wallnau. These habitats are not included in the investigation area, which means that the range of species recorded should be classed as being complete, despite the low species richness. The current summary of Lanis data compiled by the LLUR on the standing stock of species, which is contained in Annex IV of the FFH-RL (Klinge 2015), also shows no other amphibian species.

*Baseline evaluation*

(cf. Attachment 30.2 of the plan approval documents, Sections 3.2.3 and 4.4.2)

In the 43 bodies of water investigated as part of the update mapping, a total of three amphibian species were recorded which are not endangered in Schleswig-Holstein. The great crested newt (*Triturus cristatus*) is included on the early warning list i.e. the standing stock is falling but the species is not yet endangered. In addition, the great crested newt in particular is distributed widely on Fehmarn.

There is therefore little point in assigning a Red List classification. The assessment according to the meta population group, as took place in the EIA-REPORT, is not currently applicable as, with only 43, there are too few bodies of water. A general assessment is therefore carried out using the recorded range of species:

**Table 51 The value classification of amphibian habitats for classification by species richness**

| Number of species | Level | Significance |
|---|---|---|
| 3 | 3 | Medium |
| 2 | 2 | Moderate |
| 1 | 1 | Low |
| 0 | - | None |

In order to assess whether the bodies of water are isolated, which would generally lead to increased sensitivity, it would need to be investigated whether and to what extent the amphibian species in question should be classed as being isolated and, therefore, whether they should be assessed as being of greater value. This will be based upon the species' action radii as shown in the EIA-REPORT. Both species of newt were found in an action radius of 300 m.

In addition to assessing the spawning waters, the land habitats must also be considered as these may lead to impairments which have a bearing on the project.

Due to the species range observed, both species of newt found were considered as the basis for evaluating the land habitats on account of their relatively small action radius and the potential impacts associated with this. In keeping with the EIA-REPORT, all suitable land habitats located within the aforementioned 300 m radius which were assessed as being at least "average" waters were shown separately. Classifying the value of land habitats is contingent on the classification of the spawning waters.

## Reptiles

As part of the current update mapping, it was checked whether the habitat structures which were recorded in the LCP investigation area during the EIA-REPORT were still there and whether it can be assumed that the quality of the habitat remains unchanged. This investigation took place in August 2014 when the biotope type mapping was carried out.

With regard to the habitat structures, nothing has changed on a structural level since the EIA-REPORT surveys were conducted in 2009/2010, which means that assessments carried out on reptiles for the LCP are still valid. In the meantime, no discoveries pertaining to the standing stocks of strictly protected sand lizard (*Lacerta agilis*) have been made on Fehmarn (cf. Klinge 2015) (see Attachment 30.2 of the plan approval documents, Section 4.8).

*Baseline investigation*

In terms of reptiles, only the common lizard, which is not at risk either statewide or nationally, was found within the LCP investigation area.

On the basis of the density of individuals discovered, the main hot spot for the common lizard on Fehmarn is the railway embankment and the B 207 and the associated vegetation structures, due to their exposure and habitats. This area can be identified as a functional area (linking function). According to studies undertaken as part of the Bioplan (2009), this area extends southwards to the Fehmarnsund bridge.

*Existing impairments*

- Only a few suitable habitats in the investigation area (e.g. the railway and road embankments), there are hardly any suitable unused/extensively used areas (e.g. uncultivated land or larger areas of woodland or groves)
- The transport infrastructure (rail and/or B 207/E 47) has a dissecting/barrier effect

*Baseline evaluation*

Only one reptile species was found in the LCP investigation area. The entire island of Fehmarn is impoverished with respect to this class of animals.

It can be assumed that the rails of the railway embankment in use are used as a dispersal axis and therefore as a functional area. Given the large number of individuals found in the areas studied around the abandoned and currently used railway embankment east of the B 207/E 47, which is classified as highly important for Fehmarn, the significance of the entire railway embankment functional area is graded as medium even though the common lizard is not at risk. We cannot say conclusively how far the functional area extends along the western road embankment (FBioRep33) or whether a separate functional area is created by the separating effect of the B 207. Given the low density of individuals, the proportion of the western road embankment is low in any case and its function rated as of medium significance given its isolation. The road embankments therefore play a relatively subordinate role.

After comparing them with the current biotope type mapping (Attachment 30.2 of the plan approval documents, Section 4.8) no structural changes in the biotope type structure and the habitats arising from these have been recorded. At most, the investigation area is of average importance to reptiles. With regard to ratios, nothing has changed on a structural level since the EIA-REPORT surveys were conducted, which means that, as before, the assessments carried out for the LCP are still valid (Attachment 30.2 of the plan approval documents, Section 4.8).

## Dragonflies

*Baseline investigation*

(cf. Attachment 30.2 of the plan approval documents, Section 4.3)

The observation of dragonflies in the investigation area was limited to the update mappings carried out on the six bodies of water which were recorded as an intervention area in the EIA-REPORT carried out previously.

in the six bodies of water studied in the investigation area, five dragonflies from a total of eight species were identified (Table 52). None of these species is endangered at either the state or national level. No dragonflies were found in the FOd136 waters.

**Table 52 Overall list of species of dragonfly recorded, with information on the degree of risk on the Red List for the State of Schleswig-Holstein (Winkler et al. 2011) and the red list of the Federal Republic of Germany (Wildermuth & Martens 2014)**

| Species name (English) | Species name (Latin) | RL SH | RL BRD | Presence | Continuity |
|---|---|---|---|---|---|
| Southern hawker | *Aeshna cyanea* | + | + | 2 | 40,00 % |
| Migrant hawker | *Aeshna mixta* | + | + | 2 | 40,00 % |
| Hairy dragonfly | *Brachytron pratense* | + | + | 1 | 20,00 % |
| Azure damselfly | *Coenagrion puella* | + | + | 3 | 60,00 % |
| Enallagma cyathigerum | *Enallagma cyathigerum* | + | + | 1 | 20,00 % |
| Blue-tailed damselfly | *Ischnura elegans* | + | + | 2 | 40,00 % |
| Lestes sponsa | *Lestes sponsa* | + | + | 3 | 60,00 % |
| Four-spotted chaser | *Libellula quadrimaculata* | + | + | 1 | 20,00 % |

+ = note endangered, Presence = standing stock in all five bodies of water with evidence, Consistency = percentage ratio of the standing stock in five bodies of water with evidence.

No species were found in Schleswig-Holstein which are listed as species threatened with extinction. Additionally, no species were found which, according to Annex IV of the Habitats Directive, should be given special consideration under conservation law. Likewise, the presence of these species was not expected owing to the features of the habitats in the bodies of water. The standing stock of crabclaws (*Stratiotes aloides*) in the FBioOd13 waters means that the strictly protected green hawker (*Aeshna viridis*) may be found. However, the standing stocks of crabclaws are only found in small areas and the body of water sufficiently shaded so that a standing stock of this species of dragonfly would be possible. They also were not found there in the investigations carried out by BIOPLAN and leguan.

Many bodies of water are surrounded by a relatively large amount of land used for agricultural purposes. However, due to their unshielded location, these are often exposed to strong winds. Additionally, many of the bodies of water dry up either periodically or on an irregular basis. In 2014, for example, the FOd119, FOd134 and FOd136 waters dried up. Over the course of 2015, the FBioOd13 waters also dried out. This is a limiting factor for many species as larval development frequently lasts a year or longer. The fact that these bodies of water dry up in this way means only a few species can survive here. These factors severely limit the functionality of many waters for a whole range of dragonfly species.

*Existing impairments*

- Poor water quality of artificial ditches and small bodies of water
- Depletion of investigation area in terms of suitable habitats for dragonflies due to intensive land use

*Baseline evaluation*

The dragonfly fauna of the six bodies of water investigated can be graded as average at best. In addition to the low overall number (eight) of species of dragonfly, the low count of six species per body of water is the main reason why they are classed as being of low value. Many common and specialised species are absent. Alongside intensive use for farming, mention should also be made of the fact that the only type of water was investigated.

**Grasshoppers, diurnal butterflies/Zygaenidae, ground beetles:**

(cf. Attachment 30.2 of the plan approval documents, Section 4.8)

As part of the EIA-REPORT, with regard to the organism groups of grasshoppers, diurnal butterflies, zygaenidae and ground beetles, only ubiquitous and ectothermic species were detected in the LCP application area being considered here. No special importance is given to these organism groups in the investigation area. At most, only moderate importance was awarded to the sampling sites used for grasshoppers within the LCP area.

These results did not require any update surveys. As part of the current update mapping, it was therefore checked whether the habitat structures which were recorded in the LCP investigation area during the EIA-REPORT were still there and, therefore, whether it can be assumed that the quality of the habitat remains unchanged. This investigation took place in August 2014 when the biotope type mapping was carried out.

## Grasshoppers

*Baseline investigation*

With regard to habitat structure rations, nothing has changed for grasshoppers on a structural level since the EIA-REPORT surveys were conducted in 2009/2010, which means that the assessments carried out for the LCP are still valid (see Attachment 30.2 of the plan approval documents, Section 4.8

In total, six species of grasshopper were found in the investigation area (cf. LCP, Attachment 12 of the plan approval documents, Section 4.4.2.16:

- Lesser marsh grasshopper,
- Common field grasshopper,
- Speckled bush-cricket,
- Roesel's bush-cricket,
- Dark bush-cricket,
- Great green bush-cricket.

None of the grasshopper species found are at risk within Germany or the state of Schleswig-Holstein. In terms of the grasshopper fauna found, the investigation area is extremely impoverished because there is an absence of special sites (e.g. fens) in the LCP investigation area and there are few structures of relevance to grasshoppers (e.g. farmland, hedgerows and residential areas).

*Existing impairments*

- Impoverished habitat or isolated habitats as a result of large areas of land being used for intensive farming
- Use of beaches by tourists

*Baseline evaluation*

With the exception of the abandoned railway land (habitat FCar2), which is of high importance to ground beetles, the investigation area is, at best, only of average importance to the following organism groups: grasshoppers, diurnal butterflies/ zygaenidae, reptiles and ground beetles. With regard to ratios, nothing has changed on a structural level since the EIA-REPORT surveys were conducted, which means that assessments carried out for the LCP are still valid.

There are no species in the LCP investigation area displaying particular specific adaptation or special habitat conditions.

It can be noted that the investigation area is highly impaired and that there is considerable previous damage. This situation is very clearly illustrated by the fact that species very common in other parts of the state are restricted to relatively few areas here. There are no sites of very high, high or medium importance in the investigation area.

Structures, which are of slightly greater benefit to relatively immobile insect species in semi-open and open landscapes, such as grasshoppers, do not exist in the investigation area because it is extremely impoverished.

All in all, studies of transects do not allow importance to be transferred to the surrounding areas because there are no structures of great importance to grasshoppers. A functional demarcation of grasshopper habitats is not therefore possible.

**Diurnal butterflies/Zygaenidae**

*Baseline investigation*

With regard to habitat structure rations, nothing has changed for diurnal butterflies/ zygaenidae on a structural level since the EIA-REPORT surveys were conducted in 2009/2010, which means that the assessments carried out for the LCP are still valid (see Attachment 30.2 of the plan approval documents, Section 4.8).

A total of 16 species (see LCP, Section 12 of the plan approval documents, Section 4.4.2.17) were found along the transects in the investigation area. None of the diurnal butterfly and moth species found in the LCP investigation area are at risk nationally or within the state.

*Existing impairments*

- Impoverished habitat or isolated habitats as a result of large areas of land being used for intensive farming

*Baseline evaluation*

Neither at-risk nor highly specialised diurnal butterfly species were found anywhere in the area. Generally speaking, there are therefore no outstanding habitats for diurnal butterfly fauna.

Within the investigation area, there is only one site of medium importance along the B 207/ E 47 (FBioTagSal33). All other habitats were of moderate importance. No species were recorded at one site (FBioTagSal32).

By way of conclusion, the diurnal butterfly fauna in the investigation area is in a similar situation to that of grasshoppers. The lack of any highly specialised species very clearly shows how highly intensive levels of land use impair even small areas in the landscape, which in other places are often used as refuge habitats. No habitats for diurnal butterflies can therefore be defined.

**Moths**

*Baseline investigation*

The habitat structure was investigated as part of the biotope type mapping which was carried out in August 2014 (see Attachment 30.2 of the plan approval documents, Section 3.1.8). With regard to the moth habitat structures, nothing has changed on a structural level since the EIA-REPORT surveys were conducted in 2009/2010, which means that assessments carried out on moths for the LCP are still valid.

A total of 100 moth species were found at the three sites studied (see LCP, Attachment 12 of the plan approval documents, Section 4.4.2.20).

According to the Red List for Schleswig-Holstein (Kolligs 2009), the majority of the species found are not at risk in the state. One species (*Mesoleuca albicillata)* is endangered state-wide and the species *Naenia typica* is critically endangered. The species *Rhyacia simulans, Mythimna conigera* and *Idaea fuscovenosa* are included on the endangered species list. On the national level (Rennwald et al. 2011, Trusch et al. 2011 and Wachlin & Bolz 2011) most species are not endangered either. *Euxoa tritici*is classified as critically endangered in Germany. The species *Arctia caja* and *Naenia typica* appear on the endangered species list.

*Existing impairments*

- Impairments caused by man from light emissions and severe lack of structure due to human activities
- Ground sealing in place
- Intensive agricultural use

*Baseline evaluation*

The range of species found is typical of this habitat and highly differentiated given the highly agricultural nature of the landscape. This differentiation is due to the fact that the three moth sites are located in habitats of very different qualities.

If the range of species found in the investigation area is compared with the supraregional situation, it can be considered below average. If the total number of individuals recorded is viewed, the quantitative results are again below average. This is due to existing impairments of the entire LCP investigation area in the form of both existing ground sealing and intensive agricultural use and the resultant limits this places on most of the moth fauna in terms of refuge/special habitats.

An assessment of the individual sites at the shunting station shows that the shunting station/south site (FNf02) is considerably less important than the shunting station/north site (FNf03, greatest value of the three sites in the LCP investigation area) because the proportion of eurytopic/ubiquitous species is only just below that of the Marienleuchte site and also no monophagous species were found. With 65 moth species, considerably more species were recorded here than at the Marienleuchte site (FNf04, 28 species). However, overall only slight importance within the three sites was identified for the shunting station/south site. Existing impairment caused by human activities is greatest at the shunting station/south (FNf02) and Marienleuchte (FNf04) sites.

## Ground beetles

*Baseline investigation*

As part of the EIA-REPORT mappings, with regard to ground beetles, only ubiquitous and ectothermic species were detected in the LCP application area being considered here. With regard to ground beetle fauna, overall only moderate importance was given in the LCP area. Due – to the standing stock of species included on the Red List –, only the railway embankment and shunting yard in Puttgarden were classed as being high value. The junction between the B 207 and K 49 and the east route between Todendorf and Presen represented a special case as a separate water structure was recorded here which deviates from the other transects investigated. However, the transect is of only average importance to ground beetle fauna.

These results did not require any update surveys. As part of the EIA-REPORT mapping, it was therefore checked whether the ground beetle structures which were recorded in the LCP investigation area were still there and, therefore, whether it can be assumed that the quality of the habitat remains unchanged. The habitat structure was investigated as part of the biotope type mapping which was carried out in August 2014 (see Attachment 30.2 of the plan approval documents, Section 4.8).

A total of 58 species (cf. LCP, Section 12 of the plan approval documents, Section 4.4.2.22) were found in the investigation area.

Of the species found, four appear on the national Red List (*Olisthopus rotundatus, Carabus convexus, Acupalpus exiguus, Anthracus consputus*) and another three on the endangered species list (*Pterostichus diligens, Broscus cephalotes, Amara curta*). With regard to the state of Schleswig-Holstein, five of the species found appear on the state Red List (*Panagaeus bipustulatus, Olisthopus rotundatus, Laemostenus terricola, Carabus convexus, Amara curta*) (four on the endangered species list: *Pterostichus anthracinus, Broscus cephalotes, Bembidion obtusum, Amara convexiuscula*). Compared with studies in areas with similar levels of intensive land use, relatively few species were found despite the large numbers of individuals recorded. The highly agricultural investigation area is therefore comparatively species-poor.

*Existing impairments*

- Depleted habitat
- Loss of semi-natural structures due to intensive agricultural use

*Baseline evaluation*

With regard to ratios, nothing has changed for ground beetles on a structural level since the EIA-REPORT surveys were conducted in 2009/2010, which means that the assessments given below for the LCP are still valid (see Attachment 30.2 of the plan approval documents, Section 4.8).

In terms of ground beetle fauna, the investigation area of the LCP is below average. There are only relatively few structures for the more demanding species. There is an absence of woodland, which is usually important to ground beetles.

A long-standing tradition of habitat could not be found along the entire course of the linking axis first postulated along the railway and B 207/E 47. The studies have, however, shown that the combined rail and road embankment acts as a linking axis for ground beetles because it features similar structures (linear groves) and passes through the centre of the entire island. A total of 27 ground beetle species were documented as having at least a high attachment to the structures commonly found on the railway embankment (biotope types: HGy – semi-natural hedgerow, RHf – (semi-)ruderal grass and shrub corridor of damp sites, RHm – semi-ruderal grass and shrub corridor of sites with moderate moisture levels and SVv – other transportation facilities). This corresponds to close to 47% of the entire range of ground beetles found in the LCP investigation area.

Assessment of the sites using the at-risk status shows that the rail and road embankment is valued very heterogeneously by the at-risk ground beetles. This means that a new and similarly formed structure could be inhabited relatively quickly by the same ground beetle community.

The study focused on evidence of traditional habitats and the linking axis. All in all, studies of transects do not allow importance to be transferred to the surrounding areas because there are no structures of great importance to ground beetles. A functional demarcation of ground beetle habitats is not therefore possible.

**Other strictly protected species**

*Baseline investigation and evaluation*

With regard to the update mappings conducted in 2014 and 2015, there have been no significant changes to the aforementioned investigation results, which means that the information is still valid.

In addition to the strictly protected species listed in the classes already considered, the presence of the following strictly protected species was also studied:

- Beach spider
- Dormouse
- Sand lizard
- Butterflies (particular consideration of the willowherb hawkmoth (*Proserpinus proserpina*) as a moth species in Annex IV of the Habitats Directive) and
- beetles.

There was no evidence of dormouse, sand lizard, strictly protected dragonflies, moths, beetle species or strictly protected beach spiders (*Arctosa cinerea*) in the investigation area or their presence can be ruled out due to their known distribution and the lack of habitat structures.

Other than amphibians, bats and the European otter (*Lutra lutra*) first recorded in 2010, no species from Annex IV of the Habitats Directive were found. Given its species-specific range, the European otter can be assumed to at least potentially exist in the investigation area although it was recorded in Wallnau 10 km away.

#### 4.2.4.3. Marine area

**Planktic flora and fauna**

The update check shows that the biomass of phytoplankton corresponds favourably with the average values for the period 2005–2014. Overall, the data collected during the EIA-REPORT in 2009/2010 proved to be largely representative of the whole period running from 2009–2014 (see Attachment 30.1 of the plan approval documents, Section 3 for more details). In this respect, the Baseline investigation and survey are still fully valid.

*Baseline investigation and evaluation*

The significance of planktic organisms in the Fehmarnbelt region is defined by the functional value of the three components phytoplankton, zooplankton and jellyfish and is heavily dependent on parameters such as primary production or biomass.

The main function of plankton for the ecosystem stems from the production of biomass, which is available as food for the next trophic levels in the food chain. The production can be depicted spatially and depend significantly on water depth. At depths of more than 6 m, average plankton production and biomass per unit of area are twice those in shallower depths. Greater production in areas of deeper water is crucial as the main food source for fauna living on the seabed. This depth line has therefore been used as the limit between the general and special significance of planktic fauna and flora (see Figure 20 and LCP, Appendix 12 of the plan approval documents,section 4.4.3.2).

*Existing impairments*

The Belt Sea and Arkona Basin are relatively polluted and if the Bay of Kiel and Bay of Mecklenburg (which are connected to one another by the Fehmarnbelt) are included too, a number of forms of area-specific anthropogenic pollution can be identified. Only a few examples of relevance to plankton are listed below:

- Input of nutrients and heavy metals (lead, cadmium)
- Input of synthetic substances (e.g. dioxin)
- Input of microbial pathogens

Previous impairments also exist in the form of:

- Eutrophication
- Climate change
- Invasive species

- Artificial hard substrate

## Benthic fauna

The analysis of the data gathered in 2015 confirms that the description of benthic infauna in the 2009 and 2010 survey years is largely representative of the infauna present in the Fehmarnbelt.

The update check draws the same conclusion with regard to the mussel communities i.e. that both the biomass and size distribution in 2015 are similar to the conditions registered in the survey year 2009. In this respect, the following Baseline investigation and assessment are still fully valid following the plausibility check (see Attachment 30.1 of the plan approval documents, Section 5).

*Baseline investigation*

Nine different communities of benthic fauna (see Table 53) were derived from the communities model using samples. Four of the communities are only present in deep water and three only in shallow water. The other two communities exist in both shallow and deep water. The Corbula community is a marginal case because it occurs at the transition between shallow and deep water. The distribution of the Rissoa and Tanaissus communities is limited to a small area on the edge of the LCP investigation area in each case. The other communities are spread over larger areas.

Generally speaking, bristle worms are the most common species in all communities. Overall, communities contain fewer species in shallow water than deep water as well as a smaller number of classes. The three classes of bristle worm, mollusc and crab contain the most species overall. The other classes are much more common in deep water than shallow water, e.g. bryozoan (*Bryozoa*), horseshoe worms (*Phoronida*), flat worms (*Plathelminthes*) and sponges (*Porifera*). In terms of numbers, the laver spire shell, (*Hydrobia ulvae*), is most dominant in shallow water with a relative abundance of up to 85%, while it is mainly bristle worms which dominate in deep water. Not only are there fewer species in shallow water; the proportion of scarcer species is also lower compared with deep water. In deep water below the thermocline, the salt content is higher than in shallow water so this area contains many more species with a purely marine origin and which can be found in the Fehmarnbelt without establishing large populations.

Overall, the communities in deep water are more homogeneous that those in shallow water. Mixed forms of communities containing macrophytes, soft seabeds, stones and other elements, which mix with one another, are often found in shallow water. As a result, there is often no clear distinction between individual communities. The communities constitute their pure form. Within the areas derived from modelling, the communities then exist in many variants and mixed forms with other communities.

**Table 53 Summary of characteristics of benthic fauna communities, which have been identified in the marine investigation area of the LCP**

| Community | Depth zone | Number of species* | Key characteristics |
|---|---|---|---|
| Arctica | Deep | 261 | Infauna – slime-like sediment |
| Bathyporeia | Shallow | 61 | Infauna – exposed sands |
| Cerastoderma | Shallow | 87 | Infauna – protected, immobile soft soils |
| Corbula | Deep | 180 | Infauna/epifauna – transition to thermocline |
| Dendrodoa | Deep | 271 | Epifauna – hard substrate/algae |
| Gammarus | Shallow/ deep | 196 | Epifauna – hard substrate/algae |
| Mytilus | Shallow/ deep | 152 | Epifauna – hard substrate |
| Rissoa | Shallow | 42 | Epifauna – seaweed |
| Tanaissus | Deep | 182 | Infauna – exposed sands and gravel |

*Existing impairments*

- Fishing (including the removal of species and abrasion of the seabed)
- Input of nutrients and heavy metals
- Underwater noise caused by shipping
- Eutrophication
- Construction work (direct loss of habitat and changes to habitat)
- Tourism
- Extensive stone fishing (the removal of large stones from the sea floor)

*Baseline evaluation*

The importance of the individual fauna communities is classified in four levels (low, medium, high and very high). These are derived firstly from statutory rulings and secondly on the basis of scientific aspects (see LCP, Attachment 12 of the plan approval documents, section 4.4.3.4).

**Table 54 Importance of the benthic fauna sub-factor**

| Fauna community | Significance |
|---|---|
| Arctica | Very high |
| Rissoa | Very high |
| Dendrodoa | High |
| Mytilus | High |
| Tanaissus | High |
| Cerastoderma | Medium |
| Gammarus | Medium |
| Bathyporeia | Low |
| Corbula | Low |

## Fish

The currency of the data basis for fish was checked in 2015. Overall, when comparing the baseline data gathered in 2009/10 with the current data from ICES Monitoring (2011–2014), no significant changes to the fish communities in the Fehmarnbelt were found. Both the benthic and pelagic fish communities are dominated by the same species of fish as they were previously. The changes observed in the abundance of certain species of fish, specifically flat fish, gave no indication that the assessment made in the EIA-REPORT concerning the importance or degree of impairment should be revised. In addition, no significant changes to the communities in shallow waters were expected, since no change to the environmental conditions in the respective areas along the coasts is envisaged.

With regard to the inward migration of new species of fish, the appearance of the round goby in certain areas of the Fehmarnbelt gives some cause for concern, given that, in recent years, this species has experienced explosive growth in neighbouring waters (roughly in the area of the Guldborgsund). This has not however affected the evaluation basis for the EIA-REPORT.

New individual sightings of Atlantic sturgeon have been made in the last 5 years. In 2010 on the south coast of Lolland, two individual sightings were made in the southern marine area of the island of Fehmarn. Sightings were also made along the coast of Schleswig-Holstein (5 individuals) and in the Kiel Canal (7 individuals). Based on the current information on the distribution of the Atlantic sturgeon, the Fehmarnbelt region holds no relevance for this species of fish.

No new sightings of species included on the Red List were made during the Baseline investigations of 2009/10. The hazard level to the European eel on the German Red List of Fish and Cyclostomes (Thiel et al. 2013) was upgraded to category 2 (critically endangered). The European eel had already been awarded very high importance in the EIA-REPORT, which means that the hazard level cannot be raised any higher.

In this respect, the following Baseline investigation and assessment are still fully valid following the evaluation. A detailed explanation of the results of the update investigation can be found in Attachment 30.1 of the plan approval documents, Section 7.

*Baseline investigation*

A total of 60 different species of fish were recorded (see Section 4.4 LCP, Attachment 12), of which 23 were found frequently, 19 regularly and 18 infrequently. The eggs of nine fish species and the larvae of 31 were found.

The fish community in the shallow areas (water depth < 2 m) off Fehmarn is characterised by species of small fish: three-spined stickleback, sand goby and lesser sand eel. Fifteen species belonging to the fish communities of shallow water were recorded in total. The sand goby is the most common of these species. The makeup of the fish community found matches that of typical shallow water communities in the Baltic Sea (Nellen & Thiel 1996).

A total of 35 species were identified (both benthic and pelagic as well as shallow water community species), which can be classified as part of the benthic fish community. The benthic fish community is dominated by flatfish species (flounder, plaice and common dab) and semi-pelagic species (cod and whiting). Most of the recorded flatfish species only migrate to a limited local extent, e.g. during the spawning season when they move into deeper waters.

The Fehmarnbelt is important as a transit route for the silver eel stage of the European eel. All silver eels which leave the Baltic Sea area either have to pass through the Øresund or the Belt Sea as they journey to the Atlantic. The Belt Sea, comprising the Fehmarnbelt, Ulvsund, Gransund and Guldborgsund, acts as a transit route for the silver eel. The silver eel migration generally starts in late summer and lasts from August to December.

The main spawning season for cod in the Fehmarnbelt is between December and March. A large proportion of the cod spawning in the western part of the Fehmarnbelt migrate to different areas in the Baltic Sea (Belt Sea, Bay of Mecklenburg and Bornholm Sea) to feed. The Bay of Mecklenburg is their main feeding ground. This means that the parts of the cod population which feed to the east of the Fehmarnbelt have to pass the Fehmarnbelt Fixed Link area every year.

Ten species belonging to the pelagic fish community were recorded. Considered over the course of a whole year, there are higher concentrations of pelagic fish on the German side of the Fehmarnbelt than the Danish side. The spring herring uses the Fehmarnbelt as a migration corridor, although this is not its main migration route. The Fehmarnbelt and adjacent areas are a spawning ground for the European sprat population in the western Baltic Sea and are also used as a nursery ground. The European sprat migrates through the Fehmarnbelt and is present from spring to autumn. During the winter it migrates deeper into the Baltic Sea as water temperatures fall.

No species of Annexes II and IV of the Habitats Directive were identified off Fehmarn.

The majority of the species included on the Red List which are present in the Fehmarnbelt (according to HELCOM - Baltic Marine Environment Protection Commission - 2007 and Fricke et al. 1996) were present in either sporadic or very low numbers. However, some species such as the sea stickleback were very abundant and widely distributed. These species are an important part of the fish communities in the coastal areas of the Fehmarnbelt. The following red list species were identified in the investigation area: snake blenny (*Lumpenus lampretae-formis*, threatened with extinction), sea stickleback (*Spinachia spinachia*, endangered), cork-wing wrasse (*Symphodus melops*, threatened with extinction), ballan wrasse (*Labrus bergylta*, endangered), sea trout (*Salmo trutta*, critically endangered), Atlantic salmon (*Salmo salar*, en-dangered), greater weever (*Trachinus draco*, potentially endangered), European ee (*Anguilla anguilla*, endangered) and painted goby (*Poatoschistus pictus*, threatened migrant). No speci-mens of autumn-spawning herring (*Clupea harengus*, at great risk) could be caught, although evidence was found of larvae.

*Existing impairments*

- Fishing
- Shipping
- Noise pollution
- Water contamination
- Tourism (angling and water sports areas around Fehmarn)

*Baseline evaluation*

The evaluation of the shallow water community is based on a classification of the functional significance of index species. The shallow water area of Fehmarn is of medium significance for the fish species in this community. Because these species spend their entire lifecycle in a small space, they use the area for spawning, raising their young, feeding and egg and larvae drift.

There are areas of potential significance as spawning grounds for flatfish in the deeper parts of the investigation area (> 20 m) off the north coast of Fehmarn. They were all classified as of medium significance. The parts within the investigation area shallower than 20 m (waters around Fehmarn) are classified as areas with potential significance as nursery grounds for flat-fish (with the exception of common dab). Their significance is rated as medium.

The Fehmarnbelt is very important for the migration of the European eel out of the Baltic Sea area towards the Atlantic. It is not, however, as important as the Øresund, which is crossed by a greater number of migrating silver eels. Areas of importance to the migration of silver eels in the Fehmarnbelt and adjacent areas are assigned very high significance. The results con-firmed that the Fehmarnbelt is important as a transit route for a significant proportion of silver eels migrating out of the Baltic Sea. Potential nursery grounds for the cod exist in the shal-lower parts of the investigation area (< 20 m) and are of medium importance: north, northwest and northeast coast of Fehmarn. Potential areas for cod to raise their young exist in the shal-lower parts of the investigation area (< 20 m) and are of medium importance: north, northwest and northeast coast of Fehmarn.

For whiting, the Fehmarnbelt is of low importance as an area for raising young but of medium importance for migration.

No eggs of either spring-spawning or autumn-spawning herring were found in the investigation area. However, the larvae of both were found. Potential spawning sites could only be identified for spring-spawning herring. Most of the larvae studied came from the shallow waters to the east of Fehmarn (starting from Puttgarden and moving southeast along the coast, low significance). Comparing these results with video surveys did, however, show that the probability of spawning activities in these areas is very low. Studying the herring caught did reveal evidence proving that spring herring use the Fehmarnbelt as a migration corridor (high significance), but it is not the main migration route. The Fehmarnbelt is both a spawning and nursery area of medium importance to European sprat. In water deeper than 5 m, the Fehmarnbelt is classified as a potential migration area of medium significance for this species.

The fish class is evaluated on the basis of a single-species evaluation following the criteria of international/national protection status and functional importance for the natural balance and ecosystem. Levels of significance were produced for the following single species (see Section 3.9 EIA report, Attachment 15, Volume II A).

**Table 55 Significance of the investigation area for fish species**

| **Function element of Fish species recorded** | | | |
|---|---|---|---|
| **Significance** | **Fish species** | **Frequency** | **Explanation** |
| Very high | European eel | Regular | - RL HELCOM: "critically endangered"<br>- RL BRD: endangered<br>- CITES Annex II<br>- Appears on OSPAR list |
| High | Sea stickleback | Frequent | - RL G: endangered<br>- Index species of Fehmarn's coastal waters (especially areas of extensive seaweed) |
| | Snake blenny | Regular | - RL HELCOM: "critically endangered"<br>- RL G: threatened with extinction<br>- Because the western Baltic Sea is the natural distribution boundary, not "very high" |
| | Herring (autumn- and spring-spawning forms) | Frequent | - RL HELCOM: "endangered" (autumn-spawning herring)<br>- RL G: critically endangered (autumn-spawning herring)<br>- Spring-spawning herring are not classified in any at-risk category<br>- It is hard to distinguish between the two forms when not in the spawning season so they are evaluated together<br>- Major fall in population of autumn-spawning herring and none of the specimens caught during the study were identified as autumn-spawning herring<br>- Fehmarnbelt is an important migration area for both forms |
| | Cod | Frequent | - Particular ecological significance for Baltic Sea<br>- HELCOM priority List ("keystone species", population falling, global situation for codfish/cod stocks is poor) |
| Medium | Atlantic salmon | Regular | - Habitats Directive Annex II (only with regard to freshwater habitats)<br>- RL HELCOM: "endangered"<br>- RL G: endangered<br>- Significant increase in Baltic Sea salmon population due to stocking in waterways (in Germany and other countries on the Baltic Sea coast); there would however presumably be a major drop if stocking were to cease<br>- The specimens found were presumably only migratory fish (because no river systems flow into the investigation area) |

| **Function element of Fish species recorded** | | | |
|---|---|---|---|
| **Significance** | **Fish species** | **Frequency** | **Explanation** |
| | Sea trout | Regular | - RL HELCOM: "vulnerable"<br>- RL G: critically endangered<br>- Recorded in Fehmarn's coastal waters (mainly adult specimens)<br>- Fehmarnbelt transit area used for migration |
| | Whiting | Frequent | - Characteristic of Fehmarnbelt and adjacent bays |
| | European sprat | Frequent | - Characteristic of Fehmarnbelt and adjacent bays |
| | Flatfish | Frequent | - Characteristic of Fehmarnbelt and adjacent bays |
| | Fish species of the shallow water area | Frequent | - Characteristic of Fehmarnbelt and adjacent bays |
| Low | Corkwing wrasse | Rare | - RL HELCOM (2007): "vulnerable"<br>- RL G: threatened with extinction<br>- Baltic Sea distribution boundary<br>- Isolated recordings on coast of Fehmarn<br>- No reproducing stocks in Fehmarnbelt |
| | Ballan wrasse | Rare | - RL HELCOM (2007): "endangered"<br>- RL G: endangered<br>- Western Baltic Sea distribution boundary<br>- Preferred habitats are stony coastal areas and reefs |
| | Greater weever | Regular | - RL HELCOM (2007): "vulnerable"<br>- RL G: potentially endangered<br>- Few sightings made in the coastal waters of Fehmarn and in the Fehmarnbelt |
| | Painted goby | Rare | - RL HELCOM (2007): "vulnerable"<br>- RL G: endangered migrants<br>- Few sightings made in the Fehmarnbelt |
| | Other fish species in the Fehmarnbelt | | - No special ecological significance for the Fehmarnbelt |

The impact assessment is based on the key species. The named species serve as indicator species for estimating the impacts on fish communities in the entire Fehmarnbelt:

**Table 56 Key species/fish communities in the Fehmarnbelt and their usage requirements during the various stages of their lives.**

| Species/community | Usage requirement | | | | |
|---|---|---|---|---|---|
| | Spawning area | Egg and larvae drift | Nursery ground | Feeding ground | Migration |
| Cod | X | X | X | X | X |
| Whiting | | | X | X | X |
| Flatfish | X | X | X | X | X |
| Herring | X | X | X | X | X |
| European sprat | X | X | X | X | X |
| Shallow water fish community | X | X | X | X | X |
| Eel | | | X | X | X |
| Sea stickleback | X | X | X | X | X |
| Snake blenny | X | X | X | X | X |
| Salmonidae (salmon and sea trout) | | | | | X |

## Marine mammals

*Baseline investigation*

*Harbour porpoise (Phocoena phocoena)*

The results of these digital flight surveys carried out in 2015, which were obtained during the update check, broadly concur with the 2009 and 2010 data. The distribution of the harbour porpoise showed the same focal points with the highest densities being found southwest of Lolland and northwest of Fehmarn. The modelled density data was very similar (see Attachment 30.1 of the plan approval documents, Section 8.3.1).

In the LCP investigation area, the density of **harbour porpoise**based on aerial surveys, was 0.32 individuals per km² in 2009 and 0.42 individuals per km² in 2010. Throughout the Fehmarnbelt, the highest densities of harbour porpoise were found in the Danish Natura 2000 area "Femernbælt" (in the summer of 2010; 1.09 individuals per km²).

In terms of the entire Fehmarnbelt, the presence of harbour porpoise in the LCP investigation area can be classified as "high" (see Section 12 of the plan approval documents, Section 4.4.3.6). The highest harbour porpoise densities of up to one individual per km² can be found in the western part of the LCP investigation area. The further one goes into the eastern section of the area around Fehmarn, the more the density of harbour porpoise per km² decreases. The flight surveys showed that the highest population densities were found in the northwest of the investigation area and south of Gedser and the lowest were found near the Mecklenburg coast. As well as this north/south difference, figures also differ greatly between west and east.

The greatest harbour porpoise activity and population densities are found when the water temperature is between 5 and 10 °C in the spring and autumn. Harbour porpoise calves were observed during aerial surveys in the summer, mainly in the warmer months of July and August. Analysis of harbour porpoise movements using satellite transmitters showed that calves travel large distances by day just like adults without calves. There is therefore no evidence that calves (and their mothers) stay in smaller, selected areas near their reproduction areas.

*Harbour seal (Phoca vitulina)*

Harbour seals were also recorded in the 2015 digital flight surveys. The new results concur fully with the previous surveys and confirm the standing stock in the Rødsand Lagoon (see Attachment 30.1 of the plan approval documents, Section 8.4.2).

**Harbour seals** require undisturbed rest areas. The presence of harbour seals in the Fehmarnbelt is therefore mainly restricted to the Rødsand lagoon outside the LCP investigation area, where the only colonies in the investigation area are found.

*Grey seal (Halichoerus grypus)*

The distribution of **grey seals** also depends on the availability of undisturbed rest areas, among other things. As with harbour seals, the presence of grey seals in the Fehmarnbelt is mainly concentrated on the Rødsand lagoon outside the LCP investigation area. Grey seals hunt in much larger areas than harbour seals, but very few movements were recorded in the Fehmarnbelt during the study.

When the 2015 digital flight surveys were carried out, only one grey seal was identified. Therefore, there are no more recent sightings on the distribution and abundance of this species in the Fehmarnbelt (see Attachment 30.1 of the plan approval documents, Section 8.3.2.6).

*Existing impairments*

Harbour porpoise:

- Bycatch
- Hazardous substances
- Dumping excavated material at sea
- Eutrophication (influence on fish species and therefore indirectly on harbour porpoises, nature and extent not known)
- Shipping (possible noise load, despite high level of ship traffic no evidence that collisions with ships have affected the harbour porpoise populations)
- Tourism and lEIA-reporture activities (tends to play a minor role among existing impairments)
- Underwater noise
- Structures: Offshore wind farms

- Competition with fishing (significant influence not likely)

Harbour seal and grey seal:

- Disturbances at rest sites
- Inherited military waste (extremely short ramp-up time of noise signal from detonations has an adverse effect on marine mammals: fatal injuries, acoustic trauma such as permanent/temporary hearing threshold shifts)
- Noise
- Hazardous substances
- Disease
- Bycatch
- Eutrophication (algal bloom, low oxygen content in deep water, negative, indirect consequences from impact on prey cannot be ruled out, but also cannot be quantified)
- Overfishing of prey

*Baseline evaluation*

Within the Fehmarnbelt, the average seasonal density of **the harbour porpoise** in the summer is 0.43 ind./km² (2,078 ind./4,875 km²) based on spatial modelling. Overall in summer the investigation area is therefore assigned medium significance as a place for the harbour porpoise to stay. Because harbour porpoises are unevenly distributed throughout the Fehmarnbelt, it is possible that some regions are of greater importance. Other areas have densities of more than 0.5 or 1 individuals/km2 and are therefore areas of high and very high significance, as in the western LCP investigation area. Some of these areas were included in the marine protection areas of the Natura 2000 network. The level of importance in the winter is lower overall; only small areas achieve medium or high importance. It should, however, be noted that these areas are in similar locations to those of greater importance in the summer.

It is clear from the data available that harbour porpoises give birth to their calves in early summer in the area where they are living at that time. This means that during the summer harbour porpoise calves are being born and raised in the Fehmarnbelt. The proportion of calves recorded varied over the two years of aerial surveys, but matched the information from other studies. Particular importance as a nursery area was not identified. The function of the Fehmarnbelt as a breeding area is therefore assigned medium significance.

The studies carried out during the baseline study clearly show seasonality in the presence of harbour porpoises in the Fehmarnbelt, especially in the areas to the east of the Fehmarnbelt. Some results, such as the spring and autumn maximums for abundance and acoustic activity, indicate that the Fehmarnbelt acts as a migration corridor for harbour porpoise movements between the eastern and western parts of the Baltic Sea. However, it remains unclear how many harbour porpoises swim through the Fehmarnbelt as they migrate. The abundance of harbour porpoise to the east of the Fehmarnbelt is at any rate low compared with other parts of the distribution area for this population.

As for its role as a migration corridor, it was noted during the opinion and hearing session that this role should be assessed as high. In accordance with the criteria used in the EIA-REPORT, the assessment 'high' is defined as follows: "One of several migration routes between important home ranges or nursery areas and a link between subpopulations". By contrast, average importance is defined as to a route between home ranges or nursery areas which are classed as being of average importance. Given that the other potential migration routes between the western and eastern sections of the Baltic Sea, with the exception of the Øresund, are quite small, the importance of the Fehmarnbelt as a migration corridor is rated as high. (see Attachment 30.1 of the plan approval documents, Section 8.4.1.6).

No areas within the investigation area could be classified as particularly significant to **harbour seals** or **grey seals**.

### Resting birds

A detailed description of the current data basis for resting birds can be found in Attachment 30.1 of the plan approval documents, Section 9. This update was carried out by evaluating newly-available data and conducting flight surveys. Since new digital methods pertaining to recording and evaluating data obtained from flight surveys have become available in the meantime, digital flight surveys were carried out in concert with conventional observer flight surveys in 2015. This made it possible to compare the EIA-REPORT data basis and at the same time test the new methods.

Both the new flight surveys from the Fehmarnbelt and the evaluation of external data sources fully confirm the frequency and distribution pattern of resting birds, as was described in the survey years 2009/10. The species-specific update check revealed relevant frequency and distribution changes for a total of five species. The great crested grebe, Slavonian grebe and goosander showed higher standing stocks, meaning that they were classed as more important. The digital survey technique also registered higher figures for the guillemot. However, this did not trigger any change to the level of importance. The common scoter showed both a greater abundance and an altered distribution. None of the aforementioned species, however, showed significant changes in the impact assessment with regard to the severity of impairment. The primary reason for this is that the aforementioned frequency and distribution changes concern the entire investigation area and do not, or only negligibly, affect the areas concerned by the project.

Some of the changes observed can be explained by a change in the methods used. The higher quality of the data obtained from the digital flight survey makes better data gathering methods possible which, as is known, can be recognised as insufficient where this data concerns visual flight surveys. This is especially true for grebes and auks.

The current observation flights and the evaluation of updated external data essentially confirm the abundance and spreading pattern of the various species of water fowl in the Fehmarnbelt region, as described in the EIA-REPORT. The data obtained from the baseline survey and the results of the EIA-REPORT on waterfowl are therefore plausible and remain valid (cf. Attachment 30.1 of the plan approval documents, Section 9.7).

*Baseline investigation*

Breeding water birds: A total of 87 breeding bird species and 16,608 breeding pairs were recorded in the bird conservation areas studied for the EIA in the period under analysis. Nineteen of these species are listed in Annex I of the EU Birds Directive. Thirty-eight of the 87 species are relevant for marine habitats (see Section 4.4.3.10 LCP, Attachment 12 of the plan approval documents).

A species is considered relevant for the marine area if it breeds in a marine habitat or raises its young in marine habitats (eider duck and red-breasted merganser) or uses marine habitats as feeding grounds during the breeding season/when raising its young (red-necked grebe, cormorant, gulls and terns from inland breeding sites/colonies). In particular, seabird colonies sited close to the planned FBFL are classified as relevant for the evaluation. For example, there is a colony of common terns at Grüner Brink and it must be assumed that these birds search for food in the area of the planned FBFL.

Resting birds: The resting birds which occur in the LCP investigation area are listed in Table 57. Section 4.4.3.10 of the LCP (Attachment 12 of the plan approval documents) provides a description of resting bird populations in the Fehmarnbelt for all marine bird species that occur in the investigation area based on the information in the standard data sheets of the bird conservation areas and according to experts, and that could be negatively impacted by a Fehmarnbelt Fixed Link. The Baseline investigation is usually broken down by species. Data was only analysed jointly for a small number of species that are difficult to distinguish from one another (particularly, e.g. for recordings from planes) (e.g. Gannets/Arctic divers, red-footed terns).

*Existing impairments*

- Fishing
- Hunting
- Eutrophication
- Shipping
- Environmental pollution
- Offshore wind farms
- Barrier effects
- Collisions
- Other structures (onshore wind farms near the sea)
- Climate change

*Baseline evaluation*

Breeding water birds: Of all European bird conservation areas in the Fehmarnbelt region, the Eastern Bay of Kiel area is home to the most Annex I species and the most breeding pairs of species named in Annex I. This is, however, partly due to the fact that certain species are not found in marine environments. Of the species which are found in marine environments, particular mention should be made of colonies of four species of breeding terns (sandwich terns, Arctic terns, common terns and little terns) because breeding grounds for these species are rare in the southern Baltic Sea area. Mention should also be made of the breeding colonies of various gulls and the avocet. The numerous breeding eider ducks and red-breasted mergansers, which raise their chicks in marine environments, also lend particular importance to the area as a breeding ground for waterfowl. Most breeding grounds are some distance away from the FBFL route. However, in the case of terns and gulls, which breed at Grüner Brink on Fehmarn, it is probable that they search for food near the route and birds from the larger gull colonies in the Rødsand lagoon could also use this part of the Fehmarnbelt at least on occasion.

Resting birds: The table below shows the at-risk status, abundance and importance of resting waterfowl species in the Fehmarnbelt investigation area. A detailed list of the estimated maximum figures for the resting waterfowl species can be found in Section 4.4 of the LCP (Attachment 12).

**Table 57 Resting birds in the Fehmarnbelt investigation area (EIA report) and the area surrounding the route with details of at-risk status and level of importance**

| Species | Annex I | At-risk status* | Abundance* | Level of importance* |
|---|---|---|---|---|
| Loon | X | | | SH |
| Great crested grebe | | | | G |
| Red-necked grebe | | | | SH |
| Horned grebe | X | | | G |
| Cormorant | | | | SH |
| Mute swan | | | | SH |
| Bewick's swan | X | | | SH |
| Whooper swan | X | | | SH |
| Bean goose | | | | M |

| Species | Annex I | At-risk status* | Abundance* | Level of importance* |
|---|---|---|---|---|
| White-fronted goose | | | | G |
| Grey goose | | | | SH |
| Barnacle goose | X | | | SH |
| Brent goose | | | | H |
| Eurasian wigeon | | | | SH |
| Gadwall | | | | SH |
| Common teal | | | | M |
| Mallard | | | | G |
| Northern shoveller | | | | SH |
| Pochard | | | | SH |
| Tufted duck | | | | SH |
| Greater scaup | | | | SH |
| Common eider | | | | SH |
| Long-tailed duck | | | | SH |
| Common scoter | | | | SH |
| Velvet scoter | | | | G |
| Common goldeneye | | | | M |
| Smew | X | | | SH |
| Red-breasted merganser | | | | SH |
| Goosander | | | | G |
| White-tailed eagle | X | | | H |
| Eurasian coot | | | | M |
| Little gull | X | | | SH |
| Black-headed gull | | | | M |
| Common gull | | | | H |
| Lesser black-headed gull | | | | G |

| **Species** | **Annex I** | **At-risk status*** | **Abundance*** | **Level of importance*** |
|---|---|---|---|---|
| Herring gull | | | | M |
| Great black-headed gull | | | | M |
| Sandwich tern | X | | | H |
| Common tern | X | | | G |
| Arctic tern | X | | | G |
| Guillemot | | | | G |
| Razorbill | | | | M |
| Black guillemot | | | | H |

* The three columns on the right show the level of importance (vh=very high, h=high, m=medium, l=low; the darker the shade of green used, the greater the level of importance) that has been identified for each species using a combination of "at-risk status" and "abundance“ (see Section 0.2.2.11 of the EIA report, Attachment 15 of the plan approval documents, Annex B) in the Fehmarnbelt.

### 4.2.5. Plants

#### 4.2.5.1. Island of Fehmarn

**Biotopes/biotope types**

*Baseline investigation*

In 2014 and 2015, an update was carried out to the biotope types and plants included on the Red Lists. The biotope types were recorded in 2014 according to the standard list of biotope types in Schleswig-Holstein (LANU 2003).

The biotope types were recorded as part of an investigation at the start of August 2014 according to the standard list of biotope types in Schleswig-Holstein (LANU 2003). In May 2015, the current mapping guidelines for biotope types in Schleswig-Holstein came into force (LLUR 2015). These guidelines contained significantly more biotope types than the previous standard list. In addition, grasslands and salt marshes were broken down in a much more detailed manner than previously. For this reason, the GIS shape completed in 2014 was revised in September 2015. As part of this, the polygons and biotope abbreviations were adjusted in accordance with the current mapping guidelines (see Attachment 30.2 of the plan approval documents, Section 3.1.1).

The biotope types identified during the 2014-2015 update mapping are shown in Table 58 along with their conservation value. The site location can be found in Attachment 30.2 of the plan approval documents, Plan no. 2. During the course of the update mappings (Attachment 30.2 of the plan approval documents, Section 4.1), a total of 373 different locations were identified within the investigation area in 2014-15, which were assigned to 57 different biotope types or biotope type combinations in accordance with the current standard list on biotope types in Schleswig-Holstein (LLUR 2015).

Arable land makes up by far the majority of this area. A total of around 576 ha of arable land was recorded, which corresponds with approximately 74% of the total surface of the investigation area. The second most common land use was for settlement biotopes, including transport routes and wind power installations, with a total area of around 147 ha i.e. approximately one fifth of the investigation area.

Grasslands, including protection dykes, amounted to approx. 21 ha. Brush areas such as, inter alia, field hedges, thickets, coniferous woodlands or trees lining roads were recorded which amounted to approx. 16 ha. Various types of ruderal areas comprised around 5 ha with bodies and water and ditches amounting to a total surface area of approx. 3 ha. The areas containing coastal biotope types (dunes, beaches and cliff areas bordering the Baltic Sea) comprise 1.0 ha.

Of the 375 habitats recorded, 73 are legally protected according to § 30 (2) BNatSchG and § 21 (1) LNatSchG. A total of 42 habitats are protected according to § 30 (2) no. 1 BNatSchG (small and standing bodies of water), 2 habitats are protected according to § 30 (2) no. 2 BNatSchG (reed swamps and brackish water reeds) and 5 habitats are protected according to § 30 (2) no. 6 BNatSchG (near-natural grey dunes and late-Moraine cliffs). A further 24 habitats are legally protected in accordance with § 21 (1) no. 4 LNatSchG (typical field hedges and bends) (cf. leguan 2015).

The legally-protected biotope types take up an area of 5 ha. When considering the total area of the investigation area (777 ha), this corresponds to a land share of 0.4%. Of this, field hedges and bends make up around 2 ha, protected small bodies of water approximately 2 ha and coastal biotopes roughly 1 ha. (cf. Attachment 30.2 of the plan approval documents, Section 4.1).

*Baseline evaluation*

The significance of biotope types is mapped on the basis of the standard list of biotope types in Schleswig-Holstein (LLUR 2015), evaluated using the orientation framework for baseline recording and evaluation and establishing compensation measures in the context of landscape preservation planning for road construction projects (MWAV & MUNF 2004) and assigned to various conservation categories (see Table 58).

The conservation categories according to the orientation framework were applied as follows to the biotopes present in the investigation area:

**Table 58 Biotope types and usage types of the LCP investigation area and their evaluation (mapped using the mapping guidelines and biotope type reference for biotope mapping, Schleswig-Holstein, LLUR 2015).**

* The conservation category used in the investigation area is based on the second part of the combined code.

** Only protected by law according to Art. 21 of the LNatSchG if a large number of species are present (see inventory and conflict plan no. 2).

| Code | Biotope type and type of use | Classification used for conservation | Protected in accordance with § 30 BNatSchG in conjunction with § 21 LNatSchG | Standard compensation factor for 100% impairment |
|---|---|---|---|---|
| **Marine and coastal biotopes** | | | | |
| KDg | Grey dunes, near-nature | 5 | § 30 (2) no. 6 BNatSchG | 3 |
| KRs | Reed swamp/ brackish water reed bed | 5 | § 30 (2) no. 2 BNatSchG | 3 |
| KSa | Wash margin with annual flora | 5 | | 3 |
| KSs | Fauna-free beach | 5 | | 3 |
| KSv | Pebbled beach with perennial vegetation | 5 | | 3 |
| **Forests and clearings** | | | | |
| WFn | Coniferous woodland | 2 | | 1 |
| **Woodland areas other than forests** | | | | |
| HAy | Walkways through domestic shrubs | 3 | § 21 (1) no. 3 LNatSchG | 3 |
| HBy | Miscellaneous shrubbery | 3 | | 1,5 |
| HEy | Miscellaneous domestic shrubbery | 3 | | 3 |
| HFy | Typical field hedge | 3 | § 21 (1) no. 4 LNatSchG | 2 |
| HGx | Tree rows composed of non-domestic species | 2 | | 0,5 |
| HGy | Other semi-natural hedgerow | 3 | | 2 |
| HRe | Woodland areas bordering bodies of water | 3 | | 2 |
| HRy | Tree rows composed of deciduous trees | 3 | | 3 |
| HWo | Windbreaks with no shrubbery | 3 | § 21 (1) no. 4 LNatSchG | 2 |
| HWy | Typical bend | 3 | § 21 (1) no. 4 LNatSchG | 2 |
| **National waters** | | | | |
| FGy | Miscellaneous ditches | 3 | | 1 |
| FKy | Miscellaneous small water bodies | 3 | § 30 (2) no. 1 BNatSchG | 1 |
| FSy | Miscellaneous standing water bodies | 3 | § 30 (2) no. 1 BNatSchG | 1 |
| FXy | Miscellaneous artificial bodies of water | 3 | | 1 |
| **Green space** | | | | |
| GAe | Sowing grassland | 2 | | 1 |
| GYy | Moderately species-rich cultivated grassland | 2 | | 1 |

| | | | | |
|---|---|---|---|---|
| GYy/XDl | Moderately species-rich agricultural grassland/ protection dyke | 3 | | 1 |
| **Agricultural and horticultural land, tree nurseries and Christmas tree plantations** | | | | |
| AAy | Intensive fields | 1 | | 0,5 |
| **Ruderal and pioneer vegetation** | | | | |
| RHf | Hydrophilous tall herb fringe communi-ties | 3 | | 1,5 |
| RHm | Ruderal shrub corridor in fresh habitats | 3 | | 1 |
| RHt | Ruderal shrub corridor in dry habitats | 3 | | 1,5 |
| ROf | Raw soil in nutrient-rich, fresh habitats | 1 | | 0 |
| **Biotope types linked to structural installations** | | | | |
| SBg | Large buildings and high-rises | 1 | | 0,5 |
| SDe/SPh | Detached houses and splinter settle-ments/ former park facilities | 3 | | 2 |
| SDp | Agricultural factories | 1 | | 0 |
| SDs | Village-type settlement areas | 2 | | 0,5 |
| SEb | Sports fields | 1 | | 0,5 |
| SEc | Campsites | 2 | | 0,5 |
| SGb | Gardem, structure-rich | 3 | | 1 |
| SGr | Patches of grass, lack of species and structures | 2 | | 1 |
| Slg. | Industrial areas | 1 | | 0 |
| Slw | Wind power facilities | 1 | | 0 |
| SKb | Spur dykes, breakwaters | 1 | | 0 |
| SKy | Miscellaneous coastal defences and harbour facilities | 1 | | 0,5 |
| SLy | Miscellaneous storage areas | 1 | | 0 |
| SMk | Barracks, block and hall construction | 2 | | 1 |
| SVg | Roadside greenery with bushes | 3 | | 0,5 |
| SVh | Roadside greenery with trees | 3 | | 0,5 |
| SVo | Roadside greenery without shrubbery | 3 | | 0,5 |
| SVs | Fully-sealed transport routes | 0 | | 0 |
| SVu | Unsealed transport areas | 0 | | 0 |
| SVx | Track systems, disused, with ruderal areas | 3 | | 2 |
| SZg | Track systems | 1 | | 1 |
| SZh | Harbour facilities | 1 | | 0,5 |
| **Structure type - morphological features** | | | | |
| XKo | Late-Moraine cliffs | 5 | § 30 (2) no. 6 BNatSchG | 3 |

## Plants

In 2014 and 2015, an update was carried out to the biotope types and plants included on the Red List (see Table 59). The plants included on the Red Lists in the investigation area were recorded in two surveys which took place in 2014 and 2015 (August 2014 and May 2015). The classifications used in the Red Lists conform to Korneck et al. (1996) for the Federal Republic of Germany and Mierwald & Romahn (2006) for Schleswig-Holstein.

*Baseline investigation*

During the course of the update mappings carried out in the investigation area, 21 plant species from the Schleswig-Holstein Red List (Mierwald & Romahn 2006) and 19 species from the endangered species list were identified. A species was also identified whose occurrence in Schleswig-Holstein is classified as extremely rare (R). In addition, 11 of the plant species found appear on the red list of the Federal Republic of Germany (Korneck et al. 1996), in which one species is classed as potentially being endangered (Table 59). Overall, one of the species identified in Schleswig-Holstein has been classed as being threatened with extinction. This is the yellow chamomile, which was recorded at only one site. Three species found in the LCP investigation area are listed as at great risk (fringed water lily, black horehound, yellow germander). With the exception of black horehound, the named species only occur in isolated clumps or rarely in the LCP investigation area. , whereas black horehound occurs regularly. 17 of the species found in the LCP investigation area are considered at risk in Schleswig-Holstein. Table 59 contains a list of all the species in identified in the investigation area which appear on the Red Lists for Schleswig-Holstein and the Federal Republic of Germany.

**Table 59 Overall list of red list plants found within the LCP investigation area on Fehmarn (update mapping)**

| Species name (Latin) | Species name (English) | RL SH | RL BRD | Sites found in the investigation area |
|---|---|---|---|---|
| *Agrimonia eupatoria* | Common agrimony | V | + | F_016, F_073, F_095, F_145, F_202, F_249 |
| *Agrimonia procera* | Agrimony | 3 | + | F_319, F_323, F_371, F_372 |
| *Aira praecox* | Early hairgrass | V | + | F_202, F_261 |
| *Allium oleraceum* | Field garlic | 3 | + | F_031, F_037, F_038, F_085, F_114, F_195, F_258, F_335, F_344, F_372 |
| *Allium scorodoprasum ssp scorodoprasum* | Sand leek | 3 | + | F_009, F_016, F_024, F_029, F_074, F_179, F_330 |
| *Allium vineale* | Wild garlic | 3 | + | F_016, F_074, F_098, F_372 |
| *Anthemis tinctoria* | Yellow chamomile | 1 | + | F_219 |
| *Ballota nigra ssp. nigra* | Black horehound | 2 | + | F_016, F_024, F_027, F_031, F_038, F_056, F_064, F_070, F_071, F_074, F_091, F_100, F_126, F_152, F_174, F_249, F_339 |
| *Beta vulgaris ssp. maritima* | Sea beet | + | 4 | F_148, F_220 |
| *Cardamine pratensis agg.* | Cuckoo flower | V | + | F_081 |
| *Cardaria draba* | Hoary cress | 3 | + | F_258 |
| *Carex distans* | Distant sedge | 3 | 3 | F_143 |
| *Carex flacca* | Blue sedge | V | + | F_202, F_224, F_270, F_334 |
| *Carlina vulgaris* | Carline thistle | 3 | + | F_133 |
| *Centaurea cyanus* | Cornflower | + | 3 | F_036, F_070, F_074, F_100, F_119, F_179, F_192, F_202, F_224, F_345, F_351, F_358, F_372 |
| *Centaurea jacea* | Brown knapweed | V | + | FF_008, F_074, F_087, F_372 |
| *Cichorium intybus* | Common chicory | V | + | F_009, F_045, F_047, F_070, F_179, F_186, F_232, F_371, F_372 |
| *Crambe maritima* | Sea kale | V | 3 | F_131, F_220, F_325, F_329, F_372 |

| Species name (Latin) | Species name (English) | RL SH | RL BRD | Sites found in the investigation area |
|---|---|---|---|---|
| *Echium vulgare* | Viper's bugloss | 3 | + | F_046, F_083, F_111, F_131, F_148, F_249 |
| *Filago arvensis* | Field cudweed | 3 | 3 | F_261 |
| *Filago minima* | Small cudweed | V | + | F_202 |
| *Hippuris vulgaris* | Common mare's tail | 3 | 3 | F_090, F_341 |
| *Lathyrus maritimus* | Beach pea | 3 | 3 | F_131 |
| *Leucanthemum vulgare agg.* | Ox-eye daisy | V | + | F_202, F_224, F_270 |
| *Linaria repens* | Pale toadflax | R | + | F_261 |
| *Lotus corniculatus agg.* | Common bird's foot trefoil | V | + | F_143, F_192, F_202, F_216, F_268, F_270 |
| *Malva sylvestris* | Common mallow | 3 | + | F_024, F_070, F_077, F_091, F_095, F_122, F_152, F_186, F_193, F_202, F_255 |
| *Myosotis scorpioides* | Species group myosotis scorpioides | V | + | F_330 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | V | + | F_173 |
| *Nymphoides peltata* | Fringed water lily | 2 | 3 | F_341 |
| *Odontites vernus agg.* | Red bartsia | V | + | F_76 |
| *Ononis repens* | Common restharrow | V | + | F_098 |
| *Ononis spinosa* | Spiny restharrow | V | + | F_268 |
| *Potentilla argentea agg.* | Species hoary cinquefoil | V | + | F_202, F_261 |
| *Ranunculus sardous* | Hairy buttercup | 3 | 3 | F_003, F_103, F_128, F_225 |
| *Ranunculus trichophyllus* | Pond water-crowfoot | 3 | + | F_180 |
| *Sagina apetala agg.* | Annual pearlwort | 3 | + | F_261 |
| *Spergularia rubra* | Red sandspurry | V | + | F_202, F_261 |
| *Stratiotes aloides* | Water soldier | 3 | 3 | F_090 |
| *Teucrium scorodonia ssp. scorodonia* | Woodland germander | 2 | + | F_261 |
| *Trifolium campestre* | Low hop clover | V | + | F_091, F_186, F_246, F_270 |
| *Ulmus glabra* | Wych elm | V | + | F_064, F_069, F_084, F_087, F_098, F_124, F_151, F_159, F_179, F_181, F_261, F_267, F_270, F_334, F_339, F_351, F_355, F_371 |
| *Ulmus laevis* | European white elm | 3 | + | F_031, F_037, F_087, F_354 |
| *Ulmus minor* | Field elm | + | 3 | F_046, F_098, F_151 |
| *Valerianella locusta* | Lamb's lettuce | V | + | F_202, F_334 |

RL SH = Red List Schleswig-Holstein (Mierwald & Romahn 2006), RL BRD = Red List Federal Republic of Germany (Korneck et al. 1996), 1 = threatened with extinction, 2 = critically endangered, 3 = endangered, V = endangered list, R = extremely rare, 4 = potentially endangered (BRD list), + = not endangered

Pale toadflax (Linaria repens), an extremely rare species (R) in Schleswig-Holstein, was found near the rail site to the south of the ferry harbour. This is the only extremely rare species found in the LCP investigation area.

*Existing impairments*

- Intensive agricultural use (use of fertiliser and biocide, levelling of sites etc.) in most inland areas
- Major transport routes such as the B 207/E 47, national and regional roads (L 209, K 49, K 63) with a high volume of traffic (ground sealing, dissection of biotope structures, deposits of harmful substances)
- Water pollution from introduction of waste water, waste dumping, eutrophication etc.
- Manmade ditch system
- Impacts on the local, site-specific water supply, mainly through ditch drainage in fields
- Planting of foreign trees not suited to the location in the open landscape

*Baseline evaluation*

Two high-value habitats were recorded while the update mapping was being carried out (cf. Table 60). These areas are located in the area surrounding Puttgarden railway which is located south of the harbour. These two areas are broken down further into active and abandoned sub-areas with regard to biotope types. Both, however, are high value areas. In addition, another eleven areas were rated as being of average value:

11 sites were of medium significance. These are mainly coastal biotopes, hedgerows and field hedges which were classified in this category. A few fields home to Red List species are however also present.

Moderate importance was determined for 25 sites in terms of range of plant species from the Red List for Schleswig-Holstein. These were the following sites: roads, settlements, ruderal areas, hedgerows and other wooded areas, several fields and a few bodies of water. The species found included black horehound, hairy buttercup, agrimony, lamb's lettuce, wild onions and elms.

49 sites had only slight botanical value. These mainly contain the same biotope types as the sites which were classed as being of moderate importance and includes two coastal areas to the west and east of the ferry harbour as well as intensively used grassland. Sea kale (Crambe cordifolia), for example, was found in the coastal areas (Schleswig-Holstein endangered species list).

Sites with no evidence of plant species on the Schleswig-Holstein Red List were not evaluated.

**Table 60 Importance of the individual sites in relation to the occurrence of Red List species in the LCP investigation area (update mapping 2014/2015)**

| Significance | Location |
|---|---|
| Very high | - |
| High | F_202, F_261 |
| Medium | F_016, F_024, F_031, F_038, F_070, F_074, F_091, F_219, F_249, F_341, F_372 |
| Moderate | F_003, F_009, F_027, F_037, F_056, F_064, F_071, F_087, F_090, F_095, F_098, F_100, F_126, F_131, F_143, F_152, F_174, F_179, F_186, F_258, F_270, F_330, F_334, F_339, F_371 |
| Low | F_008, F_029, F_045, F_046, F_047, F_069, F_073, F_076, F_077, F_081, F_083, F_084, F_085, F_103, F_111, F_114, F_122, F_124, F_128, F_133, F_145, F_148, F_151, F_159, F_173, F_180, F_181, F_192, F_193, F_195, F_216, F_220, F_224, F_225, F_232, F_246, F_255, F_267, F_268, F_319, F_323, F_325, F_329, F_335, F_344, F_351, F_353, F_354, F_355 |

## Fungi

Areas relevant to fungi are located far from the current LCP investigation area.

The investigated locations lying within the current LCP investigation area were classed as being of low and average value.

The intervention area itself shows no areas which would be valuable to fungi from 2009, nor are any habitats expected which could potentially be of value to fungi e.g. old grasslands. This is because the investigation area is strongly characterised by agricultural land usage.

The only sections of the intervention area which represent any potential value to fungi are the steep shoreline located between Puttgarden and Marienleuchte and the junction between the B 207/ K 49. For this reason, these areas were also investigated in 2009. As a result, these areas were identified as being of average importance.

Since nothing has changed with regard to field conditions in the meantime and the results of the investigation were considered in the planning phase, no update mapping was required for fungi. The following inventory descriptions and evaluations for fungi are therefore still valid.

*Baseline investigation*

Twenty-three fungi taxons were recorded at four sites in the LCP investigation area during the biological studies. The table below provides an overview of the species mapped.

**Table 61 List of all species from all sites in the LCP investigation area**

| Species name (Latin) | Species name (English) | RL SH |
|---|---|---|
| *Aegerita Candida (NF)* | NF *Bulbillomyces farinosus* (Grain microfungi) | ** /Sig. |
| *Agaricus campestris agg.* | Field mushroom class | ** |
| *Agaricus spec.* | Mushroom species | -- |
| *Clavulina coralloides* | Crested coral | ** |
| *Crinipellis stipitaria (scabella)* | Hairy parachute | ** |
| *Daedaleopsis confragosa* | Blushing bracket | ** |
| *Digitalispora marina* | Marine Sternspor-Hyphenhaut | k. A. |
| *Hygrocybe virginea* | Snowy waxcap | ** /Sig. |
| *Inocybe geophylla var. geophylla* | White fibrecap | ** |
| *Inocybe lilacina* | Lilac fibrecap | ** |
| *Lacrymaria lacrymari. var. olivacea* | Oliver pebble beach fungi | EN-SH |
| *Marasmius oreades* | Fairy ring champignon | ** |
| *Mycena olivaceomarginata* | Brownedge bonnet | ** |
| *Octospora musci-muralis* | Octospora | EN-SH |
| *Panaeolus spec.* | Mottlegill species | -- |
| *Peniophora quercina* | Oak peniophora | ** |
| *Peziza domiciliana* | Domicile cup | 2 |
| *Psathyrella prona var. prona* | Common brittlestern | ** |
| *Rickenella fibula* | Orange mosscap | ** |
| *Rogersella (Hyphodontia) sambuci* | Elder whitewash | ** |
| *Steccherinum fimbriatum* | Jagged gloidon | ** /Sig. |
| *Tapesia rosae* | Rose tapesia | ** |
| *Tubaria furfuracea* | Scurfy twiglet | ** |

Status according to Red List for Schleswig-Holstein (Lüderitz 2001):
2 = critically endangered
** = certainly not endangered, -- = classification not possible
other entries: Sig. = signal species, EN-SH = first recording for Schleswig-Holstein

Signal species (in the sense of indicator species) are those species which indicate habitats of value to conservation with a high ecological continuity and complexity. They are usually eye-catching, easy to find and easy to classify.

*Existing impairments*

- Serious depletion of suitable habitats through intensive agricultural use

*Baseline evaluation*

Overall, the LCP investigation area only contains a few small structures considered noteworthy from a mycological perspective. For the LCP investigation area as a whole, there are three sites of medium significance (one section of cliff near Marienleuchte, one island of woodland between the B 207 and K 49 and one area to the north of the campsite at Puttgarden) and one site of little significance (south of campsite at Puttgarden).

### 4.2.5.2. Marine area

During the course of the update mapping, an investigation was carried out on the benthic flora and benthic habitats sub-factors (see Attachment 30.1 of the plan approval documents, Section 6). To do this, various biotic parameters were selected for study. These parameters are suitable for documenting any conceivable changes to the ecosystem. The investigation also includes those parameters listed under the "flora" environmental factor i.e. the benthic flora and benthic habitats sub-factors. With regard to abiotic environmental factors, key variables in water quality, hydrography and meteorology were investigated in order to demonstrate the "environment" for aquatic organisms and populations in the water column and on the seabed.

**Benthic flora**

*Baseline investigation*

New additional data on benthic flora from 2011 and 2015 was consulted as part of the update check (see Attachment 30.1 of the plan approval documents, Section 4). The data pertaining to flowering plants (seaweeds, inter alia) include estimates on the distribution of biomass which are based on new surveys carried out by the project proponents and the national monitoring programmes in Germany and Denmark. Furthermore, time series (2006 to 2015) on the distribution and standing stock of macro algae were also analysed. The distribution and frequency of benthic flora indicate a large degree of natural variation in certain areas and years. However, there is no indication of large-scale trends towards an increase or decrease. For this reason, the Baseline investigations from 2009/2010 remain fully valid.

A total of six benthic plant communities exist in the LCP investigation area. Five communities are typical of hard soils and one is characteristic of mixed sediment conditions (see Table 62).

None of the benthic flora species common in the Baltic Sea are listed in the Habitats Directive (Annexes II, IV and V), but specific species/communities are stated as characteristic of certain habitat types (Annex I). The BNatSchG (Art. 30) uses general superordinate biotope terms for the benthic flora requiring protection. Plant communities are assigned to these general terms when describing and characterising the communities.

**Table 62 Characteristic parameters of plant communities in the marine LCP investigation area**

| Plant community | Index species | Substrate preference | Vertical settlement area | Assignment to habitat types of the Habitats Directive and Art. 30 biotopes |
|---|---|---|---|---|
| Filamentous algae community | Various green, brown and red filamentous algae | Hard soil | 0.25 - 15 m | - |
| *Fucus*community | *Fucus serratus*<br>*Fucus vesiculosus* | Hard soil | 1–5 m | Habitat type 1170 reef<br>§ 30 macrophyte populations |
| *Furcellaria*community | *Furcellaria lumbricalis* | Hard soil | 2-8 m | Habitat type 1170 reef<br>§ 30 macrophyte populations |
| *Phycodrys/Delesseria*-community | *Phycodrys/Delesseria community*<br>*Phycodrysrubens Delesseria sanguinea* | Hard soil | 5–19 m | Habitat type 1170 reef<br>§ 30 macrophyte populations |
| *Saccharina*community | *Saccharina latissima* | Hard soil | 12–19 m | Habitat type 1170 reef<br>§ 30 macrophyte populations |
| Seaweed/algae community | *Zostera marina* and various algae species | Mixed substrate conditions | 1–6 m | Habitat type 1160 large shallow inlets and bays<br>§ 30 seaweed fields/macrophyte populations |

With the exception of the filamentous algae community, these are communities with perennial, sometimes large index species.

The update investigation of benthic flora focussed on individual key species (red and brown algae and seaweed) which are typical of the aforementioned benthic plant communities in that area.

Mean values and the range of values pertaining to the coverage of both these key species and the biomass data for the corresponding years were compared with the data from the years in which the Baseline investigation was carried out. In addition, time series were analysed by comparing deviations from the longtime average recorded over this period. The vertical distribution patterns were also analysed where necessary (see Attachment 30.1 of the plan approval documents, Section 4 for more details).

The time series for red algae *Delesseria sanguinea* were determined in Katharinenhof and Staberhuk on the east coast of Fehmarn (2006-2014). The highest values for both coverage and standing stock were registered at the Staberhuk station. Standing stock and coverage were especially high at this station in 2009. This pattern was not observed at the Katharinenhof station. No trends (increase or decrease) were identified with regard to coverage and standing stock over the course of the investigation.

Red algae *Furcellaria lumbricalis* was found at the Katharinenhof station between 2007 and 2015, and at the Staberhuk station between 2006 and 2013. When calculating the annual averages, the highest values for coverage and standing stock were found in Katharinenhof (table 4-3). The species is not widespread in Staberhuk. The interannual fluctuations in biomass in Katharinenhof deviated from the longtime average by between 10-90%. In Staberhuk, the very low distribution led to large interannual fluctuations of 45-240%. No trends (increase or decrease) were identified with regard to coverage and standing stock over the course of the investigation.

Fucus spp. (Phaeophytes, mainly *Fucus vesiculosus*but also *Fucus serratus*) were sampled in Wallnau and Strukkamphuk on the southwestern coast of Fehmarn over an 8-9 year period between 2006 and 2015. The highest average coverage was found in Wallnau while the highest standing stock value was found in Strukkamphuk. The highest standing stock value was found at the Wallnau station in 2009 and at the Strukkamphuk station in 2010. The interannual fluctuation was between 30-100% for coverage and between 20-80% for standing stock. No trends (increase or decrease) were identified with regard to coverage and standing stock over the course of the investigation.

Extensive seagrass meadows (*Zostera maritima*) are only found in the Orth Bay area around Fehmarn. Seaweed coverage and standing stock in the Orth Bay show significant interannual fluctuations. In some years, large increases and decreases were observed. Presumably as a result of these annually fluctuating growth conditions, seaweed experienced an increase in standing stock between 2009/2010 to 2013, whereas in the following years it decreased once again.

Large annual fluctuations in both degree of coverage and biomass were detected in the surveyed macroalgae species and seaweed for all available time series. This explains the significant natural fluctuations displayed for flora. These values do not indicate that the distribution of the species has changed. In Figure 42, examples of the time series for the standing stock of macro algae species are given which explain these significant fluctuations.

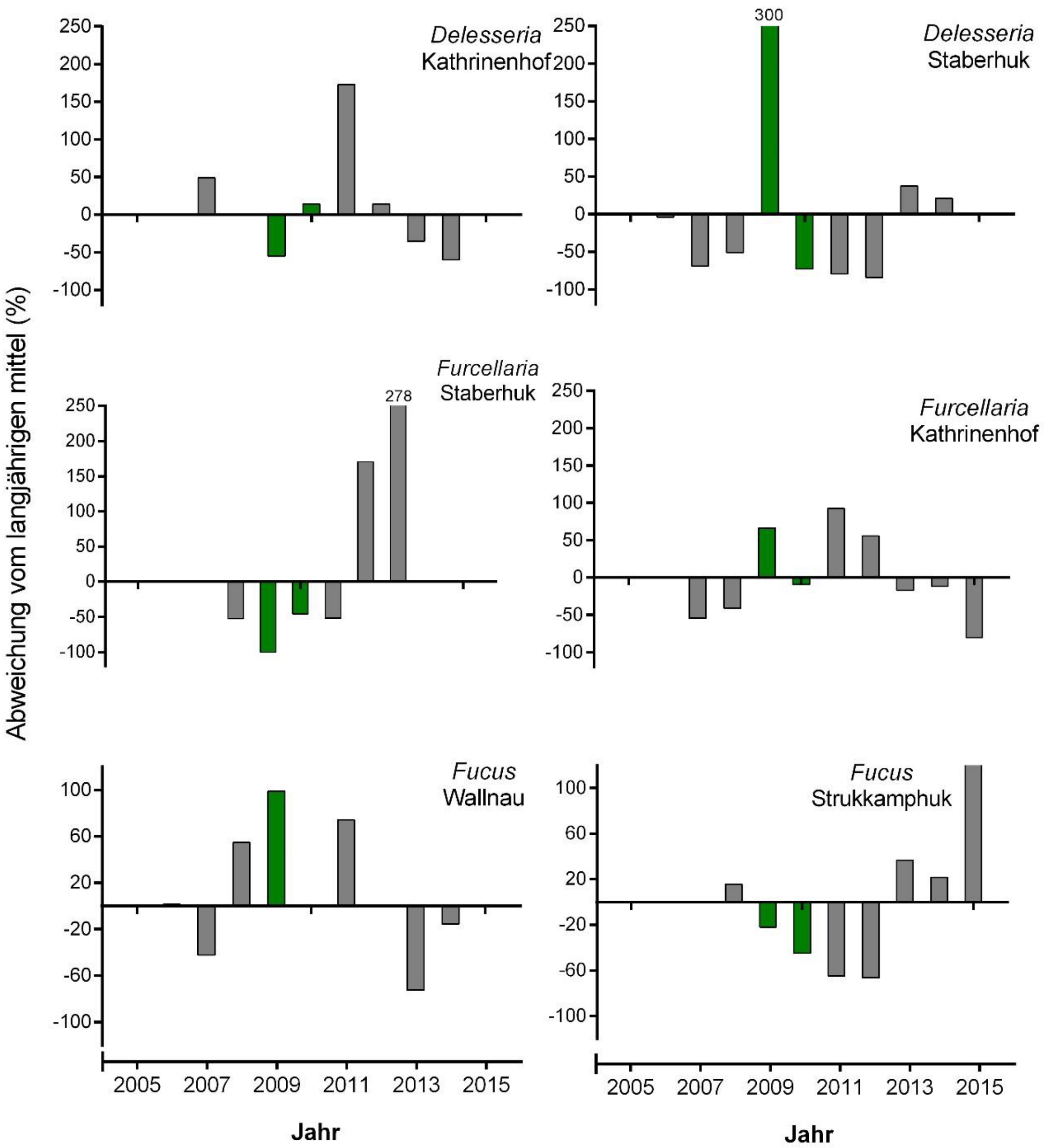



**Figure 42** Deviation from the longtime average (5) for macro algae standing stock at the sampling stations on Fehmarn between 2005 and 2015. Deviations for red algae species *Delesseria sanguinea* and *Furcellaria lumbricalis* at the sampling stations located at Katharinenhof and Staberhuk for the phaeophyte species *Fucus vesiculosus* at the sampling stations located at Wallnau and Strukkamphuk

| | |
|---|---|
| Abweichung vom langjährigen mittel (%) | Deviation from long-term average (%) |
| Jahr | year |
| Delesseria<br>Kathrinenhof | Phycodrysrubens delesseria<br>Kathrinenhof |
| Delesseria<br>Staberhuk | Phycodrysrubens delesseria<br>Staberhuk |

| | |
|---|---|
| Furcellaria<br>Staberhuk | Furcellaria<br>Staberhuk |
| Furcellaria<br>Kathrinenhof | Furcellaria<br>Kathrinenhof |
| Fucus<br>Wallnau | Fucus<br>Wallnau |
| Fucus<br>Strukkamphuk | Fucus<br>Strukkamphuk |

*Existing impairments*

- Severe eutrophication of the Baltic Sea over the last 50-80 years has primarily encouraged the growth of planktic and opportunistic, benthic algae – this has given rise to greater turbidity, a shortage of oxygen, algae deposits and the resultant emergence of slime in coastal waters
- Reduction in availability of hard substrate as base for macro algae settlements
- Permanent loss of settlement area for benthic flora near the Puttgarden ferry harbour
- Fishing with bottom trawling nets

*Baseline evaluation*

In terms of benthic flora, the levels of importance shown in Table 63 apply to the individual plant communities in the LCP investigation area:

**Table 63 Significance of benthic flora**

| Significance | Plant community | Coverage/frequency |
|---|---|---|
| Very high | All with the exception of the filamentous algae community | ≥ 50 % |
| High | All with the exception of the filamentous algae community | ≥ 10–25 % |
| Medium | All with the exception of the filamentous algae community | ≥ 10–25 % |
| Low | Filamentous algae | Regardless of coverage |
| | Individual plants | ≥ 1–10% |

The seaweed/algae community on the southeast and south coast of the LCP investigation area makes up a smaller share of the area featuring populations of very high significance. Most of the areas with vegetation populations of high significance are grouped around the areas of very high significance. But in these areas the coverage and/or density of the perennial plant communities is not sufficient for very high significance. There are also areas of high significance at the southwest tip of Fehmarn. Areas with plant populations of medium significance can be found in the LCP investigation area along large parts of the west and east coasts of Fehmarn. Areas of low significance in the LCP investigation area are spread along large parts of the coast of Fehmarn because the filamentous algae community in particular and individual vegetation populations with a coverage of less than 10% occur over large areas.

### Benthic habitats

In the EIA-REPORT, the benthic habitats formed the foundation for the habitat type (HT) mapping found in Annex I of the FBFL guideline and the biotype type protected by § 30 of the Federal Nature Conservation Act (BNatSchG). In addition to their own observations, existing data gathered by the State of Schleswig-Holstein was used for mapping the HT on the German side.

At the end of 2015, Femern A/S, in a joint approval process with the State of Schleswig-Holstein (MELUR and LLUR) adapted the mapping results from the EIA-REPORT baseline survey to the current data gathered by the State. The current HT maps, which were altered by the State of Schleswig-Holstein, formed the basis for this. In order to obtain a map which was consistent with the HT for both the benthic habitats and the § 30 biotype types, and following a vote based on the criteria used in the EIA-REPORT (Attachment 15 of the plan approval documents), the maps for the § 30 biotype type according to BNatSchG and the benthic habitats were adapted (see Attachment 30.1 of the plan approval documents, Section 6).

The benthic habitats are derived from the previously described benthic fauna and flora and provide a basis for assessing impact. Establishing the scope of compensation and balancing is contingent on the updated data.

*Baseline investigation*

A distinction can be made between 19 benthic habitats in the LCP investigation area. The characterisation of the benthic habitats results from the descriptions of benthic communities and physical habitats. There are only five benthic habitats in the circalittoral[3] zone because the number of benthic communities is reduced by the absence of plant communities and the substrate conditions are more uniform. In terms of area, the largest share is taken up by pure soft soil habitats, although the silt habitat with infauna in the circalittoral zone is dominant (59.06%) whereas sand with infauna only covers an area of 1.63%. The infauna of the silt habitat is home to a few long-living mussel species and a large number of different bristle worms.

Because the distribution of many benthic communities is concentrated in shallower water, the number of benthic habitats in the infralittoral zone[4] increases to 13 distinguishable habitats.

[3] Circalittoral: This depth zone includes the aphotic part, i.e. all parts of the seabed where the incoming light level is too low for plants to grow but which can still be reached by wave movements.

[4] Infralittoral: This depth zone includes the photic part, i.e. all parts of the seabed which receive at least 1% of surface irradiation. At least in theory, it is possible for plants to grow in this zone.

The area of coarse sediment in the infralittoral zone is greater, but compared with mixed and soft soils, this remains the habitat with the smallest coverage. Unlike the circalittoral zone, here various communities can be distinguished and they characterise the habitat. Blue mussels are present on the coarse sediment, mainly on the west coast of Fehmarn but also at the southeast tip of the island (Staberhuk). Coarse sediment with Dendrodoa is only found in the southeast part of the investigation area. It is mainly on the eastern side of Fehmarn that perennial algae can be found on coarse sediment.

All the other habitats are combinations of hard and soft soil habitats, which make up by the far the largest proportion of the total habitat area in the infralittoral. Depending on the mix ratio of the substrate, it may be home to plant communities (perennial algae: 0.72%, seaweed/algae: 0.33%), blue mussels (0.80 %), Dendrodoa (0.63%), Tanaissus (0.05%) or infauna (3.35 %). Mixed flora/fauna communities on mixed sediment make up the largest share in the infralittoral zone (10.87%). This mixed habitat can be found in the LCP investigation area mainly to the east and southeast but also to the west of Fehmarn. These areas are part of the wave platforms affected by currents but not severe erosion (so no new hard substrate appears).

*Natura 2000 habitat types (HT)*

Four different habitat types can be defined within the LCP investigation area:

- Sandbanks only slightly covered by sea water at all times (1110)
- Sand flats, mudflats and muddy sands(1140)
- Large shallow inlets and bays (1160)
- Reefs (1170)

*Protected biotopes in accordance with § 30 BNatSchG*

A total of seven Article 30 biotopes can be identified in the LCP investigation area. The largest share of area in the protected biotopes is taken up by reefs, especially on the east and west coasts of Fehmarn, the macrophyte populations (mainly on the east coast of Fehmarn) and the sublittoral sandbanks at Grüner Brink and to the northwest of it.

**Table 64 Extent by area (in km²) of Article 30 biotopes in the LCP investigation area and their percentages in relation to the total area of the LCP investigation area (344.70 km²)**

| Article 30 biotopes (BNatSchG) | Total area | Percentage |
|---|---|---|
| Species-rich coarse sand, gravel and shell grounds | 0,00 | 0,00 |
| Species-rich coarse sand, gravel and shell grounds + reefs | 0,03 | 0,01 |
| Species-rich coarse sand, gravel and shell grounds + sandbanks | 0,03 | 0,01 |
| Reefs (not overlapping with other Article 30 biotopes) | 60,04 | 17,42 |
| Seaweed fields/other macrophyte populations | 0,03 | 0,01 |
| Seaweed fields/other macrophyte populations + reefs | 1,11 | 0,32 |
| Other macrophyte populations + reefs | 15,57 | 4,52 |
| Sublittoral sandbanks (not overlapping with other Article 30 biotopes) | 5,43 | 1,58 |

*Existing impairments*

- Eutrophication
- Changes in the quality of substrates (depth of the redox layer, silting)
- Physical disturbances (fishing with bottom trawling nets, extraction of sand and gravel)
- Specific removal of economically useful species

*Baseline evaluation*

The level of significance is based on the respective ecology of the benthic habitats. Independently of their ecological significance (shown here), benthic habitat areas that are classified as Article 30 habitats or Natura 2000 habitat type are automatically classified as very high (not shown here directly but identified by the entry in the column "LCP, Article 30-Biotope" if applicable (see Table 65).

**Table 65: Classification of significance of benthic habitats**

| Significance | Benthic habitats | HT, § 30 | Explanation |
|---|---|---|---|
| Very high | Circalittoral/infralittoral coarse or mixed sediment with Dendrodoa | DE: Areas fully classified as HT and § 30 biotope | Considerable expansion of the benthic habitat into the water column through substrate and/or vegetation and<br>great stability due to prolonged growth and immobile substrates<br>Consistently high densities of components which shape the structure (rocks, growth) |
| | Infralitoral coarse or mixed sediment with perennial algae. | DE: Areas fully classified as HT and § 30 biotope | |
| | Infralittoral mixed sediment with seaweed/algae | DE: Areas fully classified as HT and § 30 biotope | |
| High | Infralittoral mixed sediment with mixed flora/fauna community | DE: Areas fully classified as HT and § 30 biotope<br>→ These areas are classified as having a very high significance | Extension of the benthic habitat into the water column is restricted because growth is close to the seabed and<br>limited stability due to growth which varies greatly depending on population<br>Densities of components which shape the structure (rocks) reduced in part |
| | Infralittoral coarse or mixed sediment with Mytilus | DE: Areas fully classified as HT and § 30 biotope<br>→ These areas are classified as having a very high significance | |
| | Infralittoral sand with Mytilus | DE: Areas fully classified as HT and § 30 biotope<br>→ These areas are classified as having a very high significance | |

| Signifi-cance | Benthic habitats | HT, § 30 | Explanation |
|---|---|---|---|
| Medium | Circalittoral and infralittoral mixed sediment with infauna | DE: Areas partly classified as HT and § 30 biotope<br>→ These areas are classified as having a very high signifi-cance | Hardly any extension of ben-thic habitat into water column due to lack of growth and low density of components which shape the structure (rocks). Different substrate compo-nents produce different habi-tats for invertebrates in the sediment. |
| | Infralittoral mixed sediment with Tanaissus | DE: Areas partly classified as HT and fully classified as § 30 biotope<br>→ These areas are classified as having a very high signifi-cance | |
| Low | Circalittoral/infralittoral sand with infauna | DE: Areas partly classified as HT and § 30 biotope<br>→ These areas are classified as having a very high signifi-cance | No expansion of the benthic habitat into the water column (or substrate or vegetation). Low stability in shallow water due to mobile sediment |
| | Circalittoral/infralittoral slime with infauna | DE: Areas partly classified as HT and § 30 biotope<br>→ These areas are classified as having a very high signifi-cance | |

### 4.2.6. Biodiversity

The environmental of biodiversity is made up of the individual elements, which comprise the factors for flora and fauna in a single category.

When considering the current version of the Federal Administration Law on this subject and the relevant technical authors (e.g. Trautner 2003), three individual aspects used to evaluate biodiversity are highlighted:

- The degree to which species are endangered/ protection responsibility
- Species diversity of the area in question
- Genetic diversity of the area in question

In the LCP, Attachment 12 of the plan approval documents, Section 4, these individual aspects are compared with the concept of value and functional elements and explained. As part of this, reference is made to the specific process chapter for the other two environmental factors, namely flora and fauna (LCP, Attachment 12 of the plan approval documents, Sections 4.4 and 4.5), which deal with biodiversity in a general context.

The information contained in the LCP, Attachment 12 of the plan approval documents, Section 4.6.1 makes it clear that the individual aspects of the biodiversity factor to be evaluated are fully covered by the flora and fauna environmental factors.

#### 4.2.6.1. Island of Fehmarn

*Baseline investigation*

The identification of individual species and biotope types is described in detail in the LCP, Attachment 12 of the plan approval documents, Sections 4.4 and 4.5. This will emphasise the fact that the representative species groups have been fully identified and that all species relevant to conservation law and, therefore species deemed vulnerable in the eyes of European law (cf. also Attachment 30.2 of the plan approval documents). Since delimiting the functional spaces for biodiversity is primarily done on the basis of conservation areas and biotope bonding areas and biotope complexes, the boundaries affected by the update mappings (see LCP, Attachment 12 of the plan approval documents, Sections 4.4.1 and 4.5.1 and Attachment 30.2 of the plan approval documents) are still valid.

The following habitats, which are located in the investigation area, are defined as special areas for biodiversity in the sense of the aforementioned explanations:

1. As a result of the legal conservation status, which is essentially based on the flora and fauna conservation goals (see LCP, Attachment 12 of the plan approval documents, Section 2.5.1), there are:

- no nature reserves, landscape protection areas, protected landscape elements, natural monuments or FBFL or Natura 2000 special protection areas as core areas for biodiversity in the immediate investigation area where the ditch is planned.

2. With regard to the networking function i.e. the biotope network areas of Schleswig-Holstein's biotope networking system (key areas of main and auxiliary connective axes), there are (see LCP Attachment 12 of the plan approval documents, Section 2.5.1.5):

- The "coastal landscape of northwest Fehmarn" has been classed as a key area of the biotope networking system. The "Baltic Sea coastal landscape" represents a connected axis area, including the east and south coasts of Fehmarn. However, the affected areas lie outside the investigation area, which means that there are no biotope networking areas belonging to the Schleswig-Holstein biotope networking system in the immediate investigation area where the ditch is planned.

3. Using the baseline mapping and evaluation of the basic data for protected flora and fauna, the following biotope complexes

and functional areas (cf.), which also represent areas with a (greater) standing stock of species protected under conservation law as well as areas with a (greater) standing stock of legally-protected biotopes can be defined. These areas are described in detail in Table 66 :

- Beach/dyke biotope complex to the north of Puttgarden (no. 1): There is a small outspread of the biotope complex which extends west far beyond the investigation area (including Natura 2000 areas/nature conservation area in the Grüner Brink) just to the north of Puttgarden adjacent to the ferry harbour. The outspread in the investigation area is neither in a conservation area nor part of the Schleswig-Holstein biotope network.
- Beach biotope complex between Puttgarden ferry harbour and Marienleuchte with a section of cliff (no. 4a): This habitat is home to a cluster of beach biotopes protected by law, but the beach section is shaped by the break at Marienleuchte and the Puttgarden ferry harbour.
- Beach biotope complex to the south of Marienleuchte with section of cliff at Marienleuchte (no. 4b): This beach section is shaped by a cluster of beach biotopes protected by law, its very high significance as a linear dispersion line for plant species on the Red List and by very highly significant amphibian habitats.
- Functional area of the bird migration route transport corridor/B 207 with peripheral structures (no. 6). The road and railway embankment along the B 207/railway line and rail site display structures which are characterised by their use as transport infrastructure, but partly semi-natural.

*Existing impairments*

In terms of the aspect of biodiversity in the investigation area on Fehmarn, there are no existing impairments which have not already been mentioned under flora and fauna (see Sections 4.2.4 and 4.2.9).

*Baseline evaluation*

To assess the baseline, the current characteristics of the conservation areas/ biotope complexes/biotope network areas/functional spaces are compared with the typical ideal concepts for each area and then the overall significance of the systems for maintaining biodiversity is rated at one of four levels according to the extent to which they meet objectives for the concept (see Table 66).

**Table 66 Significance of conservation areas, biotope complexes, biotope network areas and functional spaces in the investigation area for biodiversity**

| No. in plan* | Conservation area system, biotope complex, biotope network area, functional space | Concept(s) specific to area of unspoiled nature according to landscape programme and/or nature preservation ordinances and/or biotope network planning | Description of current baseline and significance |
|---|---|---|---|
| 1 | Beach/dyke biotope complex to the north of Puttgarden, Grüner Brink conservation area and adjacent northern lowland as part of Natura 2000 sites DE 1532-391 and DE 1530-491 | Typical coastal landscape elements of the island of Fehmarn and various complex-characteristic biotope types of the beach ridge/coastal lagoon landscapes of the Baltic Sea with natural dynamics, including drift line communities, dunes, beach ridges, large coastal lagoons, lagoons, meadow and pasture areas affected by salt, dry grassland, heathland, damp depressions and dune passages, tall forbs, sedge thickets, extended reed populations and fragmented copses as habitat for a very numerous and species-rich population of flora and fauna, some of which are at risk, such as amphibians. Coastal waters of high importance to international bird migration as a resting and overwintering area with as little disturbance as possible for numerous duck species, as a favourable feeding habitat for breeding and resting birds and as a breeding habitat for coastal, meadow and reed birds.<br><br>(Derived from: Protective ordinance for Grüner Brink nature conservation area dated 22 Dec. 1989; conservation objectives of Natura 2000 site DE 1532-391 "Strip of coast on west and north Fehmarn" and bird conservation area DE-1530-491 "Eastern Bay of Kiel" of MLUR; LANU S-H 1998/2000: key area no. 280; landscape plan for municipality of Fehmarn) | **Description:** Only the eastern outreaches of this complex lie within the LCP investigation area and form the eastern fringe of the key area of the biotope networking system. Sections of the beach areas with dykes which are located in the direction of Puttgarden are of moderate to higher significance (apart from the LCP investigation area in the direction of the Grüner Brink). Amongst the beach biotope types the pebble beach is of extremely high significance. However, because of the relatively narrow area, they are by no means as diverse as stated in the "concept" column. The dyke is of average significance.<br>However, the narrow section of beach with dyke within the LCP investigation area is in itself significant due to its close proximity to the Grüner Brink nature conservation area. The "Grüner Brink" subsection stands out in particular because it is a relatively small space yet home to a very large number of highly valued (protected) biotope types. The area is highly important to breeding birds, very highly important to amphibians and of medium to high importance to plants and fungi (outside the LCP investigation area).<br>At its western end, it links to the SCIs and bird conservation areas which extend far beyond the investigation area and which include various coastal ecosystems and biotopes with natural dynamics of very high importance to nature conservation.<br>The very high significance of the section within the LCP investigation area thus results in particular from its links to areas further to the west.<br>**Significance: Very high** |
| 4a | Beach between Puttgarden ferry harbour and Marienleuchte with | Semi-natural beach landscapes and areas used extensively for farming in the area near the coast with semi-natural, unused transition zones to the coastline, especially behind the sections of cliff | **Description:** The coastal area near Marienleuchte and on the southeast edge of the investigation area includes a section of cliff of very high importance and an adjoining grey dunes section of beach (biotopes protected by law). Its importance as a breeding bird habitat is average. Behind |

| No. in plan* | Conservation area system, biotope complex, biotope network area, functional space | Concept(s) specific to area of unspoiled nature according to landscape programme and/or nature preservation ordinances and/or biotope network planning | Description of current baseline and significance |
|---|---|---|---|
| | section of cliff | (Derived from: (Derived from: landscape programme for planning area II; LANU S-H 1998/2000, landscape plan of the town of Fehmarn) | the section of cliff are the settlement structures of Marienleuchte and fields. The value of beach section no. 4a as a (potential) dispersion line for species and as a biotope network structure is greatly limited by the break at Marienleuchte and the Puttgarden ferry harbour.<br>**Significance: Medium** |
| 4b | Beach to the south of Marienleuchte with section of cliff at Marienleuchte | | **Description:** The coastal area near Marienleuchte at the southeast edge of the investigation area includes a section of cliff of very high importance and adjoining beaches (biotopes protected by law). The importance of beach section no. 4b as a breeding bird habitat is average. However, the strip of coast in particular does have a very high significance as a linear dispersion line for plant species on the Red List. This line runs along the east coast of Fehmarn beyond the investigation area and enters an adjoining link axis of the biotope network. Amphibian habitats of very high importance abut with the beach at Presen behind the dyke (outside the LCP investigation area). With regard to this functional area, its significance derives from the network areas which lie outside the LCP investigation area.<br>**Significance: High** |
| 6 | Functional area of the bird migration route transport corridor/B 207 with peripheral structures | No official concept formulated (landscape programme for planning area II, landscape plan of the town of Fehmarn). From an expert viewpoint, the concept can be to maintain as far as possible the in part more natural peripheral areas of the road, rail and harbour infrastructure such as woodlands, shrub corridors and individual dry grassland structures as a connecting line in the intensively used farmland – taking traffic requirements into consideration. | **Description:** The road and railway embankment along the B 207/railway line and the rail site to the south of the ferry harbour in particular have an above-average number of Red List plant species (unused rail site is of very high significance to plants). With its in part dry shrub corridors and sections of woodland, the road and railway embankment is very important to reptiles (common lizard) as a large faunistic functional space. Compared with the adjacent field corridor, its biotope types give it medium significance. Constructions crossing the area give rise to medium significance for bats in some parts.<br>**Significance: Medium** |

* The numbering used here relates to the EIA report (Attachment 15 of the plan approval documents, Volume II C, Section 3.19) so that the names of the landscape areas used in the EIA report and LCP can be compared. The numbers are not therefore continuous because some complex habitats in the investigation area for the EIA report are not part of the smaller investigation area considered here.

#### 4.2.6.2. Marine area

In the plan approval documents, all elements pertinent to marine biodiversity of the Fehmarnbelt ecosystem are shown in the investigation area. These elements are the environmental factors and sub-factors, as listed in EIA-REPORT, Attachment 15 of the plan approval documents, (Volume II B, Section 3.12, page 1095 et seq.). The impact of the project on these environmental factors are also shown and evaluated in Attachment 15 of the plan approval documents (see also the information in the individual Sections on environmental sub-factors). The assessment takes into consideration criteria which serve an indicator function for biodiversity. For each sub-factor, these criteria include, inter alia, species richness, population size, abundance (frequency), standing stock and species productivity, conservation status and degree to which the species is endangered as well as rareness. These criteria coincide with those which are contained in the technical explanations e.g. those of Trautner (2003) on aspects of biodiversity in the EIA-REPORT. For the environmental sub-factor "biodiversity (marine area)", these assessments are picked up and comprehensively analysed in the EIA-REPORT, Attachment 15 of the plan approval documents (Volume IV B, Section 8.3.12, Page 3284 et seq.).

The BVerwG decision on deepening the River Elbe (decision of 2 October 2014, 7 Paragraphs 14/12, Point 20/21) is also concerned with biodiversity. In this decision it is stated that a deterioration in the suitability of the habitat of an individual species is sufficient reason for having an impact on biodiversity. Simple deterioration of the suitability of the habitat of individual locations is not sufficient reason for significance. The decisive factor in this case is the concrete reference to the location, biotope, natural region and habitat type. The significance of an individual location to a species and, therefore, species diversity in the investigation area, is determined on a case by case basis.

*Baseline investigation*

All protected areas and objects in the LCP investigation area are important for characterising biodiversity and significance. This includes all conservation areas in the Natura 2000 network (four SCIs and two bird conservation areas; see Section 8.8 LCP, Attachment 12), the Grüner Brink nature conservation area and the biotopes protected by law in accordance with Art. 30 BNatSchG (see Section 4.2.5 of the General Summary and Section 4.5 LCP, Attachment 12).

The aspects listed below for each baseline have a role to play in biodiversity in the marine area:

- Planktic flora and fauna
- Benthic flora
- Benthic fauna
- Benthic habitats
- Fish
- Marine mammals
- Resting birds
- Migratory birds

A detailed explanation of the aspects listed above can be found in Section 12 of the plan approval documents, Section 4.4 et seq. and Section 4.6.2 et seq.

*Existing impairments*

The main existing impairments for the individual aspects affect biodiversity. The table below lists existing impairments which have already partly impacted on biodiversity by reducing the extent of habitats (stone fishing, marine structures) or which have made environmental conditions less favourable due to e.g. eutrophication, climate change, noise or harmful substances.

**Table 67 Relevant impairments: which have an impact on marine biodiversity**

| Existing impairments | Relevant environmental (sub) factors |
|---|---|
| Shooting licences | Marine mammals |
| Structures in the marine area | Benthic fauna, benthic flora, benthic habitats, resting birds, migratory birds |
| Bycatch | Marine mammals |
| Eutrophication | Benthic fauna, benthic flora, benthic habitats, marine mammals, plankton, resting birds, migratory birds |
| Fishing | Benthic fauna, benthic flora, benthic habitats, fish, marine mammals, resting birds, migratory birds |
| Hunting | resting birds, migratory birds |
| Climate change | Plankton, resting birds, migratory birds |
| Disease | Marine mammals |
| Artificial hard substrate | Plankton |
| Noise | Fish, marine mammals |
| Inherited military waste | Marine mammals |
| Invasive species | Plankton |
| Hazardous substances | Fish, marine mammals, resting birds, migratory birds |
| Shipping | Fish, resting birds, migratory birds |
| Stone fishing (hard substrate) | Benthic fauna, benthic flora, benthic habitats |
| Disturbance at rest sites | Marine mammals |
| Tourism | Benthic fauna, benthic flora, benthic habitats, fish |

*Baseline evaluation*

The evaluation of a habitat's suitability is described further in the EIA-REPORT, Attachment 15 of the plan approval documents, Annex C, Section 4.1. This considers the predicted impacts of the project (immersed tunnel main variants). These additional explanations represent an expansion to the previous information on biodiversity. To do this, for each of the eight sub-factors pertinent to biodiversity (planktic flora and fauna, benthic flora, benthic fauna, benthic habitats, fish, marine mammals, resting birds and migratory birds), information is taken on their location and size and compared with the affected areas in the investigation area and the extent of their impact. It is then assessed whether the habitat's suitability for a species can be adversely affected by the project. The environmental pressure and its largest impacts will be investigated.

Should it be found that there is no impact to the suitability of the habitat to species, it may be that those pressures which are significantly higher will likewise have no impact. This is especially the case as only small areas of individual locations are affected. However, the most significant environmental pressures could potentially affect the whole investigation area or all species within an individual sub-factor.

When considering the individual sub-factors making up the biodiversity in this area, in no case has it been shown that the habitat suitability for any species has been restricted in such a way that there will be no consequences to the manifestation and quality of biodiversity in the investigation area. All construction-related pressures end, at the latest, at the end of the construction phase, with many ending considerably earlier than this. This then leads to a full regeneration. Individual locations or sections thereof which are located in the area may experience a temporary change to their suitability as a habitat. The only permanent changes to habitat areas will come in the form of reclamation areas. However, in no case have the aforementioned changes had any such impact on species. Therefore, the project does not prevent biodiversity from being guaranteed.

## 4.2.7. Landscape

### 4.2.7.1. Island of Fehmarn

No new surveys have not been carried out on Fehmarn with regard to the landscape environmental factor. Since there have been no significant short-term changes to landscape areas on Fehmarn in recent years, the following inventory descriptions and the results of the assessment are still current.

*Baseline investigation*

The **coasts** of the investigation area differ greatly in terms of their landscapes. The area to the west of the ferry harbour is dominated not only by the Baltic Sea but also by the coastal defence dyke and landscape of the north coast (K 2 – dyke/beach landscape to the north of Puttgarden). At the land end, the grazed dyke marks the end of this landscape pattern. After an interruption at the ferry harbour on the east coast, the coastal landscape continues (K 3 – sections of beach landscape with cliffs on eastern bank). This contains a narrow strip of semi-natural sandy, shingle and boulder-strewn beach and a cliff up to several metres high.

Within the dyke area/moving inland of the cliff, the landscape of the investigation area is dominated by an intensively used **agricultural landscape** . Large parts of this landscape are open and contain very few separating structures (e.g. hedgerows). Most of the interior within the investigation area is made up of this **agricultural landscape free from structures** to both the west (A 1.1) and east (A 1.2) of the "bird migration route". In the northern part to the east of the B 207/E 47 and the railway near Presen (A 1.3), the agricultural landscape is marked by the Presen wind farm.

**More divided agricultural landscapes** can be found in some settlements and inland of the north coast (e.g. northwest of Puttgarden [A 2.1]). The area tends to be divided up mainly by hedgerows, green spaces, a network of ditches and isolated small bodies of water. The landscape patterns of the agricultural landscape on the east coast (to the north [A 3.1] and south of Marienleuchte [A 3.2]) feature scenic views of the Baltic Sea and are therefore a visually distinct feature. The verges along the K 49 between Puttgarden and Burg and the K 63 to the west of Puttgarden feature **avenues** and lines of trees (A 4.1, A 4.2).

The villages of Puttgarden (O 1), Marienleuchte (O 2) and Bannesdorf (O 6) constitute landscapes with specific landscape patterns in the investigation area (**built-up areas**). Landscape patterns of the **transport infrastructure** impacting on large areas exist in the form of the ferry harbour and the railway in the north of the investigation area (V 1), which have a mainly technical appearance. The bird migration route, together with the B 207/E 47 and railway line which runs in parallel with it (V2), is green along its edges (grass, shrub and wooded structures), linking it into the landscape and producing a backdrop for the surrounding areas of mainly open farmland.

*Existing impairments*

- B 207 highway from Bannesdorf in the south to the east of Puttgarden (noise and pollutant levels, daily traffic flow > 5,000)
- Railway line running parallel to the B 207 (noise emissions and barrier effects)
- Puttgarden ferry harbour
- Commercial areas in Puttgarden and Bannesdorf (noise emissions, possibly pollution from harmful substances and odours)
- Presen wind farm (visual disturbance of landscape, noise emissions)
- Local purification plants, biogas plants, fattening units, etc. (bad odours)

*Baseline evaluation*

The table below shows the significance of the baseline with regard to landscape/landscape pattern. The baseline is assessed using a scale with three levels: "low", "medium" and "high" significance.

**Table 68 Overview of significance (landscape pattern quality) of the landscape/landscape pattern***

| **High significance** |
|---|
| - Coastal landscapes – landscape patterns K 2, K 3<br>- Built-up areas – landscape patterns O 1.2, O 2.1, O 6<br>- Distinct avenues of trees – landscape pattern A 4.1 |
| **Medium significance** |
| - Built-up areas – landscape patterns O 1.1, O 2.2<br>- Agricultural landscape with more structures – landscape pattern A 2.1<br>- Agricultural landscape with direct view of the Baltic Sea – landscape patterns A 3.1, A 3.2<br>- Distinct avenues of trees – landscape pattern A 4.2 |

| |
|---|
| - Infrastructure impacting on large areas – landscape pattern V 2 |
| **Low significance** |
| - Built-up areas – landscape pattern O 1.3<br>- Open agricultural landscape – landscape patterns A 1.1, A 1.2, A 1.3<br>- Infrastructure impacting on large areas – landscape pattern V 1 |

* The numbering of landscapes used here was taken from the EIA report to allow the names in the EIA report and LCP to be compared. Numbering in the investigation area of this LCP is not therefore continuous.

### 4.2.7.2. Marine area

*Baseline investigation*

The expanse of water can basically be split into two landscape types for the Fehmarnbelt. Given their different characteristics, the Fehmarnbelt can generally be split firstly into the marine areas visually affected by the coastal landscapes around Fehmarn and Lolland and secondly the open sea.

By far the largest part of the Fehmarnbelt in the marine investigation area is shaped by the open expanse of water (landscape pattern M). It is mainly the
effects of the weather, such as sunshine, precipitation or fog, which dictate visibility or light conditions and therefore impact on how the landscape is perceived. Despite the prevailing natural elements, shipping traffic is very present in the open sea.

The Fehmarnbelt's expanses of water close to the natural sections of coast on Fehmarn (landscape pattern KF) are shaped by the backdrop of landscape elements typical of the region such as cliffs, beach ridges, dunes, sandy and shingle beaches but also dykes with green space in the marine investigation area. A key element of the landscape of the coastal sea in the north east of Fehmarn are the ferries travelling into and out of the ferry harbour, which shape the landscape in a unique way in this area.

To the east of the ferry harbour, Marienleuchte is the only settlement in the investigation area right on the coast. The sea area around the Puttgarden ferry harbour, the technical facilities at the harbour and commercial/industrial buildings (landscape pattern F 1) are a break in the otherwise natural coastal space. The Klingenberg wind farm on the east coast near Klausdorf, above the cliff, dominates the adjacent sea landscape W 1.

*Existing impairments*

- Harbour facilities in Puttgarden with associated commercial/industrial buildings and maintenance facilities
- Wind farm right on the coast near Klausdorf on Fehmarn
- Increased shipping near the international shipping channel in the centre of the Fehmarnbelt ("T-Route") and ferry traffic between Puttgarden and Røbyhavn.

*Baseline evaluation*

Levels of significance in terms of landscape are assigned using a two-stage scale of "general" and "special" according to the table below.

**Table 69 Overview of assignment of levels of significance in relation to landscape in the marine area***

| | | |
|---|---|---|
| **Special significance** | | |
| - | Landscape M | (open sea of the Fehmarnbelt) |
| - | Landscape KF backdrop) | (space in Baltic Sea just off the coast of Fehmarn with semi-natural |
| **General significance** | | |
| - | Landscape F 1 bour) | (Sea area with existing impairments around the Puttgarden ferry har- |
| - | Landscape W 1 farm | (Sea area with existing impairments in front of the Klingenberg wind on Fehmarn) |

## 4.2.8. Climate/air

There have been no changes to the climate/air environmental factors areas on Fehmarn in recent years, which means that the following descriptions of both environmental factors remain valid.

### 4.2.8.1. Regional climate (Fehmarn and marine area)

#### Baseline investigation

The regional climate in the western Baltic Sea area is a temperate, warm and wet, oceanic climate. The climate on Fehmarn is greatly affected by its location between the North and Baltic Seas. Cool summers and mild winters are therefore common on the land. The Baltic Sea stores heat such that temperatures between July and the winter remain above the average figures for the interior. The prevailing westerly weather causes a lee effect on the Baltic Sea coast, resulting in less precipitation here than in the areas in the west of Schleswig-Holstein. Precipitation figures as low as 550 mm are recorded in the east of Fehmarn. The distribution of precipitation in individual years is marked by a large range of fluctuation. There is usually a dry spell in the spring between February and May, while the summer and autumn months are wet. Because of low levels of cloud cover and long periods of sunshine (1,700 to 1,800 hours a year), the island of Fehmarn is one of the sunniest regions in Schleswig-Holstein. Average wind speeds in the Fehmarnbelt are > 7 m/s (wind strength 4) and around the coast of Fehmarn and on the northern part of the island are 6-7 m/s. The wind blows from the west on 75% of days in Schleswig-Holstein.

*Existing impairments*

There are no existing impairments for the regional climate. The following impairments exist with regard to air:

- Air pollution from ferry traffic between Puttgarden and Rødbyhavn, freight ship traffic in the Fehmarnbelt, road and rail traffic (diesel engines)

*Baseline evaluation*

The regional climate in the (western) Baltic Sea region itself is not assessed since, with regard to climate/ air, assessments are more oriented around the local climate conditions such as impact and compensation areas (cf. Gassner et al. 2010) and functional relationships are defined by the weather events taking place over the extent of the investigation area.

The air quality in the Baltic Sea area generally and in the Fehmarnbelt region is very pure as there are few existing impairments and this quality is therefore of particular significance for the air. However, no areas of a different air quality and therefore different significance can be distinguished within the investigation area.

#### 4.2.8.2. Local climate

*Baseline investigation*

The local climate on the island of Fehmarn is dominated by a regional climate shaped by the Baltic Sea, which dictates local climatic conditions. Thanks to the dominating marine climate with plenty of wind and a lack of industrial use, air quality on Fehmarn is very good. Being directly on the coast, the climate is bracing ("natural climate").

Smaller special climates shaped by the relief (areas with climatic parameters vastly different from those of the regional climate) do not exist in noteworthy numbers due to the domination of the regional climate described above and the flat relief of the landscape (low relief energy) in the entire LCP investigation area. Small special climatic situations near settlements or so-called urban heat islands (changes in key climatic parameters due to large, vertical/horizontal surface changes/areas of ground sealing) do not exist given the rural structure of the area with small built-up areas and individual farmsteads. The investigation area also has no major woodlands with their own climate to function as areas where fresh air is produced.

Given the lack of tall-standing woodland, the very flat relief and the direct proximity to the sea, aeration on Fehmarn is good.

*Existing impairments*

The following impairments exist with regard to air:

- Emissions-related pollution from rail and road traffic and shipping near the harbour

*Baseline evaluation*

Given that the climate in the investigation area is dictated by its location, as described above, and the lack of special climatic situations covering small areas (e.g. wood as an area where fresh air is produced), no areas with functions relating to the local climatic situation can be classified or evaluated.

The air quality in the entire land area is of particular significance because the region is not polluted.

### 4.2.9. Cultural heritage and other material assets

No new surveys were carried out for the environmental factors of cultural heritage and other material assets since there had been no significant short term changes. The following information is still valid.

#### 4.2.9.1. Island of Fehmarn

**Cultural heritage assets**

*Baseline investigation*

There are stray archaeological finds over virtually the entire island of Fehmarn and these are also documented in the investigation area (see ALSH Archaeological State Records, dated January 2008). During the course of the main investigation (ALSH 2015), structures were documented in the investigation area located to the east of the railway and south of the underpass on the road to Marienleuchte on the edge of a residential area. The assumption is that these are from the pre-Roman Iron Age. However, no outstanding legally-protected archaeological monuments of any value were found in the investigation area.
Over the course of the archaeological investigations carried out as part of the new construction of the Fehmarnbelt Fixed Link, a fort dating from the early Middle Ages and labelled "LA 100", which is assumed to be Slavic in origin, as well as a harbour facility near Marienleuchte were documented. However, "their exact position is not currently known" (State Archaeological Agency for Schleswig-Holstein 2012, page 11). Since their exact location is unknown, they are not shown on inventory and conflict plan 1, Attachment 12.1.

Outstanding architectural monuments are recorded in the historical monument register for Schleswig-Holstein in accordance with Article 5. In the investigation area, only the historical lighthouse in Marienleuchte dating from 1832 (see Attachment 12.1, Plan no. 1) is protected as outstanding architectural heritage.

Furthermore, there are three simple architectural monuments (in accordance with Art. 1 of the Preservation of Historical Monuments Act, the DSchG) in the investigation area, one in Puttgarden and two in Bannesdorf. The building in Puttgarden is a half-timbered cottage in the historic centre, while in Bannesdorf there are two other buildings of historical importance within the investigation area.

There are only isolated cases of parts of the cultural landscape with historical importance. Most of the landscape elements are modern functional structures, such as wind turbines, the radio tower, the ferry harbour and most especially the agricultural landscape with its large corridor structure. Preserved historical elements of the cultural landscape, such as the common clay pits, are often not very obvious or do not have a major impact on the character of the landscape as they are overshadowed by technical landscape elements in their direct vicinity.

Separating patterns sometimes still arise in the historic settlement structure, some of which has been preserved. The basic pattern of the former Fortadorf structures with village squares can still be seen in many districts and are very easy to recognise in the investigation area in the southern part of Puttgarden.

*Existing impairments*

- Major industrial, technical projects (e.g. wind farms, large commercial operations)
- Powerlines;
- Disposal sites, excavations;
- Highways, national and regional roads with a high volume of traffic (daily traffic flow > 5,000).
- Individual structures affecting the field of vision of cultural monuments.

*Baseline evaluation*

The baseline is evaluated using a scale of four. The significance of the cultural heritage assets described in the investigation area can be seen in the table below:

**Table 70 Overview of objects considered in the cultural heritage sub-factor and their importance**

| |
|---|
| **Very high significance** |
| - Monuments registered in accordance with § 5 of the DSchG: historical lighthouse in Marienleuchte |
| **High significance** |
| - Simple monuments (not listed in the historical monument register), if necessary with surrounding conservation areas (monuments in accordance with § 1 DSchG S-H): individual buildings in Puttgarden and Bannesdorf<br>- Fortadorf structures which can still be seen in Puttgarden and Bannesdorf |
| **Medium significance** |
| - a fort and harbour facility near Marienleuchte which are presumably Slavic in origin and dating from the early Middle Ages. Their exact location is not currently known. |
| **Low significance** |
| - (Potential) stray archaeological finds all over the area<br>- Other elements of the cultural landscape frequently encountered, such as clay pits |

## Other material assets

*Baseline investigation*

The most important material asset is the coastal defence dyke on the north coast, which serves to protect the population and property and therefore has an overriding protective function.

Other significant elements of the other material assets sub-factor are formed from the individual components of the bird migration route because the transport infrastructure is of overriding public interest. This traffic line (comprising the B 207/ E 47, the railway which runs in parallel to it and the ferry harbour with railway facilities) runs from the southwest of the investigation area to just east of Puttgarden. The area around the ferry harbour is characterised by tracks, the station and access roads to the ferry terminals south of the ferry harbour, the car parks to the west of the ferry harbour and the technical facilities and buildings of the ferry harbour itself.

The Presen wind farm, roughly 108 ha in size, lies to the northwest of the village of the same name in farmland to the east of the bird migration route.

The modern, operational lighthouse in Marienleuchte is another material asset that can be seen from far away. Utilities such as purification plants, rainwater retention basins and electricity supply facilities exist in Puttgarden, Bannesdorf, at the ferry harbour and on the north coast. Outside settlements there are car parks near the beach at the campsite to the north of Puttgarden and near the border shop, which are used mainly for (retail) tourism and recreation.

*Existing impairments*

There are no existing impairments.

*Baseline evaluation*

Classification into one of the four levels of significance for the other material assets can be seen in the table below:

**Table 71 Overview of objects considered in the other material assets sub-factor and their importance**

| **Very high significance** |
|---|
| - Coastal defence dyke given its overriding protective function and highly protective effect for people and property (according to Art. 64 Para. 2 no. 1 of the Schleswig-Holstein Water Act and state development plan for Schleswig-Holstein, 2010) |
| **High significance** |
| - Harbour facilities, national/European motorway and railway line/facilities with overriding public function |
| **Medium significance** |
| - Significant material assets such as the large Presen wind farm, the modern lighthouse in Marienleuchte and settlements/buildings (baseline and legal planning; Fehmarn's land use plan) |
| **Low significance** |
| - Purification plant, rainwater retention basin, car parks; in accordance with land use plan/urban plans for Fehmarn) |

### 4.2.9.2. Marine area

#### Cultural heritage assets

*Baseline investigation*

There is a find of cultural and historical interest, a 5 m anchor stock, in the shallow waters off Fehmarn. But finds of tree remains are also of archaeological interest because they provide information on earlier sea levels.

There is a find of great cultural and historic interest in deeper water (>6 m in depth). This is a timber shipwreck that dendrological studies have dated to the middle of the 17th century.

A study of the sediment layer allowed highly varying sediment processes to be seen, which provide evidence of a structured ancient landscape with bars and bays. On the basis of our current knowledge, the evaluation of the soil samples does provide valuable information about the history of the landscape, but does not reveal any indications of early human use of the freshwater lagoon (Segschneider, written memo 27.11.2012).

*Existing impairments*

There are no existing impairments.

*Baseline evaluation*

Only one of the finds - the 17th century shipwreck (*Lindormen*) – is of great cultural and historical interest. It has therefore been assigned special significance since this wreck is the most important underwater archaeological monument in the region of the Schleswig-Holstein Baltic Sea with a specific link to an important event in the Nordic Wars, here as part of the Thirty Years' War.

**Table 72 Overview of marine cultural heritage assets and their significance in the German territorial zone**

| **Special significance** |
|---|
| - Shipwreck from the 17th century *(Lindormen)* |

#### Other material assets

*Baseline investigation*

In the investigation area there is an underwater cable between Germany and Denmark which runs to the west of the Puttgarden ferry harbour. Its route passes to the west of the Rødbyhavn ferry harbour and on to the coast of Lolland. Including the protection zone, it takes up an area more than 900 m wide. According to the international sea chart, the route is classified as a "submarine cable area," in which according to the Danish Cable Protection Committee (DKCPC) there are currently two active telecommunication cables.

To the northeast of Puttgarden is a military exclusion zone, including a restricted zone in the Baltic Sea. Anchoring, fishing, angling and the extraction of sand and stone is prohibited in the restricted zone. There is a general ban on entering the exclusion zone.

*Existing impairments*

There are no existing impairments.

*Baseline evaluation*

Given their cross-border functions for telecommunications and the transfer of energy, underwater cables are of overriding public interest and are therefore classified as material assets of special importance (see Table 4-32).

Since the military exclusion zone and associated restricted zone are not material assets in terms of environmental factors, they cannot be assigned any particular importance.

**Table 73 Overview of marine material assets and their importance**

| |
|---|
| **Special significance** |
| - Underwater cables (including protection zone) |
| **General significance** |
| - No function elements are assigned to this level of significance |

## 4.2.10. Interactions

### Baseline investigation

*Superordinate area*

The following interaction complexes can be seen in the investigation area of the LCP. They are shaped by the existing vegetation, other biotic and abiotic features and a complex dovetailing of factors:

- Marine area: In the Fehmarnbelt itself, there are a variety of interactions between the hydrographic conditions (current conditions, water exchange, water quality, salinity, etc.), marine habitat types, maritime flora (plankton, macroalgae, etc.), maritime fauna (e.g. feeding and resting places of water birds, habitats of marine mammals, fish spawning grounds, benthic fauna, etc.) and seabed conditions.
- Coastal landscape on Fehmarn: Coastal landscape on Fehmarn: interactions between marine and terrestrial, biotic and abiotic structures and the (land) use (use for recreation, coastal defences etc.) in the transitional zone between sea and coast.
- Other interaction complexes with a complex mingling of biotic and abiotic factors cannot be identified in the investigation area.

*Interaction complexes in marine area in Fehmarnbelt*

The individual environmental (sub-) factors in the marine area (planktic fauna and flora, benthic flora, benthic fauna, fish, marine mammals and resting birds) are linked in reciprocal relationships with one another and the abiotic location factors by various processes. The two most important interfaces are the food web and the habitat.

**Table 74 Interactions within the environmental (sub-) factors (grey cells) and between the environmental (sub-) factors (white cells) in the Fehmarnbelt marine area***

| | **Plankton** | **Flora** | **Fauna** | **Fish** | **Mammals** | **Birds** |
|---|---|---|---|---|---|---|
| **Plankton** | | | | | | |
| **Flora** | Z | | | | | |
| **Fauna** | N Z | N L | | | | |
| **Fish** | N Z | L | N | | | |
| **Mammals** | | | N | N | | |
| **Birds** | | N | N | N | | |

* The letters in the cells represent the main interactions between the respective environmental (sub-) factors: N = direct relationship via the food web, L = habitat relationships, Z = lifecycles.

Generally speaking, these interactions are limited by the fact that their significance cannot be quantified because datasets for them do not exist and can only be produced at great expense. Furthermore, the three interaction areas overlap with one another as many organisms inhabit different habitats during the course of their lifecycles and therefore belong to different food webs. A rough estimate of the importance or significance of an interaction is only possible in a few cases. At the same time, the marine ecosystem is highly dynamic and any change to environmental conditions results in a shift in the interactions.

The food web in the marine ecosystem is the basis which enables different organisms to survive in the sea. Put very simply, the basic food web comprises four trophic levels:

1. Phytoplankton (microalga) as primary producers
2. Zooplankton as primary consumers of the phytoplankton,
3. Secondary consumers (e.g. benthic fauna, fish),
4. Tertiary consumers (predatory fish, mammals and birds).

This simple food chain now becomes a food web in which the individual components also maintain food relationships in addition to those described above. There are very few gaps in the food web (see Table 74). For example, in the Fehmarnbelt there are no direct interactions between mammals, plankton and benthic flora and between birds, mammals and plankton.

It is not possible to list all the interactions in the food webs. The dependencies covering the environmental (sub-) factor are, however, particularly strong between plankton and benthic fauna and between benthic fauna and birds/fish and maximum significance is assigned to these interactions.

The marine habitat can basically be split into the open water (pelagial, inhabited by e.g. plankton, fish and mammals) and the seabed (benthal, inhabited by e.g. invertebrates, macrophytes and fish). Every species usually has one certain link to one particular part of the habitat where it competes with other species. In the Fehmarnbelt, two habitat interactions are particularly important because they occur frequently and help shape the distribution of habitats:

- Hard substrate + algae + blue mussels
- Macrophytes + phytal fauna + fish

For example, benthic fish spend some of their lifecycle in plankton and some of it in benthos because they have planktic larvae stages. These lifecycles therefore take place in two different habitats and consequently different food webs.

Considered as a whole, it can be seen that the different elements of the marine ecosystem are interlinked by the individual interactions such that any impact from the construction of the FBFL on one environmental (sub-) factor may also impact indirectly on other environmental (sub-) factors. These interdependencies are considered in terms of their main interactions in the impact assessment (see LCP, Attachment 12).

*Interaction complex for the Fehmarn coastal landscape*

The main interactions exist in the transition zone between sea and coast. The relationship between the transport and deposition of sediment by sea currents, waves, wind etc. is most pronounced on the coast to the west of the Puttgarden ferry harbour. The section of cliff near Marienleuchte is shaped by comparable dynamics. The high-value coastal ecosystems and biotopes produced in interaction with the marine dynamics also represent high-value landscape patterns which are very unique and diverse. Interactions also result from human use, such as the construction of dykes, which on the one hand limit the marine dynamics outlined yet on the other hand create new biotope structures, such as mesophile pastures with areas of dry grassland on the dykes.

# 5. Avoidance and minimisation measures within the project

## 5.1. Avoidability check in upstream process stages

In accordance with Art. 13 BNatSchG, avoidable impairments are not permitted and should be avoided as a matter of priority. The avoidance of environmental impairments /impacts from the project has already taken place in advance studies and/or upstream stages of the process.

The first stage of planning in relation to the environment was a spatial resistance analysis (see Section 2.2 and Attachment 17) which aimed to establish at a very early stage of planning a route which was as environmentally-friendly as possible deploying the principles of optimisation and precaution. The results of this were used when establishing the route. When determining the route (see route determination report in Attachment 18), regardless of the choice of structural variant, possible routes to the west of Puttgarden and to the east of Puttgarden/west of the B 207 and railway were ruled out for various reasons. Ultimately, route variants were selected in a corridor to the east of the current transport infrastructure on Fehmarn, which continue in the marine area and onto Lolland to the east of Rødbyhavn. From an environmental standpoint, major impairments and impacts, some with great potential for conflict, resulting from the choice of the preferred route in the eastern corridor can be avoided by this choice of route alone. Details can be found in the spatial resistance analysis (see Attachment 17) and route determination report (see Attachment 18).

Further development of the technical solutions involved optimising the variants through close links with environmental planning, consistently following the need to avoid and minimise; see examples below:

*Onshore*

- Given the requirements of the railway, and because the partly unused land is of very high value from a floral standpoint, it was decided that the route would not enter the switchyard to the south of the ferry harbour. This avoids losses of special Red List species (environmental factor flora).
- In order to minimise as far as possible the area used and the dissection of open landscape, construction and storage areas needed on a temporary basis were concentrated in the area between the planned railway and road route and the space remaining between the planned road route and existing switchyard (environmental factors fauna, flora, landscape, soil).
- A working harbour in the marine area will be set up for the construction period to help deliver construction material by sea and reduce material transport by road and the associated onshore burdens (environmental factor human beings, etc.)

*Marine area*

- Reclamation areas and the working harbour off Fehmarn are located to the east of the ferry harbour. There are no reclamation areas to the west of the ferry harbour. The reasons for this are

  - Macrophyte and seaweed populations covering large areas (biotopes protected by law in accordance with § 30 BNatSchG in conjunction with § 21 LNatSchG)
  - The fact that this area is directly adjacent to Natura 2000 and nature conservation areas, which either physically extend into the marine area or are linked in terms of function with the (shallow) areas of water to the west of the ferry harbour
  - The special geomorphological features associated with the bar at Grüner Brink (environmental factors fauna, flora and biodiversity, soil).

- To avoid hampering water exchange through the Fehmarnbelt, the contours of the reclamation areas to the east of the ferry harbour do not exceed the extent of the existing breakwaters of the ferry terminal. The breakwater for the working harbour will also not extend beyond the existing ferry harbour breakwater so currents in the Fehmarnbelt will not be affected (environmental factor hydrography).
- Various types of cross-section for an immersed tunnel solution were compared from various standpoints, including an environmental one (see Attachment 18, route determination report). Compared with cross-section type A, cross-section type B, because of its considerable height, and cross-section type C produce a greater volume of excavated material. Cross-section type A was selected for further planning because of its smaller impact, but also benefits in terms of costs, build time and risks. This enables impact in the seabed to be minimised and minimisation of water turbidity and sedimentation when excavating the ditch and negative consequences for flora and fauna (environmental factors seabed, water, fauna, flora, biodiversity).
- In the marine area, the excavated material is generally reused and the excavation method chosen with a view to reducing the extent of sediment release during excavation (see Attachment 27, construction logistics). The construction process has been optimised in order to reduce the release of sediments, sediment drift and sedimentation in the free marine area of the Fehmarnbelt with its negative consequences for fauna and flora during the construction phase when backfilling the reclamation areas and setting up and operating the working harbour. Perimeter embankments will be set up in front of excavations in the area of the working harbour to minimise the sediment that escapes to the free marine area. The same is true later on before the reclamation area is backfilled with excavated material: Perimeter embankments with only one entrance for barges will be set up around the reclamation areas. The excavated material will be installed in the fill areas behind the perimeter embankments. The offshore surface of the perimeter embankments will also be protected by a spur dyke to prevent erosion caused by waves and currents (see Attachment 27 construction logistics). This will minimise the sediment release and drift to the free marine area - while building and operating the working harbour and when bringing material in the reclamation areas - thereby limiting the impairments for the environmental factors fauna, flora and biodiversity.

## 5.2. Avoidance and minimisation measures at plan approval level

### 5.2.1. Minimising predictable impairments ahead of time together with technical planning at the plan approval level

In accordance with the BNatSchG, avoidable impairments are not permitted and should be avoided as a matter of priority (avoidance and minimisation measures as laid down in § 15 BNatSchG). This chapter outlines the measures at plan approval level that help prevent and/or minimise impacts ahead of time through planning-technical decisions. The concrete detailed avoidance and minimisation measures of the landscape conservation plan - particularly also the onshore and offshore technical precautions that contribute to minimisation - are described in detail in Section 5.2.2.

*Onshore*

- In order to minimise the area used and the dissection of open landscape as far as possible, while balancing the technical requirements with the need to minimise impact, the land affected both permanently and temporarily (during construction) was reduced to a minimum. The goal of prioritising the concentration of construction and storage areas needed on a temporary basis between the planned railway and road route and the space remaining between the planned road route and existing switchyard was described in more detail (environmental factors fauna, flora, landscape, soil).
- When designing the crossing from the mainland to the planned reclamation area, optimising the contours preserved an additional 100 m of the cliff which runs from the ferry harbour to Marienleuchte (biotope protected by law in accordance with Art. 30 BNatSchG in conjunction with Art. 21 LNatSchG) (environmental factors fauna, flora and biodiversity).
- The accumulated excavated material will consist (primarily) of glacial till (boulder clay). If these soils are suitable and acceptable as far as pollutant concentration is concerned, they are reused to construct the ramp structures or for landscaping. Itis currently assumed that all necessary general filling and backfilling work can be done with the soils accumulated from the excavation work. Thus the excavated material accumulated onshore will be almost completely reused (see. Explanatory report, Attachment 1, of the plan approval documents, Section. 7.3.2).
- Route crossing options for fauna: In the area of the Drohngraben ditch, route crossing options have been provided for amphibians and small mammals which are aligned with the gradients of the road sections (cf. LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.4). Dimensioning is based on the MAQ (2008) and the information contained in the guideline entitled "Planning of Measures Intended to Protect the Otter on the Roads of the State of Brandenburg" (2008), which are also recommended by the headquarters of the LBV-SH in Kiel.

*Marine area*

- Protection measures for or recovery of the shipwreck found off the German coast (environmental factor cultural assets).

- Location of the temporary working harbour off Fehmarn: Section 5.1 explains that the working harbour is to be situated east of the ferry harbour for different reasons. When determining the exact location of the temporary working harbour at plan approval level, a location will be selected that borders directly on the eastern breakwater of the ferry harbour. The following reasons for minimising negative environmental impacts were significant here (see Attachment 16):
  - The temporary working harbour between the ferry harbour and construction site for the cut-and-cover tunnel was chosen in such a way that most of it uses areas that will be necessary anyway later on for reclamation areas and thus minimises impacts on the environmental factors seabed and flora and fauna by reducing the land needed.
  - Positioning the ferry harbour to the east of the tunnel route would only slightly increase the desired safety distance to the ferry line, but would significantly reduce the distance to the town of Marienleuchte where operation of the working harbour would increase the negative impact (noise, light, dust) (environmental factor human beings).
  - The site of the temporary working harbour was also selected because the harbour basin already has the necessary water depth of -5.5 m to more than -7 m below sea level and thus no excavation for a channel would be necessary. This reduces the sediment release and water turbidity caused by construction with its negative consequences for the environmental factors fauna and flora.
  - The breakwater of the temporary working harbour does not jut out over the existing breakwater of the Puttgarden ferry harbour to the north which means the currents in the Fehmarnbelt are not impaired (environmental factor water).

*Protection and monitoring concepts - Onshore and in the marine area*

Furthermore, protection and monitoring concepts are being developed (see Attachment 22 of the plan approval documents) which, for the construction phase, ensure

- that (construction) procedures, in the sense of the impact regulation, are adhered to with regard to the materiality threshold in consideration of technical measures - as far as this is possible,
- and/or the limits and precautionary values (e.g. emission and soil protection) are complied with,
- and/or that the avoidance and minimisation measures adopted as part of the protection and monitoring concepts are implemented to an appropriate professional standard.

The protection and monitoring concepts, in addition to Attachment 22 of the plan approval documents, LCP, Attachment 12 of the plan approval documents, Annex IB are shown in brief form as concept sheets. The fundamental content of these concepts were also authorised as avoidance and minimisation measures in the list of measures (LCP, Annex IA). For more information on protection and monitoring concepts, see LCP, Attachment 12 of the plan approval documents, Section 7.8.2 and 7.8.3 and Annex IB.

### 5.2.2. Avoidance and minimisation measures of the landscape conservation plan

The following section describes the planned onshore and offshore avoidance and minimisation measures for the respective environmental factors of the landscape conservation plan (LCP, Attachment 12). The avoidance and minimisation measures are also described in the site plans of the landscape conservation measures, Attachment 12.2., Sheets 1 to 11 and Annex IA for the LCP (index of measures). The measure numbers indicated refer to the measure numbers in the LCP.

#### 5.2.2.1. Human beings

- Noise reduction during the construction phase (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.13), inter alia, the AVV is required to comply with noise reduction measures. If exceeding of the standard emission levels is expected, in order for the work to progress, evidence is required of the need to use the chosen construction methods or equipment. Equipment such as the concrete mixing plant that falls within the scope of the Federal Immission Control Act must comply with its immission guideline value.
- Only construction equipment that at least meets the recognised standards of the sector is to be used. The requirements of the 32nd German Federal Immission Protection Ordinance are to be observed.
- The project proponents shall designate a contact for residents who can act promptly concerning questions about noise and noise emissions. The future construction companies will provide advance information of construction works that will produce extraordinary construction noise.
- Heavy goods vehicles are to be kept from passing through the towns and villages.
- For assessment of the construction noise pollution, noise emission measurements are to be taken at representative measuring points during the construction work (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 013).
- Vibration monitoring during the construction phase (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.13).
- During the vibration-intensive construction operations, e.g. when pile drivers and vibrating rollers are used, expected compliance with requirements will be examined by vibration monitoring measurements. The building structures located at the distances to the project's vibration-intensive construction operations shall be considered as representative measurement objects and thus measuring points for vibration monitoring (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.13).

- The project proponents shall designate a contact for residents who can act promptly concerning questions about vibrations (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 013).
- Reducing nocturnal light from building sites to the minimum operational and safety level required (lighting adapted to the conditions; limiting the times lights are on; no skyward-pointing spotlights; sealing off light sources from the sides and focusing light on the ground; considering the nearest building development by planning light-intensive works at the greatest possible distance). The project proponents shall designate a contact for residents who can act promptly concerning questions about vibrations and light emissions (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.12).
- Dust reduction measures on the construction site including, inter alia, covering erodible building materials while they are transported by HGVs, Grasansaat (translator's not: I can't find this one) top soil stockpiles to reduce dust build-up; if necessary, irrigate erodible stockpiles; if necessary, attaching highly used access roads; regularly cleaning attached access roads (see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 0.10).
- Planting to the west of the E 47 embankment in the area between chainage km 8+300 and 9+100 to the west of the E 47 as a visual breakscreen/way of integrating the route and thereby minimising the (visual) impact for the Puttgarden residential area and the individual farmstead (LCP, Attachment 12 of the plan approval documents, Annex I, Measure no. 3.2). Annex I). Planting at the eastern edge of the freight train station will also help to minimise interference for Puttgarden (LCP, Attachment 12 of the plan approval documents, Annex I, Measure no. 5.2).
- New route for the footpath/cycle path running in parallel with the K 49 and new route for the road connecting Puttgarden and Marienleuchte as part of technical planning to prevent dissection of road connections that are also important for landscape-related recreation (cycle paths and footpaths).
- According to the hydrological investigations, bathing water quality is not expected to be negatively affected by water turbidity during the construction phase. As a precaution, however, to prevent impairments on water quality in the designated bathing zones "Grüner Brink" and "Presen" during bathing season, also taking tourism concerns into consideration, it is stipulated that in the coastal zones 1a and 2a off of Fehmarn (see also Section 5.2.2.8) no excavation work may take place in the marine area during the months listed below:
    - Zone 1a, chainage-km 10+600 to 10+970, from March to September
    - Zone 2a, chainage-km 10+970 to 13+670, June to August (Annex IA, Measure no. 8.3)
- Monitoring bathing water quality: Together with KrEIA-report Ostholstein, it was agreed that the current (standardised) investigation programme used by the local health department to analyse bathing water quality with a view to the construction phase of the FBFL must be expanded and enlarged. Femern A/S will bear the costs of additional investigations. These additional investigations were defined and prepared as a joint effort

between KrEIA-report Ostholstein and Femern A/S taking into account the knowledge of external experts from the University of Hamburg. The plan is to include the existing sampling sites located on the beaches of Fehmarn, Großenbrode and Heiligenhafen.

#### 5.2.2.2. Soil

- Proper temporary storage and almost complete reuse of topsoil and mineral soil from onshore excavations as well as marine soil excavated to create land reclamation areas, backfilling and onshore embankments. Temporary storage of top soil and mineral soil in professional stockpiles and, in the case of top soil, with the corresponding seeding. Securing the marine stockpile using a dam (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.8).
- The material from the section of beach (sand/gravel) for the cut and cover section of the tunnel will be retrieved and stored temporarily in marine stockpiles on the southwestern end. The sand/gravel will later be reused for creating the new beach of the reclamation area. Should the quantity prove insufficient, uncontaminated sand from existing extraction areas around Kriegers Flak may be used .
- Temporary storage heaps for sand can have a maximum height of 8 m, like the storage heaps for mineral soil (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 7.3).
- Protecting the soil when producing and using onshore construction sites inter alia, operating soil protection machines as much as possible by determining the corresponding maximum weight or contact surface pressure for the machines. Evaluating the soil's compression sensitivity in certain geotechnically-suitable areas may mean it is necessary to forego removing the topsoil (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 0.10).
- In the area of the project-related footprint, compressions caused during the construction phase and ground impairments will be removed before developing biotopes and before re-converting these to an agricultural use by using e.g. subsoilers, ploughs, cultivators, aerators, filling up sheet piles, soil replacement, targeted seeding (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.3).
- Avoiding construction-related deposits of harmful substances during de-sealing activity: Black top and anthropogenic backfilling are to be properly recycled or disposed of during pavement removal (LCP, Attachment 12 of the plan approval documents, Annex 1A, Measure No. 5.
- Development of shrub corridors and woodland plantings on route embankments and earthwork cuttings (LCP, Attachment 12 of the plan approval documents, Annex I, Measures no. 0.2 and 3.1, 3.2, 5.1, 5.2) for partial filtering and limiting pollutants from entering the soil during construction or operation.
- Minimising impairment to the seabed (partially of particular significance) due to land use in the areas around the tunnel trench, and its filling with debris: The depth of the tunnel was selected to ensure that, with the exception of the coastal area, the stone protection layer and the lateral fill with sand is always located beneath the level of the

existing seabed. This thereby guarantees a subsequent natural re-filling, and thus the reproduction of a seabed which is comparable to its current situation. Model calculations and the assumptions derived from these with regard to sedimentation rates, which are derived from the knowledge of existing sediments and flows, and an assumption of an average depth of the trench have shown that the remaining tunnel trench will be re-filled by natural sedimentation within at most 28 years. The initial depth of the tunnel trench after the end of the construction phase will vary as a result of the uneven nature of the seabed (including local terrain slopes and seabed geometries) and the geometrically linear course of the immersed tunnel. In order to promote a timely restoration of the seabed conditions in all areas of the tunnel trench, further calculations are to be made regarding the duration of the natural refilling time on the basis of the local terrain slopes and seabed geometries. The calculations show that due to the natural unevenness of the seabed in particular parts of the tunnel route, a targeted refilling should be undertaken using sand, so as to keep up with the timescale of the natural refilling. Both the sand material and the lateral backfilling used will come from approved sand reclamation areas. (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.6).

Verification of the natural refill of the tunnel trench and the reproduction of the prior habitat is a part of the planned monitoring programme in the marine area (plan approval document Attachment 22.9).

- Natural soil development above the tunnel structure in the area of the German EEZ and/or in the Fehmarnbelt Natura 2000 site: Since the surface of the protective layer of the tunnel lies below the level of the natural seabed, the height difference will be filled up in the long term with sediment transported to the seabed by sea currents. According to model calculations, a full restoration of the seabed surface within the German EEZ may be expected within a period of 15 to 28 years after completion of construction works, due to material being transported close to the seabed. The original sedimentary conditions and natural small-scale relief will be restored in accordance with the natural hydrodynamics. After the seabed surface approaches its original elevations by sedimentation, prevailing sediment transport and hydrographic processes will again form crescent-shaped seabed geometries until these reach equilibrium with hydrographic conditions. It will be ensured that the natural re-filling of the tunnel trench will be complete within a maximum period of 28 years. If more precise calculations, based on the detailed investigations of the cut-and-cover trench, show during the construction phase that this period may overrun, there is a plan to carry out additional re-filling with sand. An investigation into the tunnel trench and the associated calculations carried out during the construction phase will determine the natural re-filling of the cut-and-cover tunnel. The results of the studies and calculations will show precisely that the natural re-filling of the tunnel trench will be achieved within the 28-year period (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.6).

#### 5.2.2.3. Water

- Precautions will be taken during the construction phase to prevent water and groundwater contamination by construction materials, oil and fuels, e.g. through temporary storage areas for possible oil and fuel storage within the construction footprint, that are dismantled at a later time (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.11).

- To prevent hydraulic overload and/or significant pollution, before surface water enters waterways and/or the Baltic Sea it must pass through rainwater retention basins / up-stream sedimentation basins (RRB1 with AB, RRB 2, rainwater holding basin RKB at operating building). The intended permanent structures such as rainwater basins, sedimentation basis and rainwater basins cannot, as a rule, be built as part of pre-construction work. If possible a permanent structure should be attached to discharge receiving water at the beginning of the construction project.
During the construction phase, sand traps and any other upstream parallelograms which may be needed (e.g. sand traps, sedimentation units, light material separators) must be provided before the water is discharged to prevent the waters used as receiving waters from becoming muddy, silted or impaired by pollutants. Surface water from frequently used construction roads can likewise be treated using the aforementioned devices. The subterranean, drainage, surface and groundwater pumped from the excavations will be discharged into the Fehmarnbelt. The water to be discharged will be tested for compliance with the legal limit and treated if the limit for discharging it to the Baltic Sea is exceeded (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.11).

#### 5.2.2.4. Fauna, flora and biodiversity

- Protective measures during the construction phase (e.g. DIN 18920, mobile construction fence RAS-LP4) for vegetation to be preserved of medium to high value adjacent to the areas used for construction work, in particular for hedgerows and small bodies of water (§ 30 BNatSchG in conjunction with § 21 LNatSchG) (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.4)
- Reducing nocturnal light from building sites to the minimum operational and safety level required (lighting adapted to the conditions; limiting the times lights are on; no skyward-pointing spotlights; sealing off light sources from the sides and focusing light on the ground; considering the nearest building development while considering areas containing light-sensitive fauna groups by planning light-intensive works at the greatest possible distance). Reduced luring effect primarily on insects, and secondarily bats, by use of sodium or LBP lighting with a colour temperature between 3000 K and 3500 K, especially for floodlighting (e.g. storage and parking areas) (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.12).
- Limiting the work to clear trees and shrubs needed along the entire construction route and demolition work at the K 49 crossover (clearing of construction site) to the middle of winter, i.e. limiting work to between the start of December and end of February (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.6).
- Beginning of construction by stripping and then using the topsoil if possible outside of the breeding periods of the skylark, blue-headed wagtail lapwing etc. , i.e. outside of the period between 15 March and the end of July, in order to avoid construction-related

killings. The construction work is then undertaken continuously beyond the end of the breeding season at the very least. (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.9).

- If these construction measures cannot be started outside the breeding season or it cannot be undertaken continuously until beyond the end of the breeding season, from the start of the breeding season (start of April) if necessary until its end (mid March) measures to scare away the birds must be taken in the permanent impact area and in areas used temporarily during the construction period. The bird scaring measures (e.g. driving tractors over or harrowing the areas at least once a day; installation of vertical structures on the areas, e.g. by installing non-transparent (fence) elements at least 3 m high) must be undertaken during this period until the area is used continuously for construction to prevent the birds from building nests (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.9).
- Improved options for animal species which may migrate via waterways through passes (structures BW 09.FBQ, BW 11.207– no. 5.019 in the list of structures) with dry underpasses under roads, the dimensions of which are based on the needs of the European otter as a keystone species for mid-sized mammals (Annex I, Measure no. 5.019). The dimensioning of the passes has been planned at 3.00 clear width and at least 2.60 clearance height. In order to ensure the ecological sustainability of the smallest soil segments, the berm is filled using soil material. Erosion protection is ensured using larger stones retrieved from the area. (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.4).
- Reduction in night-time lighting to the minimum needed for operation and safety, adaptation of the intensity of the light to prevailing local conditions (control e.g. light sensors).
- Use of lighting which primarily does not attract insects and secondarily bats as well, to minimise the risk of collision. LED lighting with a colour temperature between 3000 Kelvin (K) and 3500 K is envisaged. Boom poles with downward-directed lighting shall be used. The maximum mast height is 15 m. Lamps should be located between 8 m and 12 m above the ground and fitted with a cover to prevent light from scattering upward and, as far as possible, to the sides. A uniform crossover of the lighting from the public road in the tunnel is planned, but no special lighting is planned for the tunnel portal (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 5.3).
- Planting an avenue of trees on the embankments of the structure crossing the K 49 as a potential guiding structures for bats, especially the serotine bat, to guide the bats over the roads (see Attachment 12, LCP, Annex I, Measure no. 1.2). (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 1.2).
- Tree-lined/ wooded areas will also be created to guide bats to the west of the routes (LCP, Attachment 12 of the plan approval documents, Annex IA Measure no. 3.2 and 12, 5.2), which will work in conjunction with the K 49 crossover and the avenue of trees on it as a general minimisation measure.

- No attractive feeding habitats will be created to the east of the route to prevent the risk of collision.
- As a conservation-related avoidance measure (for the Eurasian coot and moorhen) the clearing of the bodies of water FBioAM56 and FBioAM57 must take place in the winter (start of December to end of February) before the start of construction work, to prevent the waterbound species potentially being affected by the construction work , (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 2.1, 3.7).
- In order to avoid/minimise the risk of killing and injuring crested newts from nearby water bodies FBioAm 55, FAm160; FAm164 and FAm167, which are near the Fehmarnbelt Fixed Link, during the migration phase of the amphibians towards the wooded areas along the existing railway route and B 207 as part of the terrestrial habitats during the construction period:
  - Prior to the onset of construction (and grove clearance in the construction area, see LCP, Attachment 12 of the plan approval documents, Measure 0.6), the area between axis 900, km 1+474 to axis 970, km 0+576 (end of construction phase) will be cordoned off by a mobile amphibian barrier fence during the aquatic phase of crested newts. The amphibian barrier fence must be set up between April and early May and has to be in place throughout the construction period. The instructions given in MAmS (2000) must be observed (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 1.3).
  - The function of the woodlands along the road and railway as a winter habitat, which is lost firstly through physical loss and secondly through the mobile amphibian fence, is to be bridged near the bodies of water FBioAm 55 and FAm160 through the use of alternative wintering structures. For this purpose, during the construction phase a 755 m long row of prunings, roots and/or field stones with gaps in it will be created in front of the amphibian protection fence. Some of this material will be dug into the ground (1 m) so as to generate a system of cracks which can be used by crested newts and to ensure that there is an area which is protected against subzero temperatures so newts can hibernate there. Each section of packed material must each be at least ten metres long and two metres wide and there must be no more than 25 m between them. The project must be completed prior to the start of the terrestrial phase (from mid-July) in the year the construction area is fenced off. Functionality is available immediately after the measure is implemented (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 1.3).
  - The temporary winter hideouts must be dismantled during the aquatic phase (April to the end of June) in order to prevent potential danger for the newts located in “interim structures”. If this is not possible, the interim structures must be fenced off during the aquatic phase to prevent them from being used again. The material must be reinserted along the new hedgerow to be created immediately afterwards as permanent wintering grounds (see following paragraph LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 2.2).
  - As soon as the temporary winter substitute accommodation for the crested newt has been dismantled in the area of 970 axis, chainage-km 0 +180 to chainage-km 0+500 (end of construction) (see measure 1.3 above), the material for creating a row of prunings, roots etc. with gaps in it will be permanently placed along a length of 320 m on the road to Presen at the eastern edge of the hedge for use as wintering grounds. Some of this material will be dug into the ground (1–1.5 m) so as to

generate a system of cracks which can be used by crested newts and to ensure that there is an area which is protected against sub-zero temperatures so newts can hibernate there. Each section of packed material must each be at least ten metres long and approx. two metres wide and there must be no more than 25 m between them. The permanent winter hideouts must be completed by mid-September during the year the temporary winter hideouts are dismantled to make sure they can be used and are within reach of the local population. Functionality is available immediately after the measure is implemented (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 2.2).

- In order to avoid/minimise the risk of killing and injuring crested newts from nearby water bodies FAm158, FAm162, FAm166 and FAm171 which are near the Fehmarnbelt Fixed Link, during the migration phase of the amphibians towards the wooded areas along the existing railway route and B 207 as part of the terrestrial habitats during the construction period:
  - Prior to the onset of construction, the area between km 8+090 and km 8+980 (railway) is cordoned off by a mobile amphibian barrier fence during the aquatic phase of crested newts. The mobile amphibian fence must be set up in the period from April to the beginning of May. This exclusion of the intervention area will be kept in the pertinent areas throughout the construction phase, and checks will be performed at regular intervals to ensure that it is functioning properly. The instructions given in MAmS (2000) must be observed (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.5).
  - The function of the woodlands along the B 207 and railway as a winter habitat for the crested newt, which is lost firstly through physical loss and secondly through the fence, is to be bridged near the bodies of water FAm162, FAm166 and FAm171 through the use of alternative wintering structures. During the construction phase, a row of (partly countersunk into the ground) prunings, roots, etc. partly countersunk into the ground (1 m) with gaps in it will be created in front of the amphibian protection fence (see above), which will provide a usable system of gaps and frost protection as a substitute winter habitat for crested newts. Each section of packed material must each be at least ten metres long and two metres wide and there must be no more than 25 m between them. The measure must be completed before the start of the terrestrial phase (from mid-July) in the year when the construction site is fenced off (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.5 as an avoidance/minimisation measure in line with species protection legislation).
  - The temporary winter shelters for great crested newts (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.5) must be dismantled in the aquatic phase (April to end of June) to avoid potential risk for newts in the "interim structures". If this is not possible, the interim structures must be fenced off during the aquatic phase to prevent them from being used again. As soon as the temporary winter substitute accommodation for the crested newt has been dismantled, to the east of the railway the material for creating a row of prunings, roots etc. with gaps in it will be permanently placed at the edge along an appropriate length of rail route as winter accommodation with the same level of quality as for the temporary winter accommodation (see above). The permanent winter hide-outs must be completed by mid-September of the year in which the temporary winter hide-outs are dismantled such that these are functional and can be reached by the local population (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.6 as an avoidance/minimisation measure in line with species protection legislation).

- Avoiding/ minimising the risk of killing and injuring the crested newt stock in water body FAm158 due to the planned construction on the water body:
  - 3 years before removal of the water body FAm158, the amphibian population in water bodies FAm158 as well as the two water bodies FAm162 and FAm166 with proven populations of Great Crested Newt within the species' radius of action should be caught, so as to prevent a possible migration from there to water body FAm158 (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.3).
  - Catching the crested newt population in water bodies FAm158, FAm162, FAm171 and FAm166 with subsequent filling of water body FAm158 Based on the newly obtained information gathered from the 2015 update mapping, the three bodies of water labelled FBioAm55, FAm160 and FAm164the three-year interception operation must also be included as these also contain great crested newts (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.3).
  - To shield the intervention area prior to the start of construction during the aquatic phase of the crested newt (and other amphibians), a mobile amphibian fence must be put up in order to reduce to an unavoidable minimum the risk of being killed or injured of all crested newt in the water bodies FAm158, FAm162, FAm166 and FAm171, which may use the intervention areas as land habitats around the water body FAm158. The mobile protection fence for amphibians will be built via Measure 3.5 (see above, LCP, Annex IA, Measure no. 3.5). Isolating the southern area of the project using a mobile amphibian safety fence, see (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 1.3.
  - In the year when the last capture operation is carried out in body of water FAm158 as much material as possible will be removed from the body of water (vegetation, plants that have not decayed or only partially decayed on the floor of the body of water) and deposited right next to the edge of the water as soon as the ice has melted. This improves the chances of successfully catching all of them. Resulting dangers for individuals must be eliminated by choosing the right time (no eggs or larvae yet) and proceeding with the appropriate care. Capture is considered complete when no crested newts (including all states) can be found or captured on a schedule capture day (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.3).
  - Immediately after the last scheduled capture day (when no newts are found), the body of water FAm158 should be filled in to prevent animals re-entering it and thereby preventing renewed danger (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.3).
- Erecting a buffer strip approximately 15 m in width above the cliff located at the edge of the areas used for the project (construction sites). This makes it possible to prevent soil compaction from occurring above the cliff as well as preventing impairments caused by the sections of the cliff edge falling off, thereby threatening its protected biotope status in accordance with § 30 BNatSchG in conjunction with § 21 LNatSchG and as an object of geological protection value (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 7.4).
- Semi-natural development of reclamation areas in the direction of coastal biotopes (development of soil by covering backfilled soil with a layer of sand, development of perennial vegetation on beaches, sandy/shingle beach, marram grass vegetation etc.).

Keeping areas open, if necessary using supportive maintenance measures, as biotopes typical of the landscape, as areas for birds which breed in open ground. Development of areas around the tunnel portal as open, dry grass and shrub corridor as passage to the coastal biotopes as part of the design concept (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 7.1).

- Avoiding the risk of killing/injuring the Ringed Plover during preparatory construction works in the area of the sand/pebble beach: Should construction start (including, inter alia, recovery of beach material, see LCP, Annex IA, Measure 7.3) within the ringed plover's breeding season (mid May - start of August), scaring measures should be undertaken to avoid construction-related deaths from the start of the breeding season (from mid May). A startling exercise must take place within the breeding period of the species in question (up to the start of August at the latest) and over the entire area of the beach section located to the south of the Puttgarden breakwater. This should take place constantly throughout the area used for the project in order to prevent the species from establishing a network of nests. Startling exercises take place as part of a sharp increase in visual impulses and a corresponding increase in the number of people entering the area. Checks for the presence of potential breeding birds are to be carried out in two- to three-day intervals. If the ringed plover (or any other potential breeding bird species such as oystercatchers) is found, disturbance-intensive startling tactics must be employed at least twice per day (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 7.5). If construction begins outside the breeding season (outside the period from mid May - early August), this measure need not be adopted.
- During the construction of the work harbour, the tunnel trench and the land reclamation areas sediments will be released in the marine area. In order to control the construction process in terms of avoidance and minimisation requirements, zone-dependent maximum sediment release rates for seasons and months are predefined, which may not be exceeded. Using the aforementioned sediment release rates by area and season (see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.2, Point. 8.2-1 and Table 8.2-1) ensures that the excavation work are carried out in such a way as to guarantee that impairments to protected biotopes/ biotope type in accordance with § 30 BNatSchG (in conjunction with. § 21 LNatSchG) and marine flora and fauna over the whole vegetation period caused by released sediments are prevented as much as possible and that the project-related impairments forecast in the impact assessment are not exceeded (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.2).
- Reducing the effects of disruption and preventing a barrier effect for the harbour porpoise during marine tunnelling work by limiting noise at > 144 dB at 20% to a maximum of 30% in the Fehmarnbelt (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.4).
- Minimising impairments to breeding and resting birds due to disturbances/noise or barrier effects and collisions during the construction phase (Tm3), impairments to breeding

and resting birds arising from turbidity and sedimentation, disturbing effects and impairments to the Harbour Porpoise arising from barrier effects in the Fehmarnbelt:

- Limiting the working area at a given moment: In the whole Fehmarnbelt, two work areas will be operated simultaneously using fixed equipment, with a free-moving excavator outside the working area. In addition, compared to the normal working area a smaller working area will be used in the region of the German EEZ and/or the Fehmarnbelt Natura 2000 site DE 1332-301 and/or in the area of the T route. This permits minimisation of disruptive effects on resting areas and feeding grounds for resting and migrating birds in the Fehmarnbelt area by avoiding substantial barrier effects on bird migration from construction ships and associated light and sound immissions, as well as minimising the risk of collision of birds with construction ships (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure No. 8.4).

- Potential impairment / risk of injury for harbour porpoise individuals due to noise due to ramming/piling work that may be necessary for sheet piles in the work harbour at Puttgarden:
  - The piles will be driven using a ramp-up procedure in which the pile driving energy increases gradually, so that the maximum sound levels are not immediately reached and animals can distance themselves from the area close to where piles are being driven. The ramp-up procedure should extend over a period of approx. 10 minutes.
  - As a precaution, during the period when any pile driving that may be needed for sheet piling is taking place, pingers should be used as an avoidance measure in line with species protection legislation to scare harbour porpoises from the close vicinity of the pile driving. The use of pingers (e.g. "Aquamark 100") will scare them away over a range of 100 - 200 m. For this purpose, 4 pingers are to be set out in a semicircle around 300 m away from the pile driving location (see
  - Noise emissions will be monitored at a measuring point at a distance of 750 m from the pile driving work using a hydrophone on the first day driving activities are carried out. Data will be evaluated directly on site and sent to the approval authorities. These measurements will be taken in accordance with the measurement specifications laid out for underwater sound measurements by the Schleswig-Holstein authorities (BSH 2011) (LCP, Attachment 12 of the plan approval documents,, Annex IA, Measure no. 8.1).
- Minimisation measures for spotlighting and illumination of tugboats which must, however, only be carried out while considering work and vessel safety (avoiding illuminating water surfaces in order to carry out construction activities as much as possible; avoid using skyward-facing spotlights with appropriate guards; switch off ground-facing lighting on ships as soon as possible and switching off spotlights in bright conditions.
- In order to prevent birds from colliding, work lights on board ships must be switched off while birds are migrating over the Fehmarnbelt and during temporary misty periods when necessary. In order to recognise the weather conditions, an authorised environmental construction supervisor (an ornithologist) will support the operation (cf. Attachment 22.8 of the plan approval documents, Section 5.4.3 and LCP, Attachment 12 of the plan approval documents, Annex IB, concept sheet 22.8). This consultant will produced a daily risk prognosis for day and night conditions during the main migration period in Spring and Autumn. This shall correspond to expected weather conditions and expected bird migration. When risky weather conditions are present, there must be an

ornithologist on site who can ensure that work lighting is switched off and work interrupted. Ship crews must receive instruction before they are deployed on the project, informing them about this situation (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.5).

- Damage-limiting measures for Natura 2000 sites
  - To avoid construction-related impairments/disturbances to marine mammals, resting and migrating birds in the neighbouring Natura 2000 regions (Tm6), the sand dredging construction ships are to give a wide berth to SCI DE 1251-301 "Adlergrund" and the Bird Conservation Area DE 1552-401 "Bay of Pomerania". They are to keep at least 1 nautical mile (1nm) from the Natura 2000 sites. In this way, disturbances that may be caused by planned shipping traffic to the species described in Annex II of the Habitats Directive as conservation objectives (Harbour Porpoise, Grey Seal) in the "Adlergrund" Protection Area, and to bird varieties listed as conservation objectives in the Protection Area DE 1552-401 "Bay of Pommerania" can be avoided (c.f. LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 8.8; c.f. also Attachment 19 of the plan approval documents, part B VI and B VII).
- To avoid temporary disturbances to resting and migrating birds in the SCI DE 1733-301 "Sagas Bank", the planned compensation measure of reef production is to take place outside the resting and wintering areas of migrating and resting birds in the Sagas Bank area from 15.10 to 15.04..

### 5.2.2.5. Landscape/scenery

- Landscape Integration of route from the start of construction up to chainage-km 10+130 into the agricultural landscape, integration with the southwest of Puttgarden and in the direction of Marienleuchte (at the road connecting Puttgarden with Marienleuchte) through design measures from the design concept with grass and shrub corridors (measure 0.2) to minimise the impairments on the landscape in the agricultural landscape and adjacent towns. Other measures to develop large-scale and linear woodland structures should be seen as compensatory measures (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 1.1, 1.2, 2.2, 3.1, 3.2, 3.9, 5.1, 5.2, 5.4).
- Design of a natural-looking section of beach in the east of the reclamation areas. Development of reclamation areas into coastal biotopes as natural as possible with soils and vegetation typical of the landscape. Keeping areas open, if necessary using supportive maintenance measures, as biotopes typical of the landscape and to preserve views of the Baltic Sea (Attachment 12 of the plan approval documents, Annex IA, Measure no. 7.1). Development of areas around the tunnel portal as open, dry grass and shrub corridor as a passage to the coastal biotopes during the course of the development concept (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 7.1).

### 5.2.2.6. Climate/air

- Dust reduction measures on the construction site (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.10).

#### 5.2.2.7. Cultural heritage and other material assets

- Advance studies and/or protection measures in coordination with the State Archaeological Department of Schleswig-Holstein before and during the construction phase to prevent impairments on potential archaeological finds.
- In the marine area, preparations must be made for protection measures for the historically significant shipwreck off the German coast in the form of dives and studies into the timbers and protection measures must be undertaken, e.g. installation of a protective zone around the wreck (approx. 200 m) and complete coverage to protect the wreck (sand/stone covering or marram grass mats) and monitoring undertaken during construction.

#### 5.2.2.8. Other technical precautions against preventable impairments

(Technical) measures that go beyond those in the previous sections for preventing and minimising negative impacts are listed below:

**Lowering of groundwater level during construction phase**

The areas directly affected onshore by the construction measure are described and balanced in the LCP as an impact limit. The areas needed for construction, e.g. as a construction site, construction roads, storage areas for road construction materials, temporary soil depot, etc. are defined with the limit of the land needed for construction and which are also included in the balance.

No other land outside of these areas shall generally be used. If, however, more areas are needed as part of implementation planning or during construction, existing sealed areas or fields should be used if possible for environmental reasons. By determining the function and significance of individual environmental factors, areas can be identified for exclusion from use for construction (taboo areas). The following criteria are used to identify taboo areas: settlement areas, recreation areas and surrounding residential areas, all legally protected biotopes in accordance with Article 30 BNatSchG in conjunction with Article 21 LNatSchG (including avenues of trees, hedgerows, reeds and hedges), all (lying outside of previous impact areas) beach areas, other biotopes with a high and very high nature conservation value, faunistic functional areas with high and very high significance, biotope network areas, geotopes with special significance such as cliffs, coastal raw soils and fen soils with special significance, strip protected by law for waterways (100 m toward land from the coast line of the Baltic Sea in accordance with Article 35 LNatSchG), ditches and small bodies of water with 5 m strips along their shores, landscape patterns of high overall sensitivity in the landscape, cultural heritage and material assets with very high and high significance.

**Precautions on protecting and monitoring the onshore area during the construction phase**

Precautions on protecting and monitoring the onshore area during the construction phase are guaranteed by the following protection and monitoring concepts (Attachment 22 of the plan approval documents):

- Attachment 22.1: Volume management- (part 1) and soil protection concept (part 2) - onshore section
- Attachment 22.2: Noise reduction concept (onshore)
- Attachment 22.3: Vibration monitoring concept (onshore)
- Attachment 22.4: Light management concept (onshore section)

The protection and monitoring measures and precautions listed below can be found in the following documents:

- Tree and woodland protection measures; protection of valuable vegetation: see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.4.
- Amphibian fences erected during the construction phase to protect amphibians: (see article on species protection, Attachment 21 and LCP, Attachment 12 of the plan approval documents, Volume IA, Measures no. 1.3 and 3.5.
- Coastal water protection: see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.11.
- Soil protection and volume management: see Attachment 22.1 of the plan approval documents and LCP, Annex IB, concept sheet no. 22.1 and LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.3 (dismantling necessary onshore seals and eliminating soil compaction following the construction phase), Measure no. 0.5 (pavement removal and removal of material resulting from said pavement removal); Measure no. 0.8 (storing and re-use of top soil and mineral soil from on shore and marine excavation); Measure no. 0.10 (soil protection when creating and operating construction sites); Measure 7.1 (construction of reclamation areas using excavated marine soil and a permeable layer of soil); Measure no. 7.3 (professional temporary storage of the sand used for the cut-and-cover tunnel to be reintroduced to a new beach at a later stage as part of the reclamation area).
- Noise reduction: see Attachment 22.2 of the plan approval documents and Annex IB, concept sheet no. 22.2 and LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.13 (minimising noise emissions during the construction phase).
- Vibration monitoring concept: see Attachment 22.3 of the plan approval documents and LCP, Annex IB, concept sheet no. 22.3 and LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.13 (monitoring vibration emissions during the construction phase).
- Reducing light emissions, light management: see Attachment 22.4 of the plan approval documents and LCP, Attachment 12 of the plan approval documents, Annex IB, concept sheet no. 22.4 and LBP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.12 (minimising the impact of lighting from onshore construction sites).

### Precautions on protecting and monitoring the marine area during the construction phase

The main precautions on protecting and monitoring the marine area during the construction phase are listed below. The content of the protection and monitoring measures and precautions listed below can be found in the following documents.

- Soil protection and volume management: see Attachment 22.1 of the plan approval documents and LCP, Annex IB, concept sheet no. 12 and LCP, Attachment 22.1 of the plan approval documents, Annex IB, concept sheet no. 22.1 and LCP, Annex IA, Measure no. 0.8 (storing and re-using excavated marine material).
- Reducing light emissions, light management: see Attachment 22.4 of the plan approval documents and LCP, Annex IB, concept sheet no. 12 and LCP, Attachment 12 of the plan approval documents, Annex IB, Concept sheet no. 22.4 and LCP, Annex IA, Measure no. 8.5 (minimising the impact of lighting from tugboats).
- Noise protection concept – underwater noise: see Attachment 22.5 of the plan approval documents and LCP, Attachment 12 of the plan approval documents, Annex IB, concept sheet no. 22.5 and LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.1 (minimisation measures during pile driving activities to protect marine mammals) and Measure no. 8.4 (reducing the impact of disruptions and preventing a barrier effect for the harbour porpoise during marine tunnelling activities).
- Concept for controlling and checking sediment release: see Attachment 22.6 of the plan approval documents and LCP, Attachment 12 of the plan approval documents, Annex IB, concept sheet no. 22.6 and LBP, Annex IA, Measure no. 8.2 (measures on managing and controlling sediment release); Measure no. 8.3 (measures on managing and controlling sediment release in relation to bathing water quality).

*Supplementary explanations of the measures for controlling and checking sediment release*

To control the release of sediments during the construction of the immersed tunnel, excavation and backfilling work will be monitored and controlled in the marine area during the entire construction period. To achieve this goal, environmental construction supervision is planned with support from a working group of Danish and German authorities as well as project developers and their expert assessors.

The marine excavation and backfill work shown in the environmental impact assessment report and Attachment 27 are based on a specific and realistic construction process according to the current planning level whereby all work during creation of the working harbour, the tunnel trench, the reclamation areas and backfill of the tunnel trench once the tunnel elements are immersed could result in sediment release. This construction process requires certain excavation and backfill methods and a specific schedule that leads to a projected release rate of sediment in space and time.

Figure 43 shows the zones that are defined for determining the sediment release rates to be complied with in the Fehmarnbelt. The area where the excavation and backfill work will be carried out is divided into eight zones. The results of the environmental impact assessment were taken into account to define the zones. For each of the eight zones, the sediment release rates to be complied with are indicated depending on the season and thus the framework to be complied with specified for any further planning of the construction for excavation and backfill work. Table 75 shows the quantities of sediment to be released in tons. The quantities for sediment release specified in cubic metres in the environmental impact assessment were converted here to tons. The conversion takes into account the specific volume weights of the various sediment types affected.

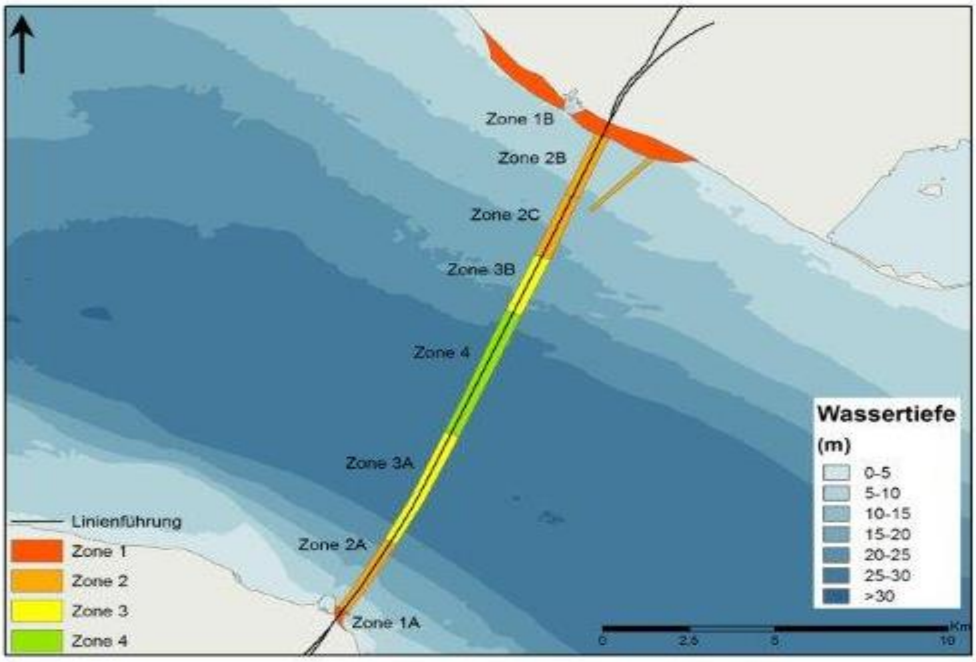



**Figure 43 Geographical demarcation of areas to establish the appropriate sediment release rates- as a result of excavation and refill works carried out in the Fehmarnbelt**

| | |
|---|---|
| Linienführung | Alignment |
| Wassertiefe | Water depth |

**Zone 1A:** **Reclamation area and working harbour on Fehmarn**

**Zone 1B:** **Reclamation area and working harbour on Lolland**

**Zone 2A:** **Tunnel trench near the coast off Fehmarn up to 2.7 km away from the land reclamation**

**Zone 2B:** **Tunnel trench and channel near the coast off Lolland up to 2.2 km away from the land reclamation**

**Zone 2C:** **Tunnel trenches between 2.2 and 4.4 km away from Lolland's land reclamation**

**Zone 3A:** **Tunnel trenches between 2.7 and 6.7 km away from Fehmarn's land reclamation**

**Zone 3B:** **Tunnel trenches between 4.4 and 6.5 km away from Lolland's land reclamation**

**Zone 4:** **Central section of the tunnel trench and 6.5 km and 6.7 km away from the Danish and German land reclamation/coast**

## Table 75 Sediment release rates to be complied with by zone and season (in t):

| Zone | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1a | max per month | 8.100 | 8.100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8.100 | 8.100 | 8.100 |
| | max winter | 8.100 *) | | | | | | | | | 8.100 *) | | |
| 1a | max summer | | | | | | 0 | | | | | | |
| | max spring + summer | | | 0 | | | | | | | | | |
| | max per year | 8.100 | | | | | | | | | | | |
| | max total | 8.100 | | | | | | | | | | | |
| 2a | max per month | 85.000 | 85.000 | 10.000 | 10.000 | 10.000 | 0 | 0 | 0 | 14.000 | 85.000 | 85.000 | 85.000 |
| | max winter | 85.000 *) | | | | | | | | | 85.000 *) | | |
| 2a+1a | max summer | | | | | | 0 | | | | | | |
| | max spring + summer | | | 6.206 | | | | | | | | | |
| | max per year | 89.502 | | | | | | | | | | | |
| | max total | 110.381 | | | | | | | | | | | |
| 3a | max per month | 42.000 | 42.000 | 74.000 | 74.000 | 74.000 | 8.400 | 8.400 | 8.400 | 74.000 | 42.000 | 42.000 | 42.000 |
| | max winter | 120.000 *) | | | | | | | | | 120.000 *) | | |
| 3a+2a+1a | max summer | | | | | | 8.412 | | | | | | |
| | max spring + summer | | | 85.815 | | | | | | | | | |
| | max per year | 208.635 | | | | | | | | | | | |
| | max total | 294.992 | | | | | | | | | | | |
| 4 | max per month | 76.000 | 76.000 | 53.000 | 53.000 | 53.000 | 53.000 | 53.000 | 53.000 | 53.000 | 76.000 | 76.000 | 76.000 |
| | max winter | 180.000 *) | | | | | | | | | 180.000 *) | | |
| 4+3+2+1 | max summer | | | | | | 269.041 | | | | | | |
| | max spring + summer | | | 512.754 | | | | | | | | | |
| | max per year | 792.407 | | | | | | | | | | | |
| | max total | 1.227.560 | | | | | | | | | | | |
| 3b | max per month | 42.000 | 42.000 | 42.000 | 42.000 | 42.000 | 42.000 | 42.000 | 42.000 | 50.000 | 42.000 | 42.000 | 42.000 |
| | max winter | 75.000 *) | | | | | | | | | 75.000 *) | | |
| 3b+2c+2b+1b | max summer | | | | | | 189.280 | | | | | | |
| | max spring + summer | | | 355.590 | | | | | | | | | |
| | max per year | 486.634 | | | | | | | | | | | |
| | max total | 680.673 | | | | | | | | | | | |
| 2c | max per month | 50.000 | 50.000 | 97.000 | 97.000 | 97.000 | 97.000 | 97.000 | 97.000 | 97.000 | 50.000 | 50.000 | 50.000 |
| | max winter | 50.000 *) | | | | | | | | | 50.000 *) | | |
| 2c+2b+1b | max summer | | | | | | 147.354 | | | | | | |
| | max spring + summer | | | 313.664 | | | | | | | | | |
| | max per year | 420.227 | | | | | | | | | | | |
| | max total | 550.302 | | | | | | | | | | | |
| 2b | max per month | 85.000 | 85.000 | 97.000 | 97.000 | 97.000 | 6.400 | 6.400 | 6.400 | 97.000 | 85.000 | 85.000 | 85.000 |
| | max winter | 85.000 *) | | | | | | | | | 85.000 *) | | |
| 2b+1b | max summer | | | | | | 39.098 | | | | | | |
| | max spring + summer | | | 205.408 | | | | | | | | | |
| | max per year | 311.971 | | | | | | | | | | | |
| | max total | 427.360 | | | | | | | | | | | |
| 1b | max per month | 40.000 | 40.000 | 37.000 | 37.000 | 37.000 | 29.000 | 29.000 | 29.000 | 18.000 | 40.000 | 40.000 | 40.000 |
| | max winter | 100.000 *) | | | | | | | | | 100.000 *) | | |
| 1b | max summer | | | | | | 32.730 | | | | | | |
| | max spring + summer | | | 81.232 | | | | | | | | | |
| | max per year | 135.505 | | | | | | | | | | | |
| | max total | 245.171 | | | | | | | | | | | |

*) the figure is the maximum spill in any consecutive period October - February.

**1. Maximum monthly sediment release**
**2. Maximum sediment release during the winter period, October – February**
**3. Maximum sediment release during the summer period, June – August**
**4. Maximum sediment release during the spring and summer period, March – August**
**5. Maximum annual sediment release**
**6. Maximum sediment release during the entire construction phase**

The sediment release rates to be complied with relate to the individual zones and seasons.

The sediment release rates to be complied with for the "summer" and "spring and summer" periods and the annual sediment release rates to be complied with and those during the entire construction phase are indicated as a total, whereby the maximum sediment spillage

- in Zone 2a includes the total release in Zones 1a and 2a;
- the maximum sediment spillage in Zone 2b includes the total release in Zones 1b and 2b;
- the maximum sediment spillage in Zone 2c includes the total release in Zones 1b, 2b and 2c:
- the maximum sediment spillage in Zone 3a includes the total release in Zones 1a. 2a and 3a;
- the maximum sediment spillage in Zone 3b includes the total release in Zones 1b, 2b, 2c and 3b:
- the maximum sediment spillage in Zone 4 includes the total release in Zones 1a, 2a, 3a, 1b, 2b, 2c, 3b and 4.

As shown in Table 75, Zones 1a, 2a, 3a and 4 are located partially on German sovereign territory. Zones 1b, 2b, 2c, 3b and 4 are located partially on Danish sovereign territory.

Table 75 assumes a maximum sediment release of a total of 1,227,560 tons during the entire construction phase in all zones which may not be exceeded. For the individual zones, maximum release rates related to individual months are always indicated and a maximum total release rate during the winter period. The sediment release rates to be complied with for the "summer" and "spring and summer" periods and the annual sediment release rates to be complied with and those during the entire construction phase are indicated as totals which ensures that the advancing dredging work on land is always consistent with the permitted zonal release rates, both per year and for the entire construction phase. The maximum sediment release of 1,227,560 tons is distributed within the individual zones depending on the season and month whereby the maximum rates are always indicated.

For Zones 1a and 2a, it is ensured by means of the sediment release rates specified in Table 75 that the quality of bathing water is not negatively impacted in the designated bathing areas "Grüner Brink" and "Presen" during the summer months (also taking tourism concerns into consideration). Impairments to protected biotypes/biotope types in accordance with § 30 BNatSchG (in conjunction with Article 21 LNatSchG) and marine flora and fauna caused by released sediment is also prevented to the extent possible during the vegetation period. As a result, no excavation work which causes sedimentation to create the working harbour and the subsequent reclamation area will take place in the marine area of Zone 1a in the months from March to September. Dredging work which causes sedimentation will not take place in Zone 2a in the summer months from June to August.

Overall, the sediment release rates specified, on the one hand, take account of the avoidance and minimisation requirement stipulated in nature conservation laws and, on the other, the construction activities can be carried out flexibly depending on the actual currents and weather conditions, the construction equipment to be used and the actual construction start taking in to account the specified release rates for the individual zones.

The compliance of the aforementioned sediment release rates during the construction activities is controlled as part of a self-monitoring exercise performed by the building contractor on compliance with the planned and approved boundaries (see Attachment 22.6 of the plan approval documents and LCP, Annex IB, Concept sheet no. 22.6, with a description of the fundamental methodological procedures, measurement processes, numerical calculations and reporting). The environmental construction supervision in turn is carried out jointly with the construction management team and ensures that the contractor carries out the construction works as part of the approved values (see Attachment 22.8 of the plan approval documents, Section 5.4.1 and LCP, Attachment 12 of the plan approval documents, Annex IB, concept sheet No. 22.8).

# 6. Residual project impacts on environmental factors

The residual, unavoidable and significant impairments in the sense of impact regulation are mapped on the basis of the impacts depicted in the LCP, Section 12 of the plan approval documents Section 8, and under consideration of the avoidance and minimisation measures (see LCP, Attachment 12 of the plan approval documents, Sections 5 and 7). For a detailed description, please refer to Section 8 of the LCP (Attachment 12 of the plan approval documents).

The various losses of area from various impact limits on land and at sea are listed in Table 76 by way of an overview.

**Table 76 Overview of losses of area in the various impact zones of the FBFL on the German side, split into land area (Fehmarn) and marine area (coastal waters and EEZ)**

| Area | Installation-dependent impact zone, permanent (ha) | Construction-dependent impact zone, temporary (ha) | Anchoring zone (ha) (losses on 2.5 % of anchoring zone, temporary) * | Total (ha) |
|---|---|---|---|---|
| Land on Fehmarn | 62,0092 | 59,4980 | - | 121,5072 |
| German coastal waters | 92,5076 | (see details under anchoring zone) | 13,0997 | 105,6073 |
| German EEZ | 55,3868 | (see details under anchoring zone) | 12,0257 | 67,4126 |

* According to technical calculations, 2.5% of the area in the anchoring zone will be temporarily destroyed by anchoring. The remaining 97.5% is not affected by anchoring (also refer to details for benthic habitats and seabed in LCP, Attachment 12, Section 11).

## 6.1. Human beings

### Island of Fehmarn

Physical structures and the use of land for construction work close to residential areas will result in slight losses of land surrounding residential areas near Marienleuchte and Puttgarden. All in all slight impairments to land surrounding residential areas will remain. Taking into consideration average-value areas with existing impairments, residential areas in towns and villages adjacent to the railway track and the E 47 (Todendorf, Puttgarden, Bannesdorf and Marienleuchte), should expect an increase in disturbance in the range of 49 dB(A) for the daytime isophone (see LCP, Attachment 12 of the plan approval documents, Section 8.1.1). For the area particularly suitable for recreation near Marienleuchte and around residential areas, the additional disturbances from noise will cause impairments.

Since the aspect of human beings is not subject to impact regulation, compensation is not needed in this respect.

Monitoring exercises on noise and vibration emissions during the construction phase (LCP, Attachment 12 of the plan approval documents, Annex IB, Concept sheets no. 22.2 and 22.3 and Annex IA, Measure 0.13).

**Marine area**

No significant impairments remain on the German side for human beings and/or recreation in the Fehmarnbelt. In particular, the aforementioned sediment release rates did not cause any impairment to the bathing water quality in the indicated bathing areas on Fehmarn (while also taking tourism concerns into consideration, cf. LCP, of the plan approval documents, Annex IA, Measure 8.3).

## 6.2. Soil

### Island of Fehmarn

*Building on, destruction of and/or changes to accumulated soils and geomorphological formations (installation-dependent, B1)*

- Permanent impairment on soil and its functions on 62.0092 **ha** (impact limit) resulting from construction of road and railway and installation of maintenance facilities (of which 54.9593 ha are soils of particular significance [Fehmarn black earth, beach ridge] and 8.51 ha are soils with existing impairments [existing road embankments including 2.25 ha of sealed surfaces]).
- **New ground sealing** on a total of 18.4596 **ha** (of which 17.6333 ha are of particular significance and one section of cliff (geomorphological object) of 0.0370 ha).

*Changes to accumulated soils from ground sealing, compaction and addition/removal of soils (construction-dependent, B2)*

- **Temporary impairments on soil functions** within the limit of the land used for construction on 59.4980 ha, of which 42.5299 ha are < 5 years (of which 38.6627 ha are soils of particular significance), 16.9681 ha ≥ 5 years, of which 16.8682 ha are soils of particular significance.

*New pollution/impairment on soil due to pollutant and nutrient input within the impact zones (operation-dependent, B3)*

- in total, impact zones 1 and 2: 3.4032 ha, of which 3.1313 ha makes up soil of special significance.
- Impairments on the soil due to pollutant and nutrient input near the impact zones (see Plan no. 3 LCP, Attachment 12)
- Impairments on the soil due to pollutant emissions decrease with distance from the emission site.

### Marine area

*Impairments in relation to the seabed (construction- and installation-dependent, Bm1)*

- Installation-dependent use through reclamation of land and the raised layer protruding from the seabed protecting against collisions with ships and erosion in the coast area and the tunnel elements on a total area of **35.8842 ha of seabed** of general significance (new ground sealing).
- The partial sealing of the seabed of particular importance in the realm of tunnel elements, covers 29,2581 ha; and of the seabed of general importance in the realm of tunnel elements covers 7,0762 ha.
- In the long term, **20.1375 ha of seabed** of particular significance will be impaired by the tunnel trench and their filling with debris.
- Construction-dependent use for anchoring within the anchoring zone of **19.4166 ha of seabed with seabed geometries**.

*Impairments in relation to coastal morphology (construction- and installation-dependent)*

- Loss of one section of coast between the ferry harbour and Marienleuchte through the creation of reclaimed land to the east of the harbour breakwater.

## 6.3. Water

### 6.3.1. Island of Fehmarn

*Loss of surface waters of particular significance (W1)*

- Loss of a total of 0.1627 **ha of small bodies of water** due to construction (protected small body of water of particular significance near the planned Puttgarden exit, protected small body of water near the Presen wind farm, two small bodies of water near the tunnel portal, two small bodies of water near the K 49 within the land used for construction and at the new harbour link).
- Several **sections of ditches** with a total length of 624 **m** near the Drohn and Nieland ditches will be built on.
- Between ferry harbour Puttgarden and Marienleuchte, there are impairments of water protection areas that are protected under Section 61 BNatSchG in conjunction with Section 35 LNatSchG. In an approximately 100-metre long section of the coast (3.3400 ha), the water protection area will be impaired by the tunnel construction, working harbour and backfilling area.

*Additional dissection of waterways (W3)*

- Additional dissections in the route area around the Nieland ditch (near start of road construction) and the Drohn ditch (north of Puttgarden junction).

### 6.3.2. Marine area

No impairments remain for the hydrography and water quality in the marine area.

### 6.3.3. Summary of the water legislation specialist contribution

In a separate water legislation specialist contribution (Attachment 20 of the plan approval documents), the activities and measures pertaining to the construction and operation of the FBFL are shown and described as well as the potential impact resulting from said activities and measures on the waters in the application scope of the project. These impacts will be assessed using the national water legislation provisions on prohibiting deterioration and encouraging improvement. These provisions are implemented by the Water Framework Directive (WRRL) and the Sea Strategy Directive (MRSL). The presentation and assessment differ between those waters located in the marine area (coastal and territorial waters according to the WRRL and maritime waters according to the MRSL), and watercourses in addition to groundwater on the island of Fehmarn.

While the management goals according to the WRRL are contingent for the project to be approved, it is possible that the MRSL provisions are only target objectives which must be considered alongside other requirements during specialised planning and may be overcome. IT is evident that thus far neither case law nor legal literature addresses the issue of commitment to project authorisation in the MRSL. Therefore, it cannot be understood from the water legislation contribution that the goals for managing coastal waters have the same binding effect on authorisation of the FBFL as do the WRRL management goals.

#### 6.3.3.1. Activities and measures for construction and operation of the FBFL

In order to construct the FBFL, various activities and measures are required. Before the construction works themselves are carried out (excavation works for the dredged tunnel trench as well as sinking and backfilling the tunnel elements), a working harbour, temporary construction sites and a temporary stockpile must be constructed.

A seawater desalination plant will be used to supply water to the construction site. The water used to operate this facility will be drawn from the Baltic Sea surrounding the working harbour. 252 $m^3$ per day of leftover water from the desalination process will be fed back into the Baltic Sea through an outlet pipe located on the east pier of the working harbour.

A trench will be excavated between Fehmarn and Lolland to construct the tunnel. The excess soil resulting from this excavation will be used, inter alia, to create a reclamation area in front of Fehmarn. The reclamation areas will be constructed to the east of Puttgarden harbour. This reclamation area will be permanently present.

After the tunnel trench has been excavated, the individual tunnel elements will be immersed in the trench. The temporarily stored sediment will be removed from the trench before the tunnel elements are immersed and an underlay made from gravel will be laid. Once a tunnel element is immersed and correctly positioned, a locking fill made from gravel is attached. The remaining section of the trench will then be filled later with sand.

A protection layer made of larger stones will also be added on top of and to the side of the tunnel elements. The depth of the tunnel was selected to ensure that, with the exception of the coastal area, the stone protection layer and the lateral fill with sand is always located beneath the level of the existing seabed.

While the construction works are being carried out and the FBFL is in operation, different bodies of water will be used in order to carry away waste water created in the project area. Various drainage sections and systems are planned to drain the FBFL's rail line, road, ramp, tunnel, portal area and sewage drainage. A drainage zone (ramp section, portal area, part of the north sheet drainage) will feed into the Baltic Sea. The discharge point will be located to the west of the reclamation area. The discharge quantity shall not exceed 654 litres/second. Two more drainage zones lead into the Todendorf ditch/ Bannesdorf ditch on Fehmarn. Two separate discharge points will be built for this purpose.

#### 6.3.3.2. Environmental pressures caused by activities and measures

The water legislation contribution identifies the impacts which may be caused by the aforementioned activities and measures employed during the construction and operation of the FBFL and the effects they may have on bodies of water (hereinafter: environmental pressures). It is forecast that the following environmental pressures may be caused by the construction and operation of the FBFL:

- Environmental pressures caused by the presence and use of building machinery (ships, cranes, excavators etc.): light, noise, barrier development, non-resident species, collision, drainage. These are project-related environmental pressures which may be caused by building machinery and which, once the works in question have been completed and at the latest once the machines have been removed, will have no further impact on waters.
- Environmental pressures caused by construction measures: Suspended materials, sedimentation and impacts on groundwater These environmental pressures may lead to oxygen depletion and the entry of foreign elements.
- Environmental pressures caused by construction activities and the resulting and used structures: Footprint, drainage, electromagnetic fields. These environmental pressures may cause the following impacts: Changes to the hydrography, seabed and coastal morphology or the amount of hard substrate in the sea.

#### 6.3.3.3. Thematic and geographic classification

The environmental impacts will arranged according to thematic and geographic classification. As part of the classification, those environmental pressures which, because of their magnitude, require a water legislation-related assessment will be identified.

At the same time, those environmental pressures will be identified which have a very low likelihood of having any future impact on the current condition or the objective of achieving good conditions of a body or region of water (thematic classification). In addition, those bodies and areas of water will be identified for which it is clear from the outset that the FBFL project will cause no environmental pressures (geographical classification).

A water legislation assessment is not required for a thematically classified environmental pressure. The same applies to environmental pressures where it is established that it cannot have any impact on a specific body or area of water. In both cases, the article on water law does not require a water legislation assessment.

### Thematic classification of environmental pressures

According to the thematic classification, the following environmental pressures remain, which are relevant to the representation and water legislation assessment of the effects on the management goals for the Todendorf/ Bannesdorf watercourse ditch:

- Footprint
- Nutrient inflow

According to the thematic classification, the following environmental pressures remain, which are relevant to the representation and water legislation assessment of the effects on coastal and territorial waters:

- Footprint
- Suspended sediments
- Sedimentation
- Nutrient inflow
- Decrease in oxygen content

To conduct the water legislation assessment of the impacts on the environmental condition and environment objectives for the territorial waters of the German section of the Baltic Sea, the following environmental pressures remain according to the thematic classification:

- Footprint
- Barrier effect
- Suspended sediments
- Sedimentation
- Nutrient inflow
- Decrease in oxygen content
- Collision
- Light and noise

The thematic classification leads us to the conclusion that, for the environmental pressure of groundwater impacts, there is a very low likelihood that these will have any future impact on the current condition or the objective of achieving good conditions for groundwater. A water legislation assessment is not required for a this environmental pressure.

### Geographic classification of environmental pressures

The geographic classification means that the impacts of the project on six coastal water bodies and a specific area of the coastal waters must be assessed.

- The relevant environmental pressures in the coastal water bodies of the Fehmarn Belt, Orth Bay, Putlos, Fehmarnsund, Hohwacht Bay and Fehmarnsund East must be assessed in accordance with water legislation.
- With regard to territorial waters, the relevant environmental pressures are assessed out to a maximum range of 25 km (beeline) of the FBFL. For a relevant assessment, the assessment range corresponds to the maximum extent of the farthest reaching environmental pressures, sedimentation and suspended sediment.
- For the territorial waters of the German section of the Baltic Sea, the examination area, in accordance with § 45a, Para. 3 WHG is the German section of the Baltic Sea in its entirety.

### 6.3.3.4. Deterioration prohibition and improvement requirements for the Todendorf/ Bannesdorf ditch watercourses

#### Status description

The starting point for carrying out an assessment of the FBFL in accordance with deterioration prohibition and improvement requirements are the ecological and chemical status of the Todendorf/ Bannesdorf ditch watercourse.

The management plan (MP) encompasses the Todendorf/ Bannesdorf ditch as so-called altered bodies of water, with an ecological potential assessed as being "moderate" (MP, Map 4.2). The chemical condition of the body of water is classed as not good (MP, Map 4.3).

#### Deadline extensions

The MP provides for a deadline extension up to 2021 for the objectives of achieving a good ecological potential and a good chemical condition (MP, Maps 5.1 and 5.2).

#### Assessment of the consequences

On the basis of the status description the article on water law forecasts how the environmental pressures may impact the watercourses/ bodies of water (impact assessment). On this basis, it will be investigated whether the environmental pressures identified might cause conditions in the body of water to deteriorate. It will also be assessed whether the project is compatible with the improvement requirements for this watercourse.

*Deterioration prohibition*

The environmental pressures caused by the project will not have any future impact on the ecological potential of the Todendorf/ Bannesdorf ditch water course/ body of water. From the outset, the possibility that the environmental pressures will change the condition of the quality components, to the extent that these will be classed as having worsened in the future, is ruled out. It is also ruled out from the outset that the FBFL will have future impairments on water functions. With regard to the current ecological potential, the project does not violate the water legislation deterioration prohibition. It is forecast that the environmental pressures may lead to an improvement in certain quality components e.g. the condition of the quality components macrophytes/ phytobenthos.

The same applies to the chemical condition. Likewise the environmental pressures caused by the FBFL will not have any future impact on the chemical condition of the watercourse. It is also ruled out from the outset that there will be any future impairments to water functions from a chemical perspective. The environmental pressures will not lead to the relevant environmental quality norms being exceeded. With regard to the chemical condition, the project does not violate the water legislation deterioration prohibition.

*Improvement requirement*

According to the MP, the good ecological potential should be adjusted after 2021 i.e. until 22.12.2027. The project will not endanger the achievement of this objective. The project is compatible with the water legislation improvement requirements with regard to a good ecological potential. Some of those project impacts which affect the hydromorphological, chemical and general physical-chemical quality components, may contribute to an improvement in the ecological potential of the water body. Additionally, the project will have no future impact on the goal of achieving a good chemical condition in the water body by 22.12.2027.

#### 6.3.3.5. Deterioration prohibition and improvement requirements for coastal and territorial waters

With regard to the environmental pressures, the article on water law assesses whether the forecasted impacts are compatible with the deterioration prohibition and improvement requirement for coastal and territorial waters separately.

**Status description**

The starting point for carrying out an assessment of the FBFL in accordance with deterioration prohibition and improvement requirements are the ecological and chemical condition of the territorial water bodies of the Fehmarn Belt, Orth Bay, Putlos, Fehmarnsund, Hohwacht Bay and Fehmarnsund East and the chemical condition of the territorial waters.

*Ecological condition of coastal waters*

Evaluation of the condition of surface waters in the MP shows a moderate ecological condition for the bodies of water under consideration in the investigation area.

*Chemical condition of coastal waters*

In the MP, the chemical condition of the coastal waters/ water bodies is classed as "not good". A reason put forward for this was that the environmental quality norms for mercury in fish and in national and coastal waters have been exceeded.

*Chemical condition of territorial waters*

The MP classes the chemical condition as "not good". The reason for this is the extremely high concentration of mercury found in fish in the coastal waters/ water bodies.

## Deadline extensions

In order to assess whether the FBFL is compatible with the objectives of achieving a good condition for coastal and territorial waters (improvement requirement), it depends significantly on when this objective needs to be achieved by.

*Deadline extensions for good ecological condition of coastal waters*

The MP describes how the FGE Schlei/Trave deadlines extensions up to 2021 must be taken into account for all coastal waters/ water bodies. In order to carry out a water legislation assessment for the project, it is assumed that the good ecological condition of the coastal waters/ water bodies under consideration need not continue until 2021. The objective of a good ecological condition must be achieved by the end of the next management period, i.e. 22/12/2027.

*Deadline extensions for good ecological condition of coastal waters*

The MP contains deadline extensions for the good chemical condition. The MP describes the FGE Schlei/Trave deadlines extensions up to 2021 which must be taken into account for achieving a good chemical condition in all 24 coastal waters/ water bodies,

*Deadline extensions for good ecological condition of coastal waters*

According to the MP, a deadline extension up to 2021 for territorial waters should be taken into account with regard to the objective of achieving a good chemical condition.

## Assessment of the consequences

On the basis of the status description the article on water law forecasts how the environmental pressures may impact the individual watercourses/ bodies of water under consideration (impact assessment). This impact assessment is the basis for the water legislation assessment on whether the pressures identified could cause a deterioration in the condition of the coastal waters/ water bodies or territorial waters. It will also be assessed whether the project is compatible with the improvement requirements.

Below, the assessment results will be pooled, separately for coastal and territorial waters:

## Coastal waters

*Deterioration prohibition*

The environmental pressures caused by the project will have no future impact on the ecological condition of the coastal waters/ water bodies of the Fehmarn Belt, Orth Bay, Putlos, Fehmarn Sund, Hohwacht Bay or Fehmarn East. From the outset, the possibility that the environmental pressures, specifically suspended sediment, sedimentation and oxygen depletion, will change the condition of the quality components, to the extent that these will be classed as having worsened in the future, is ruled out. It is also ruled out from the outset that the FBFL will have future impairments on water functions in these coastal waters/ water body. With regard to the ecological condition, the project does not violate the water legislation deterioration prohibition for coastal waters.

Likewise the environmental pressures caused by the FBFL will not have any future impact on the chemical condition of the coastal waters/ water bodies. It is also ruled out from the outset that there will be any future impairments to water functions from a chemical perspective. The environmental pressures will not lead to the relevant environmental quality norms being exceeded. With regard to the chemical condition, the project does not violate the water legislation deterioration prohibition for coastal waters.

*Improvement requirement*

According to the MP, the good ecological condition in the coastal water bodies of the Fehmarn Belt, Orth Bay, Putlos, Fehmarnsund, Hohwacht Bay and Fehmarnsund East should be adjusted until after 2021, i.e. 22.12.2027. The project does not endanger the achievement of this goal because, inter alia, the environmental pressures of the project do not increase the pressures on coastal waters which in the MP are identified as being responsible for the fact that the water bodies are not currently in a good ecological condition e.g. nutrient depletion from discharging waters. The project is compatible with the water legislation improvement requirements with regard to a good ecological potential for coastal waters.

The same applies to the objective of maintaining or achieving a good chemical condition after 2021. At present, the project has no impact on the chemical condition of the coastal waters/ water bodies, which means that building and operating the FBFL does not endanger the goal of achieving a good chemical condition by 22.12.2027.

**Coastal sea:**

Likewise the environmental pressures caused by the FBFL will not have any future impact on the chemical condition of territorial waters. It is also ruled out from the outset that the FBFL will cause any future impairments to territorial water functions. The environmental pressures will not lead to the relevant environmental quality norms being exceeded. With regard to the chemical condition, the project does not violate the water legislation deterioration prohibition for territorial waters.

The aforementioned information on coastal waters applies to the objective of achieving a good chemical condition in territorial waters. The objective of achieving a good chemical condition in territorial waters must be realised by 22.12.2027. Building and operating the FBFL do not endanger the achievement of this management goal.

#### 6.3.3.6. Deterioration prohibition and improvement requirements for the territorial waters of the German section of the Baltic Sea

It is conceivable that the MSRL for the territorial waters of the German section of the Baltic Sea contains only target objectives which must be considered alongside other requirements during specialised planning and which may be overcome. Therefore, it cannot be understood from the water legislation contribution that the provisions for managing coastal waters have the same effect on authorisation of the FBFL as do the WRRL management goals for surface and coastal waters. The assessment of whether the construction and operation of the FBFL are compatible with the management goals for the territorial waters of the German section of the Baltic Sea is based on an analysis of the condition and significant impacts identified. In addition, the description of the good environmental condition and environmental goals are considered, which were specified in order to ensure that a good condition can be developed in territorial waters. It will also be investigated whether the project is compatible with the implementation of measures provided in the draft management programme.

**Analysis of sea conditions**

The fundamental characteristics and features of the territorial waters of the German section of the Baltic Sea and its condition are analysed in the report on implementation of the Sea Strategy Directive, which is presented in the initial assessment of the German section of the Baltic Sea (BLANO 2012a) and its condition. The analysis shows that the territorial waters are not in a good environmental condition. The initial assessment (BLANO 2012a) also contains a representation of the most important impacts which may affect the environmental condition of the German section of the Baltic Sea.

**Description of the good environmental condition and determining environmental objectives**

It has been determined which requirements must be fulfilled in order to achieve a good environmental condition in territorial waters. Additionally, environmental objectives were also established for target achievement.

*Good environmental condition*

The description of the good environmental condition of territorial waters (GES) is shown in the report on implementation of the Sea Strategy Directive, which is a description of good environmental conditions for the German section of the Baltic Sea (BLANO 2012b). As part of the GES description, 11 qualitative descriptors were used which were seen as being relevant to the Baltic Sea. These descriptors included, inter alia, biodiversity (D1), eutrophication (D5), hydrographic impacts (D7) or the use of energy (D11).

*Determining environmental objectives*

The description of environmental conditions for territorial waters is shown in the report on implementation of the Sea Strategy Directive, which determines the environmental objectives for the German section of the Baltic Sea (BLANO 2012c). These objectives include the existing environmental objectives according to the Habitats Directive, the WFD and the Helsinki Commission in addition to other objectives set by international conventions. The environmental objectives contain qualitative or quantitative information on the desired condition of the various components in the territorial waters and their impacts or impairments. The following seven environmental objectives were established:

- Oceans without impairments through anthropogenic eutrophication
- oceans without contamination through harmful substances
- oceans without impairments of marine species and habitats through the effects of human activity
- oceans with sustainable and wisely used resources
- oceans without impacts from waste material
- Oceans without impairments through anthropogenic energy input and
- oceans with natural hydromorphological characteristics

*Operative environmental objectives and indicators*

In turn, in order to achieve these environmental objectives, a range of so-called operative objectives have been established. The operative objectives will interact and support efforts to achieve a good condition in territorial waters. The report on establishing the environmental objectives for the German section of the Baltic Sea (BLANO 2012c). contains a different number of operative environmental objectives for each of the above environmental objectives. The indicators are part of the operative environmental objectives. These make it possible to assess whether the operative environmental objectives have been achieved.

### Programme of initiatives

The German Federal Government has presented a draft for an MSRL programme of initiatives on marine conservation of the northern and eastern regions of the German section of the Baltic Sea (Version 31.03.2016, BLANO 2016). The programme of initiatives contains those initiatives used to develop a good environmental condition in the German section of the Baltic Sea. The initiatives were established on the basis of the operative environmental objectives and the indicators associated with them.

### Deadline extensions

The good environmental condition of the territorial waters in the German section of the Baltic Sea must be achieved by 31.12.2020. The programme of initiatives, unlike the MP for coastal and territorial waters, does not provide for any deadline extensions in achieving this objective.

### Assessment of the consequences

The territorial waters in the German section of the Baltic Sea, unlike watercourses or coastal waters, are not divided into sections for management in accordance with the MSRL provisions.

The deterioration prohibition and improvement requirements for each of these must be adhered to. The management goals do not apply to all waters. As a precautionary measure, the article on water law will investigate whether the impacts of the FBFL

- will lead to a deterioration in the condition of the fundamental characteristics and features or the situation of significant impacts or
- to an improvement in the condition on the descriptors as well as the operative environmental objectives to achieve a good environmental condition by 31.12.2020.

### Deterioration prohibition

The presentation and assessment of how the environmental pressures of the FBFL will impact the fundamental characteristics or features of the territorial waters of the German section of the Baltic Sea show that their effects will not reflect on the future condition of the marine environment. All impacts on features or characteristics, especially those caused by the environmental pressures of suspended sediment, sedimentation and oxygen depletion are below the de minimis limit

The FBFL will have no future impact on the structure, functioning or processes of marine ecosystems. The existing physiographical, geographical, biological, geological and climatic factors of these ecosystem components will not be altered in future.

The possibility can also be excluded that the FBFL may significantly increase the most significant impacts, which will impair the condition of the marine environment in the German section of the Baltic Sea. All initiatives which may have a future impact on the impact situation will operate below the de minimis limit for the specific assessment parameters. The initiatives will not significantly increase the impact situation that the condition of the marine environment will be significantly affected in future.

### Improvement requirement

The initiatives for the FBFL of the sea waters in the German Baltic Sea and the project does not prevent the good environmental condition from being reached on time. will not lead to the good environmental condition not being achieved. The project will not endanger the achievement of the condition described by the descriptors. Its impact on the target condition is minimal. The impacts of the project on these target conditions fall below the de minimis limit, so long as the initiatives for the FBFL have any influence of the defined descriptor conditions.

The same applies to the objective of achieving the operative environmental objectives used to define the good environmental condition. The effects of the FBQ on target conditions are minimal. There is no evidence of the achievement of this objective being endangered. The project will not leas to the non-achievement of the operative environmental objectives in the German section of the Baltic Sea.

As a result, the initiatives for the FBFL do not endanger the objectives of assessing the environmental condition of the territorial waters of the German section of the Baltic Sea as good by 31.12.2020.

## 6.4. Fauna

### Superordinate area

With regard to bird and bat migration, the project will not result in any significant impairments and no aspects relevant to impact are therefore expected.

### Island of Fehmarn

*Impairment on valuable animal species resulting from habitats or parts thereof being built on (T1)*

- Significant (partial) losses of bat habitats in two areas of greater relevance to bats than their surroundings (FL4, FL5) (T1F)
- Considerable losses of breeding bird habits for the following breeding bird communities (T1V) (permanent loss of habitats; see SPC, Attachment 21):
    - Breeding birds which use older tree populations (blue tit, spotted flycatcher, hawfinch,, great tit),
    - Birds which breed in shrubs (blackbird, chaffinch, willow warbler, garden warbler, icterine warbler, greenfinch, dunnock, lesser whitethroat,blackcap, wood pigeon, robin, song thrush, wren, chiffchaff),
    - Birds which breed in hollows and holes (house martin, white wagtail)
    - Bird species inhabiting open ground, reed beds, sedge thickets and corridors of tall shrubs (skylark, reed bunting, ringed plover and yellow wagtail),
    - Bird species inhabiting semi-open sites/ecotones (common repdoll, common linnet and whitethroat)
    - Species of bird which use bodies of water (Eurasian coot and mallard).
- Significant habitat losses for amphibians as a result of three spawning waters being built on (T1A):
    - FAm182 (smooth newt) and FAm187 (edible frog and smooth newt) to the east of the ferry harbour (high significance)
    - Body of water (FAm158) at site of the Presen wind farm of relevance to the crested newt (Annex IV Species).
    - Building on bodies of water FAm187 and FAm182 and the terrestrial habitats associated with them to the east of the ferry harbour (high and medium significance)
- Building on biotope structures suitable for reptiles (medium significance) near the rail and road embankment/around the Presen wind farm (T1R)

- Loss of one small body of water (significant loss) between the B 207 and K 49 (FBioOd13) of great significance to dragonflies (T1L) For five bodies of water, the habitat losses are described as being insignificant since no dragonfly stockpiles of any special value were found (FOd134 to the east of the ferry harbour with low significance, FOd114 the east of the K 49 and FOd119 on the Presen windfarm with low significance, FOd113 on the K 49 with moderate significance).

*Impairment on breeding birds from disturbance/noise during the construction and operating phase (T4)*

- Loss of breeding habitats due to disturbance and noise:
  - Breeding birds which use older tree populations – loss of one breeding habitat for the spotted flycatcher and two breeding territories for the stock dove.
  - Birds which breed in bushes and other wooded areas and fault-related reduction in the habitat's suitability for one particular breeding pair of icterine warblers European greenfinch, dunnock, blackcap, woodpigeon, robin and the common chiffchaff.
  - Birds which breed in open ground – permanent habitat loss for one breeding pair each of skylark and yellow wagtail
  - Birds which breed in semi-open areas and ecotones - permanent habitat loss of one breeding pair of linnets and a breeding pair of whitethroat, three skylark areas are being disturbed by the project and the habitat is being permanently lost as a result of startling exercises. A breeding pair of yellow wagtails is being impaired by the project due to disturbances and startling exercises.
  - Birds which breed in hollows and holes: During the operation phase, buildings are affected by startling-related loss of a breeding pair of white wagtails.
  - Not at-risk bird species inhabiting semi-open sites/ecotones: One pair of common redpolls, whitethroats and pheasants which will be impaired by project-related disturbances. In accordance with accounting methods, the permanent loss of a pair of the aforementioned species must be balanced out.

## Marine area

### Risk of death and injury for harbour porpoises due to construction-related noise during pile driving (Tm1), conflict as per species protection legislation

The precautionary avoidance and minimisation measure no. 8.1 (use of pingers to scare off animals, see LCP, Attachment 12 of the plan approval documents, Annex IA) eliminates any conflict as per species protection legislation (risk of death and injury) for harbour porpoises caused by pile driving.

### Possible impact on fish, migratory and resting birds, and bats from light emissions during the construction phase (Tm2)

The precautionary avoidance and minimisation measure no. 8.5 (adapting work lighting on tugboats , see LCP, Attachment 12 of the plan approval documents, Annex IA) eliminates any significant impairments to fish, migratory and resting birds during the construction phase.

### Potential impairment to resting birds due to construction-related barrier effects and collisions with construction ships (Tm3, species-protection-related conflict)

To prevent significant impairments to resting waterfowl in connection with conflict Tm2 (see above), the precautionary avoidance and minimisation measure no. 8.5 (adapting work lighting on construction ships, see LCP, Attachment 12 of the plan approval documents, Annex IA) is applied. It should also be considered that, out of the entire Fehmarnbelt, simultaneous use of stationary equipment takes place in two working areas and one free-moving excavation machine is used outside the working area (cf. LCP, Attachment 12 of the plan approval documents, Annex IA, Measure Sheet 8.4).

Therefore, there remain no significant impairments with regard to barrier impacts or collision risks during the construction phase.

### Disturbing effects and potential impairment to the harbour porpoise due to a barrier effect in the Fehmarnbelt caused by noise emissions (Tm4, species-protection-related conflict)

To prevent a species protection-related conflict to harbour porpoises, the prevention and minimisation measure no. 8.4 is applied (during the construction phase, only 20% to a maximum of 30% of the Fehmarnbelt may be impaired by building noise > 144 dB, see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 8.4), meaning that no significant impairments will remain.

### Impairments to fish caused by footprint or habitat loss or from solid substrate

Only benthic fish communities/ species or their life stages, which are directly dependent on the availability of benthic habitats, may be affected by loss of habitats (see Attachment 15 of the plan approval documents, Annex B, Section 0.3.3.9).

The constitutional loss or impairment primarily affect shallow water fish communities/ species, including the life stages of species which use shallow waters (e.g. areas where cod and flatfish bring up their young). Overall, the areas impacted make up a proportionately small share of the areas of shallow water in the Fehmarnbelt.

Likewise, project-related impairments are found mostly in shallow water areas. This is where the project-related and constitutional effects on shallow water species and life stages of the dominant fish communities/ species which use shallow waters. Because in particular the shallow water species, in comparison to the more mobile deep water species, show an affinity to a particular region, there is then the potential to avoid habitat loss in neighbouring areas, to a greater extent than for all other varieties of fish.

Temporary loss of functions are a result of the deposition of solid substrate. This affects those varieties of fish in particular for which the route area has a medium significance as a feeding area (e.g. Flatfish, Atlantic cod). Due to the opportunistic feeding patterns of these fish varieties, the area will return to being a feeding area within a short time, following its resettlement by the benthic pioneer species (c.f. LCP, Attachment 12 of the plan approval documents, Section 6.4.3).

Since the habitat loss caused by the construction project is low compared to the existing shallow water areas of the Fehmarnbelt, as is the significance of the area as a living and functional area for shallow-water fish communities and species is limited to middling, there does not arise from the loss and the deposition of solid substrate a substantial conflict in relation to the shallow-water fish fauna. This applies even more to German territory, as the significance of the habitats affected by loss there is lower than around the Lolland coast, which means that habitat loss will not be considered a significant impairment to fish fauna and it is therefore not relevant in terms of impact (see LCP, Attachment 123 of the plan approval documents Section 6.4.3).

**Temporary construction-related impairments/disturbances as a result of noise, light and ship movements that appear in the area of the work strips (anchor zone) and the general, 3 km impact and disturbance zone on either side of the working area (Tm5)**.

With regard to summary changes in the work strips (anchoring zone) and the 3 km-wide impact and disturbance zone on each side of the tunnel trench (outside the anchoring zone) there are still functional faunistic functional impairments in the marine environment (specifically marine mammals, resting birds, fish), although individual project-related disturbance effects caused by tunnel excavation works and immersion of the tunnel elements (light, noise, ship movements, ballast, seawater desalination)are not classed as significant (see above sections).

The following areas of the aforementioned zones are affected:

- Anchoring zone: 1,005,0585 ha (coastal waters: 524,0305 ha, EEZ 481,0280 ha)
- 3 km impact and disturbance zone: 4.856,4548 ha (coastal waters: 2.802,1590 ha, EEZ 2.054,2958 ha)

**Temporary project-related impairments/ disturbances in the Rønne Banke sand extraction area for marine mammals, resting and migratory birds in neighbouring Natura 2000 areas (Tm6)**

Considering that the sand construction ships largely leave out the "Adlergrund" SCI and "Pomeranian Bay" Special Protection Area (see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 8.8), significant impairments are not expected (cf. Attachment 19 of the plan approval documents, Parts B VI and B VII).

**Conclusion:** Additionally, there remain significant adverse effects in the marine area with regard to **benthic habitats**, which are addressed in Section 6.5.

## 6.5. Plants

### Island of Fehmarn

*Loss of habitat/biotope within the impact limit and/or land used for construction due to building, covering and temporary use (PT1), including loss of biotopes protected by law in accordance with Art. 30 BNatSchG in conjunction with Art. 21 LNatSchG (PT 2)*

- Unavoidable, permanent loss of 59.7689 ha of biotope and a loss of 3,297 m of linear biotope inside the project boundary
- Temporary loss of a total of 58.5767 ha of biotopeand 1,283 m of linear biotope due to project-related land use.
- Biotopes affected within the impact limit:
  - 48.7952 ha total of field biotope (AA)
  - 1.5820 ha woodland area not including forests and clearings
  - 2.0257 ha (ruderal) transportation facilities biotopes
  - 0.4736 ha ruderal vegetation away from transportation facilities
  - 1.9241 ha of settlement biotopes/ biotope types linked to structural installations
  - 33 m of field hedges/ hedges
  - 2098 m tree lines, Roadside greenery with trees
- Loss of biotopes protected by law under Art. 30 BNatSchG in conjunction with Art. 21 LNatSchG (impact limit and temporary use):
  - Loss of 1.7059 ha of coastal biotopes protected under § 30 BNatSchG in conjunction with § 21 LNatSchG through construction of the tunnel portal and the creation of reclaimed land to the east of the ferry harbour
  - 33 m of ground level hedges (evaluated as hedgerows)
  - 0.1627 ha (six) small water bodies, miscellaneous standing water bodies
  - 0.14 ha of corridor of shrubs along ditches
  - 1121 m of avenues of trees along the K49 near the planned Puttgarden junction

*Impairment on habitats/biotopes from pollutant and nutrient emissions within the impact zones (PT3)*

- Impairments within impact zones 1 and 2 (up to 25 m away from road edge and 25-50 m from road edge; according to orientation framework) from pollutant and nutrient emissions ($NO_x$ - nitrogen oxides)
- 3.4248 ha of impaired area in biotope structures in impact zones 1 and 2

*Impairment of a section of cliff, protected according to § 30 BNatSchG in conjunction with § 21 LNatSchG (PT5)*

- By building the reclamation area, a section of the cliff approximately 320 m in length (0.0483 ha) located to the east of Puttgarden Harbour's breakwater will be separated from the impact of the Baltic Sea and the marine dynamics.

## Marine area

*Loss of habitat/biotope in relation to benthic habitats within the impact limit and/or land used for construction due to building, covering and temporary use (PTm1), including loss of bio-topes protected by law under Art. 30 BNatSchG in conjunction with Art. 21 LNatSchG (PTm2)*

- Significant losses within the impact limit and as a result of land used for construction totalling **173.0199 ha** (67.4126 ha in the German EEZ and 105.6073 ha German coastal waters)
- Permanent loss as a result of land reclamation and the tunnel structure above the seabed near the coast (36,0286 ha only in German coastal waters)
- Long-term loss caused by spur dyke above the tunnel trench (61.3460 ha; German EEZ: 30.8064 ha and German coastal waters 30.5396 ha)
- Long-term losses caused by the working harbour (8.2128 ha only in German coastal waters)
- Long-term losses from working harbour and backfilled areas of the tunnel trench (42.3070 ha, German EEZ 24.5804 and German coastal waters 17.7266 ha)
- Temporary losses resulting from anchoring within the anchoring zone (in total 25.1255 ha, German EEZ 12.0258 ha, German coastal waters 13.0997 ha)

*Impairment on benthic habitats from sedimentation (PTm3)*

- Considerable impairments on benthic habitats resulting from sedimentation totalling 656.4436 ha
- Serious impairments within the German EEZ totalling 0.4368 ha (only affecting circalittoral slime with infauna)
- Average impairments on an area totalling 656.0068 ha (German EEZ in total 342.3045 ha, German coastal waters in total 313.7023 ha)
- For a detailed list of the benthic habitats impaired, please refer to LCP, Attachment 12 of the plan approval documents, Section 8.5.

## 6.6. Biodiversity

### Island of Fehmarn

With regard to the functional space of the bird migration route transport corridor (functional space 6/B 207/railway with peripheral structures), 2,400 m sections of road and 700 m sections of railway will be built on and/or subject to temporary use.

An area of 1.65 ha of the biotope complex on the beach (biotope complex 4a) will be built on directly to the east of the breakwater although only the edge of one section of beach with existing impairments will be dissected and therefore impaired. Evaluation of the impairments should also take account of the fact that biotope complex 4a is already severely limited as a dispersion line for species through the break at Marienleuchte and the Puttgarden ferry harbour.

### Marine area

There is no need for further consideration of impairments to biodiversity in the marine area since the changes recorded in no case have an impact on the species of marine environmental sub-factors. Thus, no significant impairments to biodiversity in the marine area are expected (see LCP, Attachment 12 of the plan approval documents, Section 6.6).

## 6.7. Landscape

### Island of Fehmarn

*Loss/overshadowing of landscape pattern elements and spaces within the road zone (installation-related) (L1)*

- Major impacts on the landscape patterns of high overall sensitivity in the landscape pattern of the avenue of trees structure in the agricultural landscape (A4.1) on the K49 heading south and in the coastal landscape to the east of the ferry harbour (K3) (total loss of 0.7791 ha, overshadowing by maintenance facilities 3.6779 ha).
- Total loss of landscape patterns of medium overall sensitivity of 8.5243 ha and overshadowing by maintenance facilities of 18.2271 ha (landscape pattern of the avenue of trees structure in the agricultural landscape (A4.2) heading north on the K49, in the agricultural landscape with views of the Baltic Sea (A3.1 and A3.2) and near the bird migration route transport corridor (V2)).
- Total loss of landscape patterns of low overall sensitivity of 10.7530 ha and overshadowing by maintenance facilities of 20.0478 ha (cleared agricultural landscape [A1.1, A1.2 and A1.3], ferry harbour and rail facilities [V1]).

*Visual and sensory impairments on landscape pattern beyond the road zone (installation- and operation-related) (L2)*

- The project will result in the loss of strips of woodland along the edge of the bird migration route transport corridor and the avenue of trees along the K49 (see L1), which in the past ensured a certain level of integration for the existing route. For this reason, the design and route of the new railway/road will be at least partly integrated back into the agricultural landscape. The measures stated also integrate the route to the southeast of Puttgarden and in the direction of Marienleuchte (at the road connecting Puttgarden with Marienleuchte).
- The area of reclaimed land and the tunnel portal near the coast are integrated into the landscape pattern using a semi-natural design typical of the landscape as part of a design concept, meaning that no significant impairments remain.

**Marine area**

*Loss/overshadowing of landscape pattern elements and spaces within the impact limit (Lm1)*

- Considerable losses of landscape pattern elements in the part of the Baltic Sea just off the coast of Fehmarn with a semi-natural backdrop (KF) and in the marine area with existing impairments around the Puttgarden ferry harbour (F1) result from reclamation of land and the working harbour; the losses at the working harbour only being temporary in nature. The considerable losses in landscape patterns KF and F1 are redeveloped through the semi-natural design of the reclaimed land such that no significant impairments remain. The KF landscape pattern unit with existing impairments from the Puttgarden ferry harbour will even be enhanced by the semi-natural design of the reclaimed land.

*Visual and sensory impairment on landscape pattern beyond the impact limit (construction-, installation- and operation-related) (Lm2)*

- No significant impairments remain because most of the construction-related and therefore temporary visual and sensory project impacts only have an impairment on marine landscape pattern units KF and F1. The area of reclaimed land will also be designed to be semi-natural such that its creation will not result in significant impairments in the long term.

## 6.8. Climate

The only residual impairments relate to air near the island of Fehmarn.

**Island of Fehmarn**

During the operation phase (calculation of annual averages for the forecast year 2030) nitrogen dioxide ($NO_2$) levels near the tunnel portal result in the air quality standards according to Section 39 of the Federal Immission Control Ordinance (BImSchV) (limit value 40 µg/m³ yearly average) being exceeded with a total concentration of up to 101 µg/m³. In terms of fine dust ($PM_{2.5}$ and $PM_{10}$) the air quality standards (limit values of 2,5 µg/m³ and 40 µg/m³) are exceeded with a total concentration of up to 148 µg/m³ ($PM_{2.5}$) and 672 µg/m³ ($PM_{10}$) respectively near the tunnel portal. Away from the tunnel entrance itself, the values are not exceeded by pollutants or fine dust. Impairments are therefore localised and limit values are not exceeded at any sites of relevance to people (residential/recreation areas). Given that aeration on the island is good, there is no functional loss in terms of air quality but there is a major local impairment (KL1).

## 6.9. Cultural heritage and other material assets

### Island of Fehmarn

To rule out the possibility of loss or impairments on stray finds not yet discovered, advance studies and/or protection measures will be prepared in coordination with the State Archaeological Department of Schleswig-Holstein before and during the construction phase to keep impairments as low as possible (see conflict K1 LCP, Attachment 12).

The four wind turbines lost through the project are to be replaced in another location (see conflict S1 LCP, Attachment 12).

### Marine area

The German part of the Fehmarnbelt is home to the highly important *Lindormen* shipwreck (17th century) which lies around 300 m away from the tunnel trench for the immersed tunnel. The construction work will change currents and therefore the erosion to which the cultural monument is subject, representing a specific risk which could result in a very severe functional loss. The object may also be damaged by anchoring. Protection measures are planned, such as a protection zone around the wreck (approx. 200 m) and/or completely covering the wreck to protect it and monitoring during construction (see conflict Km1 LCP, Attachment 12). If necessary, salvage of the entire ship's hull must be arranged to avoid adverse effects.

# 7. Compensation measures (offset and/or substitution) for residual impairments

## 7.1. Compensation measures

In order to meet the requirements of §§ 13 et seq., BNatSchG for compensation and replacement on German territory, including the EEZ, within an appropriate period, landscape conservation measures will be undertaken in parallel with the construction of the FBFL and/or once it is complete to compensate for the project-related impacts on the natural balance and landscape (see LCP, Attachment 12, of the plan approval documents). According to the Federal Nature Conservation Act, avoidable impairments are not permitted and should be avoided as a matter of priority (see Section 5 of the Summary for a general audience and Section 5 and 7 LCP, Attachment 12 of the plan approval documents). If an impact cannot be avoided, according to § 15 BNatSchG, the polluter is obliged to offset the impairments through conservation or replacement measures. If this is not possible, major impairments should be offset through monetary compensation (see § 13 and § 15 Para. 6 BNatSchG).

Depending on their intended purpose or the respective situation, the measures are split into:

- Avoidance and minimisation measures (see Section 5 of the Summary for a general audience and Sections 5 and 7 of the LCP, Attachment 12):
  Measures for avoiding and minimising impairments in the sense of § 15 BNatSchG.
- Design measures:
  Road and rail routes are usually planned for the areas directly affected by the impact (e.g. dam and cut embankments, verges along edges and in the middle of roads/railways, rainwater retention basins).
- Compensatory measures:
  These measures are undertaken in the area surrounding the impact that is characterised by comparable ecological circumstances. An impact is considered to be offset as soon as the impaired functions of the natural balance are restored and the landscape is restored or redesigned as is appropriate (§ 15 Para. 2 BNatSchG).
- Replacement measures:
  Replacement measures compensate for impairments on the natural balance in other ways and/or redesign the landscape as is appropriate (§ 15 Para. 2 BNatSchG). There does not have to be a direct spatial link between impact and replacement measures.
- Recognising provisioning measures:
  In accordance with § 16 BNatSchG, nature conservation and landscape protection measures, which are implemented with regard to interventions expected to nature and landscape, should also be recognised as compensatory and replacement measures This includes, amongst other measures from the eco-accounts in the sense of § 16 BNatSchG in conjunction with § 10 LNatSchG and §§ 1 et seq. of the ÖkokontoVO.
  In an eco-account as defined by § 16 BNatSchG, upon request, a measure proponent will survey certain areas and assess the appropriate compensatory and replacement measures to take there, and evaluate them. According to § 16 BNatSchG in conjunction with § 10 LNatSchG and §§ 1 et seq. of the ÖkokontoVO Eco account regulations, the compensatory

and replacement measures must be recognised by the local nature conservation authority in the sense of § 3, Para. 1, Point 1 BNatSchG in conjunction with § 2, Para. 1, No. 4 LNatSchG as being included in an eco account. An eco account will be created when compensatory and replacement measures are recognised for a particular area. The rights and responsibilities arising from an eco account are negotiable in accordance with § 16 Para. 2 BNatSchG in conjunction with § 10 Para. 1 LNatSchG and § 6 ÖkokontoVO.

- Species protection measures
  If required, these measures are undertaken to avoid the prohibitions according to § 44 Para. 1 no. 1-4 BNatSchG. Avoidance and minimisation measures to protect species may be undertaken, as may compensatory and replacement measures (preferred compensatory measures = CEF measures).
- Damage limitation measures
  If required, the purpose of damage limitation measures is to prevent and limit the negative impacts on project-related impacts on the compliance objectives of a Natura 2000 conservation area (SCI, Special Protection Area) as well to contribute to the SCI compatibility of the project in the sense of § 34 BNatSchG (cf. BMVBW 2004).

The compensatory and replacement measures focus on the following (measure numbers are taken from LCP, Attachment 12 of the plan approval documents, Annex IA):

### 7.1.1. Onshore measures

- Planting of woodland/hedgerows and field hedges:
  In addition to design functions, trees planted will also partially take over the function as (potential) guiding lines for bats.
  Native shrub species found here correspond to the potential natural vegetation use. The composition of woody plants in the hedgerows/field hedges matches that of a poor to rich blackthorn/hazel hedgerow. Woodland is planned for various reasons (biotope compensation, species protection, landscaping) (LCP, Attachment 12 of the plan approval documents, Annex IA, I, Measures no. 2.2, 2.3, 3.1, 3.2, 5.1, 5.2, 5.4).
- Planting of rows/avenues of trees:
  Rows of trees serve partly to create an optical shield for neighbouring areas and partly as (potential) guiding lines for bats. Rows of trees are also planned for landscaping reasons along the road and railway at the beginning of the Fehmarnbelt Fixed Link in front of the structure of the K 49. The interrupted avenue of trees at the new K49 crossover structure will be restored. Rows of trees are also planned for landscaping reasons along the road and railway at the beginning of the Fehmarnbelt Fixed Link in front of the structure of the K 49 (LCP, Annex IA, Measures no. 1.1, 1.2). Additional rows of tress are planned for the western embankments of the transport roads (Measures no. 3.1, 3.2, LCP, Attachment 12 of the plan approval documents, Annex IA).
- Verge down centre of carriageway, hard shoulder with ditches (corridor of lawn/grass and shrubs):
  The verges along the sides of the roads and the drainage ditches will be seeded with a standard seed mix and developed as lawn areas. The seeded areas will be mown once or

several times a year so that they look like well-maintained lawns. If such intensive maintenance is not needed, grass and shrub corridors may develop (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.1).

- Development of grass and shrub corridor:
  Away from the verges and ditches, most of the embankments and other areas should be allowed to develop naturally as grass and tall shrub corridors. Natural development will be initiated by initial seeding with species as indigenous as possible. As much as possible, the seeds used for dry grasslands and meadows should be native to the area and be drawn from hay mulch from the corresponding local grass and meadow stockpiles (preferably from "Grüner Brink Fehmarn"). The area will usually be mown in the early autumn/ autumn every few years (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.2).
- Extensive use of green roofs:
  Extensive use of green roofs is planned above the portal building and between the light shafts above the tunnel portal to integrate the technical structures(LBP, Attachment 12 of the plan approval documents, Annex IA, Measure 7.2). The initial greening must be carried out using plants adapted to extreme conditions and with good regeneration capacity such as mosses, sedum species and drought-tolerant herbaceous vegetation which are as local to the area as possible.
- LCP, Development of dry grass and shrub corridor and coastal vegetation:
  This basically relates to the areas addressed in LCP,, Attachment 12 of the plan approval documents, Annex IA (tunnel portal, reclaimed areas of land). The areas surrounding the tunnel portal will be developed by creating a dry grassland and meadow with initial seeding of autochthonous grasslands, if possible, and/or oatgrass meadows. If possible, vegetation, grassland or meadows typical of coastal areas should be allowed to develop, which can be initiated and guided by using autochthonous seeds, if possible. All in all, it is imperative that an open vegetation structure is permanently maintained (with additional maintenance if needed).
  In the central section of the reclamation area and the northern section of the tunnel portal, a 15-30 cm-thick nutrient-free, sandy top layer with no top soil cover should be applied and/or incorporated and the development of typical coastal vegetation, grasslands or meadows should be promoted (LCP, Anlage 12 of the plan approval documents, Annex IA, Measure no. 7.1).
- Development of beaches/beach vegetation:
  This relates to the new bay that is to be created at the eastern edge of the land reclamation areas (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure No. 7.1). The beach area will be formed through the addition of sand/gravel typical of the site in the newly created bay in the transitional area between the land and sea. Prior to the construction on the beach section east of the ferry port, the beach sand / gravel that is typical of the location is removed from the existing beach, temporarily stored and put back once the land reclamation areas have been established (LCP, Attachment 12 of the plan approval documents, Measure no. 7.3, Annex IA). Should the quantity prove insufficient, uncontaminated sand from existing extraction areas around existing sand extraction areas may be used .
  Beach vegetation should be allowed to develop taking into account the area's extensive use for recreation. While developing the biotopes, primary dune structures will be created

through the addition of beach sand. If anchoring is needed, this should take the form of European marram grass (*Ammophila arenaria*); alternatively, natural colonisation should be allowed to take place.

- Sedimentation and rainwater retention basins:
  Everything from damp tall shrub corridors to waterside shrubs with reed beds will develop in the flooded parts of the rainwater retention basins because
  of the (alternating) damp conditions (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.7).
- Development of damp tall shrub corridors/waterside shrubs:
  There are plans to develop strips along ditches (LCP, Attachment 12 of the plan approval documentsAnnex IA, Measures no. 3.4, 3.8). These will not be managed or will only be mown if necessary.
- Semi-natural design of sections of waterways:
  Along the Drohngraben, ditch sections will be opened up and/or redesigned to be semi-natural (LBP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.4). Slopes gentler than 1:2 and the development of damp corridors of tall shrubs should be used to design/redesign the open sections of ditch in a semi-natural manner.
- Creating small bodies of water:
  To compensate for the loss of small bodies of water, there are plans to create one new small body of water near the route (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 4.1) . The area will be left to develop naturally as waterside vegetation and reed beds will colonise the area relatively quickly. The approx. 100 $m^2$ small water body will have a protective strip of at least 10 m in width.
- Reconstruction of existing paths, roads and railway tracks/pavement removal:
  The rerouting of the old B 207 road will enable impervious surfaces to be transformed into pervious surfaces. Most of the areas will be left to natural succession so that corridors of shrubs can develop on the immature soils and/or they will be included in the development of large grass and shrub corridors on the slopes of the FBFL (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.5).
- Restoration of land used temporarily/return to agricultural use:
  Land which has to be used for the construction but is not used afterwards for minimisation, compensatory or replacement measures will be returned to its former use. By far the majority of this is a return to agricultural use (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 0.3).
- Creation of new structures as winter homes for amphibians (crested newt):
  It is planned that a temporary protection facility for amphibians will be constructed close to bodies of water with crested newts. The function of existing woodland stockpiles on road and rail routes as a wintering habitat which is due to be lost through, on the one hand, loss and, on the other, the amphibian protective fence located in this area must be bridged by alternative wintering structures by, firstly, on a temporary basis (on the temporary amphibian protection fence) and then will be permanently replaced (on the edge of the new railway embankment (LCPand outer road embankments ) (LBP, Attachment 12 of the plan approval documents, Annex IA, Measures 1.3 und 2.2 in the southern section  Measures no. 3.5 and 3.6 in the northern section).

The temporary winter shelters for great crested newts (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 2.2 and 3.6) must be dismantled in the aquatic phase (April to end of June). Immediately following the dismantling of the temporary structures used as winter shelters, these will be replaced by temporary winter accommodation for the great crested newt. The temporary winter hiding places will be made from used material and guidelines on time restrictions during installation must be observed (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 2.2 and 3.6).

- Providing nesting aids (stock dove):
  The preferred way of offsetting the loss of two breeding habitats for stock doves in areas with an older tree stock very close to the impact area is to provide four nesting aids by the end of February in the year before construction work starts (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 9.1).
- Developing extensive green spaces for birds which breed in open land (skylark) and the development of open, short-grassland pioneer habitat (ringed plover):
  The preferred way of compensating) for the skylark and the conservation compensation for the yellow wagtail, in the area to the northwest of Puttgarden the existing green space surrounding damp to mesophilic green space will be expanded to include the current agricultural land. The total area will be used intensively and mown one to two times a year (LCP, Attachment 12 of the plan approval documents, Measure 9.4, Annex IA).
  The preferred compensatory measure for the ringed plover and the additional habitat offering for the lapwing and the great crested newt is the development of suitable habitat structures with open structures as an extensive pioneer habitat with short grassland pioneer stadia for vegetation, and to provide a new small body of water. An open area located to the northwest of Puttgarden must be permanently secured through measures such as ploughing and harrowing (LCP, Attachment 12 of the plan approval documents Annex IA, Measure 9.5).
- For the Fehmarnbelt Fixed Link project, in the sense of § 16 BNatSchG in conjunction with §10 LNatSchG, to obtain compensation in the onshore area, eligible compensation measures from the recognised eco-account 56 for the Stiftung Naturschutz Schleswig-Holstein "Gömnitzer Berg" and the “Krummsteert/Sulsdorfer Wiek” eco-account are used. The „Gömnitzer Berg“ areas are outside the LCP investigation area to the west of Neustadt/Holstein on the mainland. As stipulated in the eco-account ordinance (Ökokontoverordnung) of 23 May 2008, Art. 8, the area of impact and the eco-account are in the same area unit of the Schleswig-Holstein hills (southern part). The areas of the recognised eco-account, along with the development objectives of extensive green space with small waterbodies and drained sinks as well as smaller patches of forest may be used to compensate for or replace the territorial impacts caused by the project (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 10.1).
  The "Krummsteert/Sulsdorfer Wiek" eco-account area is on Fehmarn. By creating a coastal biotope (extensively-used green space with saltwater in-flow in the Baltic Sea flood zone), the loss and impairment of coastal biotopes is compensated with morphological structure types (cliffs) (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 9.3).

### 7.1.2. Measures for the marine area

- Recreating a reef in the Sagasbank area:
  The impairment of faunitic function in the marine area will be partially compensated by re-creating reef structures (25 ha) on Sagas Bank, which takes the form of a looming sand and sediment bank located nearly 8 m below sea level between Fehmarn and the Bay of Lubeck (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 8.7).
  - Before commencing the actual compensation measures, those areas in which there are few to no stones (≥ 60 cm) present and no mussel standing stocks, must be highlighted.
  - The stones should be of glacial origin from the Baltic Sea area.
  - The size of the stones must be orientated towards the material obtained from stone fishing and correspond to a diameter of 60 - 100 cm. It is possible to increase structural diversity by using smaller stones (at least 30 cm in diameter) in combination with ≥ 60 cm stones (mosaic structures).
  - The objective is loose/patchy coverage, a degree of coverage of 30-50%.
  - The subsequent function check with respect to the long-term development of the faunal and floristic colonisation of the reef will be via a monitoring programme (annual monitoring during the first 10 years, then at 5-year intervals until the 25th year, depending on the developments recorded).

- Measures for reducing nutrient inputs in the Baltic Sea:
  Areas used to reduce nutrient input into the Baltic Sea will be employed as replacement measures for the marine area (see LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 11.1 to 11.25).

  According to § 16 BNatSchG in conjunction with § 15 LNatSchG and § 4 ÖkokontoVO, measures from eco-accounts as defined in § 16 BNatSchG in conjunction with § 15 LNatSchG and §§ 1 et seq. of ÖkokontoVO are to be considered comparison and replacement measures as defined by § 15 Para 2 BNatSchG in conjunction with § 9 LNatSchG. The compensation obligation for interventions in the marine area should be met partially by eco-accounts. The selected eco-accounts are used for adapted agricultural management of areas near the coast and/or areas near inflows into the Baltic Sea. These contribute to a reduction in nutrient inputs and therefore also to a mid- to long-term improvement in the conditions of water bodies in the Baltic Sea. The measures for reducing nutrient inputs also represent an important contribution to achieving a good condition in the bodies of water (pursuant to the Water Framework Directive) in the Baltic Sea. The following **eco-accounts** along with measures suitable for objectives, have been selected for the Fehmarnbelt Fixed Link project and the value of those measures (eco-accounts) have been taken into account:

**Table 77 Overview of the eco-accounts used for the Fehmarnbelt Fixed Link project, which contribute to a reduction of nutrient input into the Baltic Sea**

| Eco-account | Eco-account location (municipality, district) | Water system with inflow into the Baltic Sea | Available, chargeable eco-accounts [1)] | Measures-no. in the LCP |
|---|---|---|---|---|
| Oldenburger Graben - Plügger Wiesen | Göhl, Ostholstein | Oldenburger Graben | 164.237 | 11.1 |
| Ehlerstorf | Wangels, Ostholstein | Johannisbek Randkanal/ Oldenburger Graben | 34.148 | 11.2 |
| Taarstedt - Loiter Au | Taarstedt, Schleswig-Flensburg | Loiter Au/ Füsinger Au/ Schlei | 80.774 | 11.3 |
| Riepsdorf I | Riepsdorf, Ostholstein | Oldenburger Graben | 29.920 | 11.4 |
| Gömnitz II (Schneckenkuhl) | Süsel, Ostholstein | Redingsdorfer Au/ Steinbach/ Mühlenbach/ Lachsbach/ Neustädter inland waterways | 18.045 | 11.6 |
| Woltersteich I | Süsel, Ostholstein | Schwartau/ Trave | 174.080 | 11.7 |
| Woltersteich II | Süsel, Ostholstein | Schwartau/ Trave | 40.500 | 11.8 |
| Barkau I | Süsel, Ostholstein | Schwartau/ Trave | 33.219 | 11.9 |
| Redingsdorfer Au 1 | Süsel, Ostholstein | Redingsdorfer Au/ Steinbach/ Mühlenbach/ Lachsbach/ Neustädter inland waterways | 57.345 | 11.10 |
| RedingsdorferAu II | Süsel, Ostholstein | Redingsdorfer Au/ Steinbach/ Mühlenbach/ Lachsbach/ Neustädter inland waterways | 27.709 | 11.11 |
| Hassendorf I (Katzburg) | Bosau, Ostholstein | Glasau/ Trave | 34.815 | 11.12 |
| Gömnitz | Süsel, Ostholstein | Redingsdorfer Au/ Steinbach/ Mühlenbach/ Lachsbach/ Neustädter inland waterways | 30.101 | 11.13 |
| Gothendorf II | Süsel, Ostholstein | Schwartau/ Trave | 34.122 | 11.14 |
| Gothendorf (Witt) | Süsel, Ostholstein | Schwartau/ Trave | 115.921 | 11.15 |
| Griebel I | Kasseedorf, Ostholstein | Lachsbach/ Neustädter inland waterways | 219.676 | 11.16 |
| Augustenhof I | Heringsdorf, Ostholstein | Kalkberggraben/Oldenburger Graben | 321.447 | |

| | | | | |
|---|---|---|---|---|
| Augustenhof II | Heringsdorf, Ostholstein | Kalkberggraben/Oldenburger Graben | 24.172 | 11.17 |
| Lübbersdorf | Lübberstorf, Ostholstein | Oldenburger Graben | 43.458 | 11.18 |
| Suksdorfer Wiesen | Gremersdorf, Ostholstein | Godderstorfer Au | 9.958 | 11.19 |
| Wasbuck | Wangels, Ostholstein | Mühlenau | 40.019 | 11.20 |
| Eco areas in Hohwacht | Howacht, Ostholstein | Large inland Lake | 26.320 | 11.21 |
| Green space in Mühlenfeld | Helmstorf, Plön | Kossau/Großer Binnensee | 56.350 | 11.22 |
| Grube I (Rosenhof) | Grube, Ostholstein | Oldenburger Graben | 458.400 | 11.23 |
| Bujendorf I | Süsel, Ostholstein | Redingsdorfer Au/ Steinbach/ Mühlenbach/ Lachsbach/ Neustädter inland waterways | 9.586 | 11.24 |
| Bujendorf II | Süsel, Ostholstein | Redingsdorfer Au/ Steinbach/ Mühlenbach/ Lachsbach/ Neustädter inland waterways | 13.642 | 11.25 |
| | | | | |
| **Total eco-points** | | | **2.097.964** | |

Furthermore, the appropriate **replacement measure** for "Johannisbek 2", which are designed to reduce nutrient input into the Baltic Sea in the sense of a real compensation measure will be developed see Annex IA, Measure Sheet no. 11.5 and Attachment 12.2, Sheet 11.5). Development and implementation follow the development concept for a measure originally requested as an eco-account for which, due to time constraints, no recognition certificate could be issued. In this case, the eligible compensation for the project is calculated according to the Road Construction Framework applied to the Fehmarnbelt Fixed Link (MWAV & MUNF 2004), which corresponds to the policy presented in LCP, Attachment 12 of the plan approval documents Section 11.

**Table 78 Overview of the eco-accounts used for measure areas of the Fehmarnbelt Fixed Link project, which contribute to a reduction of nutrient input into the Baltic Sea**

| Name of eco-account | Location in district | Location in municipality | Water system with inflow into the Baltic Sea | Eligible compensation scope (in $m^2$)[2)] | Measures-no. in the LCP |
|---|---|---|---|---|---|
| Johannisbek 2 | Ostholstein | Lensahn | Johannisbek Randkanal/ Oldenburger Graben | **25.213** | 11.5 |

[2)] according to road construction orientation framework cf. Section11.4.3.2.

In summary, the replacement measures available as compensation measures in the marine area and therefore 25,213 m² of eligible areas as well as measures arising from 25 eco-accounts with a value of **2,097,964** eco-points, in addition to crediting interest.

More details can be found in the LCP (Attachment 12, Annex IA and Section 9.).

## 7.2. Calculating the compensation required

In the German project area, the orientation framework (MWAV & MUNF 2004) is used to determine the scope of compensation needed for the impacts of road and rail. Since the orientation framework only relates to the land area, it is being developed analogously for calculating impacts in the marine habitats of the German coastal waters and the Exclusive Economic Zone (EEZ).

The results of calculating the compensation required are listed in the following sections (see Table 80). Details of how this compensation was calculated can be found in Section 11 of the LCP (Attachment 12 of the plan approval documents).

### 7.2.1. Land area

An area of **43.0957 ha** of land requires **biotope type-related compensation** of and overall compensation is needed along **1,950 m** of different linear biotope types, including biotopes protected by law in accordance with § 30 BNatSchG in conjunction with § 21 LNatSchG. Because of the **new sealing** and impairment caused by the project footprint ≥ 5 year as an additional land-based compensation requirement an additional compensation requirement of **15.3460 ha** is necessary. There is no further compensation requirement resulting from impairments on faunistic functional relations or abiotic value and function elements of particular significance and/or the landscape or recreation linked to the landscape.

Compensation - including compensation for conservation - is secured using measures in the area near the trench including de-sealing measures on measures areas to the northwest of Puttgarden/Fehmarn and crediting and measures in the context of the recognised "Gömnitzer Berg" eco-account and the recognised "Krummsteert/Sulsdorfer Wiek" .

### 7.2.2. Marine area

In principle, the methods of the orientation framework for calculating road construction compensation (MWAV & MUNF 2004) can also be used for the marine section of the investigation area. However, marine habitats are only generally listed in the list of biotope and use types in Annex 3 of the orientation framework. As a result, the marine benthic habitats are used to determine a habitat-related need for compensation instead of these biotope types in Annex 3.

#### Calculating the scope of compensation in relation to marine benthic habitats

Standard compensation factors for benthic habitats are calculated on the basis of the underlying fauna and flora elements, the significance and the restorability of the benthic habitats. A standard compensation factor of 1:1 is not used because this is only used in the orientation framework (MWAV & MUNF 2004) for artificial and degraded biotopes which do not exist in the marine area under consideration.

In the marine area, biotopes protected by law in accordance with Art. 30 of the BNatSchG, FFH habitat types (Annex 2 of the Habitats Directive) and/or location in Natura 2000 areas/natural conservation areas serve as location factors in the sense of the orientation framework (MWAV & MUNF 2004). Habitats in these protected areas are all multiplied by a factor of 2.0 and thereby upgraded.

As with the requirements of the orientation framework (MWAV & MUNF 2004) on land, when determining impact in the marine area the type of impact in the impaired area should be considered to calculate the intensity of the impairment (see Figure 44 et seq.):

- Installation-related permanent impact (loss): Reclamation areas including the future wave breakers and temporary stockpiles and stone packing as protection from collision and erosion.
  100% impairment intensity = factor 1.0
- Installation-related long-term permanent impact (loss): Areas with tunnel elements and protection layer made from rock layers (see Figure 44, no. 1 and 2).
  100% intensity of impairment = factor of 1.0
- Long-term impact in the area of the working harbour
  85% impairment intensity = factor 0.85
- Long-term impact near working harbour and in areas around tunnel trench, which are not covered with the layer of stones (see Figure 44, no. 3).
  70 % impairment intensity = factor 0,70
- Construction-related temporary impact: area of land used for construction during the build phase through anchoring activities in the anchoring zone (see Figure 44, no. 4 "Anchoring zone"). A temporary loss of habitat covering 2.50% of the area is assumed to calculate impact in the anchoring zone. For the parts of the anchoring zone which are not affected directly by anchoring (97.5% of the area), impairments on the benthic habitats from suspended materials and sedimentation are taken into account (see Figure 44, no. 4a and 4b).
  50 % impairment intensity = factor 0.5
- (Project-related) impact zones which result from construction-related sedimentation. Impact zone 1 includes areas with a high impairments, impact zone 2 includes areas with an average impact.
  Impact zone 1: 10 % intensity of impairment = factor of 0.10
  Impact zone 2: 5 % impairment intensity = factor 0.05
- Project-related disturbances to the marine environment in working strips (anchoring zone), summary impairment to faunistic functional relationships .
  5% impairment intensity = factor 0.05

- (Project-related) 3 km-disturbance and impact zone: Impairment of faunistic relationships caused by project-related disturbances.
  2.5 % impairment = factor 0.025

The aforementioned impact zones (impact zones 1 + 2, disturbances to the marine environment in the working strips, 3 km disturbance and impact zone) will be employed alternatively when determining compensation. If the compensation requirement calculated for impairment of the faunistic functional relationships (within the work strips and in the 3 km disturbance zone) creates a significantly higher compensation requirement, the compensation requirements calculated for impact zones 1 and 2 will be covered (multifunctional). If the compensation requirement for impact zones 1 and 2 is higher than the requirement for the work strip and 3 km disturbance zone, this should be taken into account when determining compensation.

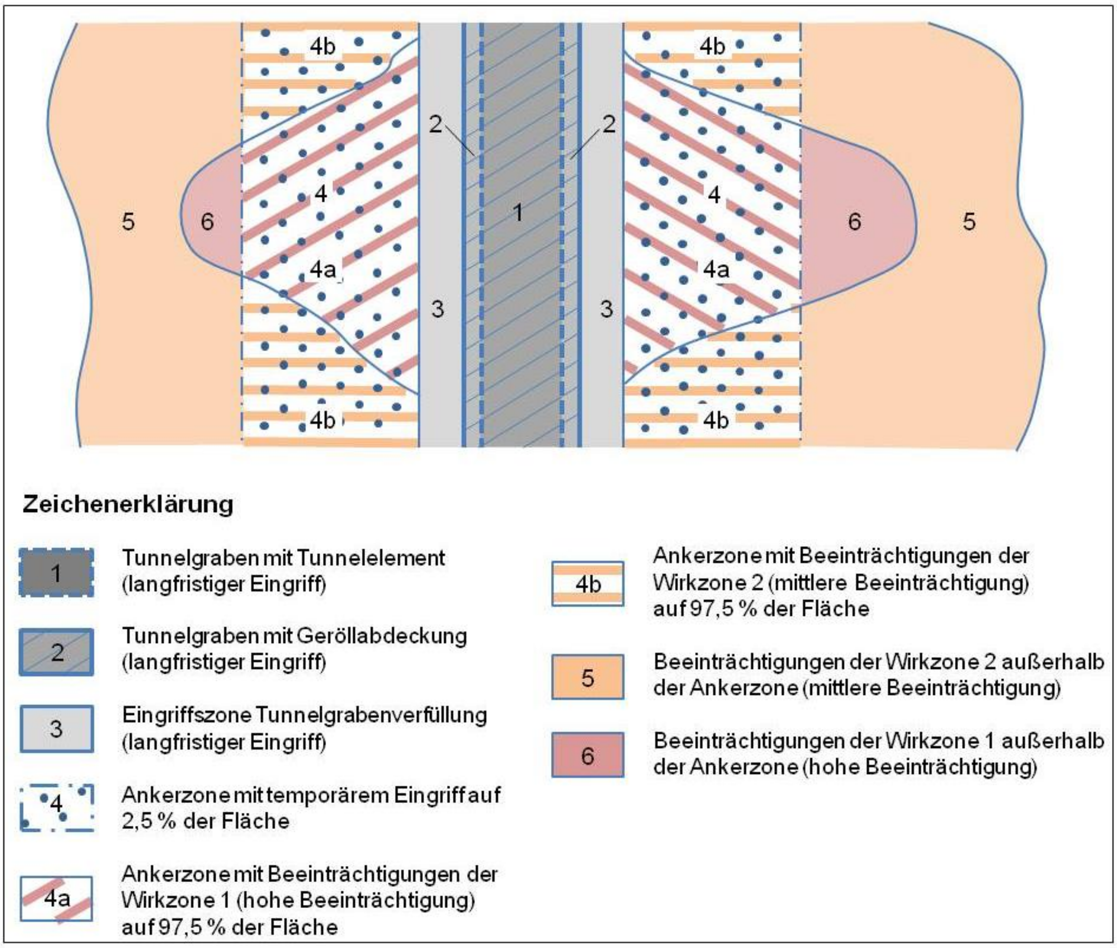



**Figure 44 Schematic diagram of impact calculation**

| Zeichenerklärung | Key |
|---|---|
| Tunnelgraben mit Tunnelelement (Langfristiger Eingriff) | Tunnel trench with tunnel element (long-term impact) |
| Tunnelgraben mit Geröllabdeckung (Langfristiger Eingriff) | Tunnel trench with debris covering (long-term impact) |

| | |
|---|---|
| Eingriffszone Tunnelgrabenverfüllung (Langfristiger Eingriff) | Tunnel trench backfilling impact zone (long-term impact) |
| Ankerzone mit temporärem Eingriff auf 2,5 % der Fläche | Anchoring zone with temporary impact on 2.5% of area |
| Ankerzone mit Beeinträchtigungen der Wirkzone 1 (hohe Beeinträchtigung) auf 97,5 % der Fläche | Anchoring zone with adverse impacts of impact zone 1 (major adverse effect) of 97.5% of area |
| Ankerzone mit Beeinträchtigungen der Wirkzone 2 (mittlere Beeinträchtigung) auf 97,5 % der Fläche | Anchoring zone with adverse impacts of impact zone 2 (average adverse effect) of 97.5% of area |
| Beeinträchtigungen der Wirkzone 2 Ausserhalb der Ankerzone (hohe Beeinträchtigung) | Adverse effect on impact zone 2 outside the anchoring zone (major adverse effects) |
| Beeinträchtigungen der Wirkzone 1 Ausserhalb der Ankerzone (hohe Beeinträchtigung) | Adverse effect on impact zone 1 outside the anchoring zone (major adverse effects) |

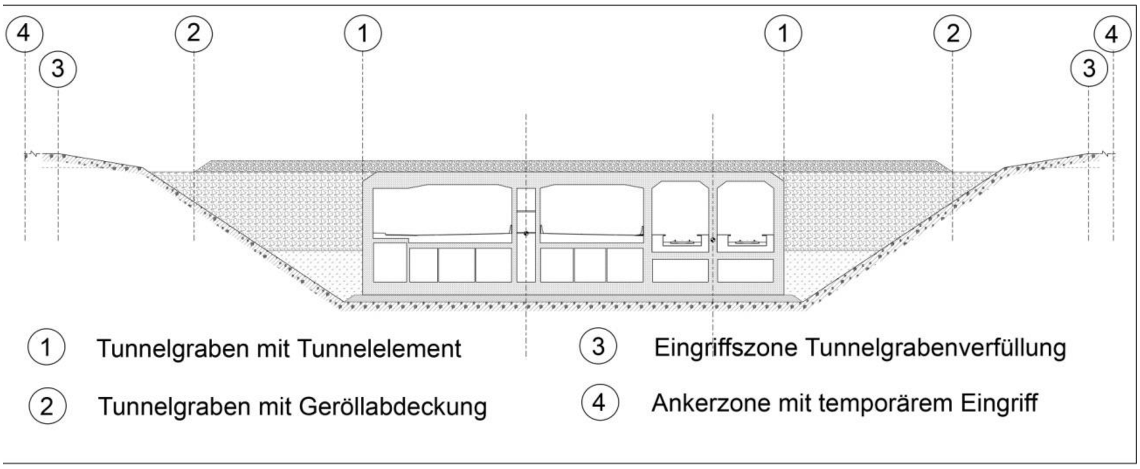



**Figure 45 Cross-section of tunnel with permanent and temporary impact zones**

| | |
|---|---|
| Tunnelgraben mit Tunnelelement | Tunnel trench with tunnel element |
| Tunnelgraben mit Geröllabdeckung | Tunnel trench with debris covering |
| Eingriffszone Tunnelgrabenverfüllung | Tunnel trench with backfilling impact zone |
| Ankerzone mit temporärem Eingriff | Anchoring zone with temporary impact |

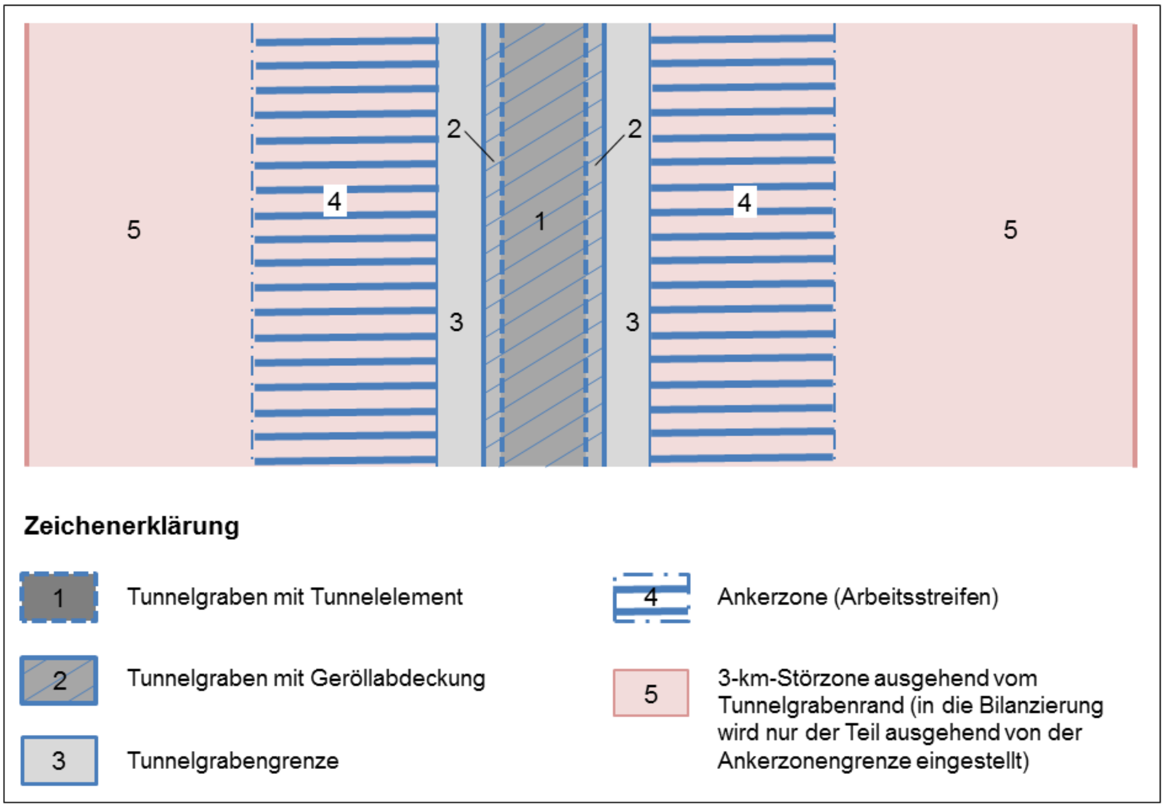



**Figure 46 Schematic representation of the balancing of disturbances to the marine environment in the work strips and 3 km disturbance zone**

| Zeichenerklärung | Key |
|---|---|
| Tunnelgraben mit Tunnelelement | Tunnel trench with tunnel element |
| Tunnelgraben mit Geröllabdeckung | Tunnel trench with debris covering |
| Tunnelgrabengrenze | Trench excavation boundary |
| Ankerzone (Arbeitsstreifen) | Anchoring zone (work strips) |
| 3-km-Störzone ausgehend vom Tunnelgrabenrand (in die Bilanzierung wird nur der Teil ausgehend von der Ankerzonengrenze eingestellt) | 3-km disruption zone extending from the tunnel excavation area (only the part originating from the anchoring zone is used) |

The need for compensation by area is then calculated in the same way as in the orientation framework (MWAV & MUNF 2004):

- Standard compensation factor x location factor x impairment factor x benthic habitat area affected

The total compensation needed for the **marine benthic habitats** in German coastal waters and the German EEZ is 516.7044 ha (231.9664 ha German coastal waters and 284.7380 ha EEZ).

### Determining the scope of compensation with regard to faunistic functional relations in the marine area

Impacts on faunistic functional relations and their compensation are determined and depicted for each individual case and in relation to function. More specifically, the impairments on the benthic fauna are included in the quantitative compensation approach for benthic habitats (see above) and thereby compensated for. For all other fauna elements in the marine area (planktic fauna, marine mammals, fish), resting birds and bird and bat migration, by way of summary it can be said that summary disturbances to the marine environment are expected and must be compensated for. The compensation requirement for impairments to faunistic functional relations in the marine (resting birds, marine mammals, fish) is worked out based on the aforementioned impact zones.

In total, the compensation requirement for impairment to faunistic functional relationships in the anchoring zone and the 3 km disturbance zone with a total area of 171.6642 ha more than the compensation requirement of 116.7733 as a result of impairments to benthic habitats caused by sedimentation. For this reason, the compensation requirement of 171.6642 ha will be used to establish the overall compensation requirement for interventions in the marine area (biotic functions) caused by the project. The compensation requirement for impairment of benthic habitats by sedimentation in impact zones 1 and 2 (116.7733 ha) is therefore covered in a multifunctional way.

### Determining the scope of compensation and balancing in terms of abiotic value and function elements (soil, water, climate and air) and landscape

Based on the orientation framework for road building (MWAV & MUNF 2004), the value and function elements of soil, water, climate/air and landscape are also given special consideration for the marine area alongside the biotic factors. The assessment concentrates on the impairments of the value and function elements of special significance. The exception is new sealed ground that takes into account both value and function elements of special significance and general significance. The reasons for the procedure used in the event of the loss/impairment of value and function elements are provided below in verbal/argument form:

*Soil*

- As a result of **new ground sealing of seabed of general significance** through the reclamation areas and the layer of protection against collisions with ships and erosion covering a total of 35.8842 ha (only in German coastal waters) x an impairment factor of 1.00 to be balanced in a ratio of 1:0,5 , compensation is needed on 17.9420ha.

- Partial sealing of the seabed in the area of the tunnel elements
  - sealed soil of general importance: SCF 0.5 x BI 0.8 = factor of 0.4 x area
  - sealed soil of particular importance: SCF 1 x BI 0.8 = factor of 0.8 x area

  Accordingly, those tunnel elements in the area of soils of general significance and those tunnel elements in the area of soils of particular significance are subject to additive compensation in the ratios 1:0.4 and 1:0.8 respectively (compensation requirement see Table 79).

- **Seabed formations of particular significance** are impaired near the tunnel trench outside the tunnel elements in the area of the protective stone layer and around the anchoring zone, but all such cases are temporary. Given the dynamic system of currents on the seabed, it can be assumed that corresponding formations will re-establish themselves. As a result, the significant impairments to values and functions of general importance caused by biotype-related (habitat type-related) compensation will be compared in a multifunctional manner.

A summary of the aforementioned intervention types are shown in the following Table 79. The difference in interventions and impairments in the Exclusive Economic Zone (EEZ) and other such elements which must be considered in the German coastal area.

**Table 79 Determining the compensation scopes caused by re-sealing seabed and impairment of seabed formations of special significance – summary**

| Impairment location/ type | Impairment area/ Impairment ha | | Impairment intensity | Compensation requirement in ha | | |
|---|---|---|---|---|---|---|
| | Coastal waters | EEZ | | Coastal waters | EEZ | Total |
| Land reclamation areas/ protective layer to protect against ship collisions and erosion (re-sealing seabed of general significance) | 35,8842 | -- | Impairment intensity 50% (factor 0.5) | 17,9420 | -- | **17,9420** |
| Partial sealing of the seabed of special importance in the area of the tunnel elements | 11,0090 | 18,2491 | Impairment intensity 80% (factor 0.8 for seabeds of special significance) | 8,8072 | 14,5993 | **23,4065** |
| Partial sealing of the seabed of general importance in the area of the tunnel elements | 7,0762 | -- | Impairment intensity 40% (factor 0.4 for seabeds of general significance) | 2,8305 | -- | **2,8305** |

| **Impairment location/ type** | **Impairment area/ Impairment ha** | | **Impairment intensity** | **Compensation requirement in ha** | | |
|---|---|---|---|---|---|---|
| | **Coastal waters** | **EEZ** | | **Coastal waters** | **EEZ** | **Total** |
| Loss of stone protective layer without tunnel elements (long-term impairment of seabed of special significance) | 7,5802 | 12,5573 | Impairment intensity 25% (factor 0.25) | 1,8951 | 3,1393 | **5,0344** |
| Anchoring zone, area loss of 2.5% (temporary impairment of seabed of special significance) | 7,3909 | 12,0257 | Impairment intensity 10% (factor 0.1) | 0,7391 | 1,2026 | **1,9417** |
| **Total** | | | | | | **51,1551** |

Overall, the compensation requirement for interventions to the seabed is 51.1551 ha (German coastal waters: 32.2139 ha, German EEZ: 18.9412 ha).

*Water:*

Water: only reclamation areas result in permanent losses to the open surface of the Baltic Sea off Fehmarn. Given the comparatively small size of the area of reclaimed land in proportion to that of the open sea, the impact on the body of water should be considered insignificant overall. There is therefore no further need for compensation.

*Climate/ air:*

In terms of the climate in the investigation area, no areas of varying significance or sensitivity can be defined so there are no conflicts with function elements of particular significance. Major impairments relating to air quality are not expected in the marine area. There is therefore no further need for compensation.

*Landscape:*

Only land reclamation areas result in permanent losses to the landscape of the open seas near the Baltic Sea coast off Fehmarn. Given the comparatively small size of the reclamation area in proportion to that of the open sea and since the area is designed in a semi-natural manner as is typical for the landscape, the impact on the landscape should be considered insignificant overall. There is therefore no further need for compensation.

**Summary of compensation needed in the marine area**

The need for compensation in the marine area therefore comprises the compensation required for benthic habitats and for the seabed (see above).

The total requirement for the German coastal waters area amounts to 312.2980 ha, for the German EEZ 310.4524 ha and the total compensation requirement for the German marine area is 622.7504 ha.

## 7.3. Assessment of compensation and replacement measures in the marine area

With regard to compensating interventions in the marine area, the following types of measure are planned:

- Real compensation through restoring and upgrading reef areas on Sagas Bank by importing stones and boulders.
- Reducing nutrient inputs in the Baltic Sea as a replacement measure.

### 7.3.1. Eligibility for reef restoration measures (real compensation)

The area planned for compensation (see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 8.7 and LCP Sections 9.1.3.6 and 9.2.2.1 and Attachment 30.4 of the plan approval documents) is located in SCI DE 1733-301 "Sagasbank", including, inter alia, reefs.

The development of stone reefs in the suggested search areas, the ecological value of which is taken into account by stone fishery, gives reason to expect upgrades and improvements in terms of the development of Natura 2000 sites existing at the locations, an increase in the proportion of legally protected biotypes as well as an upgrade in the diverse functional relationships between flora, fauna and abiotic factors. Specifically, the following superordinate positive effects must be cited for the eligibility of compensation measures in the marine area:

- The planned measure area is located largely in SCI DE 1733-301 "Sagas Bank", in which the reef habitat type represents a preservation object. The development of the 'reef' preservation object is promoted in the long-term.
- There is a large-scale upgrade due to the development of stone reefs in areas devalued by former stone fishery (LCP, Section 9.1.3.7). In accordance with § 30 BNatSchG, Para. 2, No. 6, reefs represent legally protected biotopes; the measure means that there will be a consolidation and structural upgrade of the reefs at the intended locations.
- The measure may contribute - within the meaning of the EU Water Framework Directive and Marine Strategy Directive - to strengthening diversity and the function of the marine ecosystem by introducing supplementary solid substrate as a balance for the historic loss of marine seabed geometries.

- For benthic habitats in the marine area and the symbiotic communities co-existing in the stone reefs, a relatively short period of 5 to 10 years is set for restoration and/or development. The shorter recoverability of benthic marine habitats, here in particular those linked to the stone reefs, is another reason to assess the eligibility of the planned compensation measures in the marine area as high.

The extent of the eligible scope of compensation area is determined using:

- the extent of the ecological revaluation of the habitats;
- the value of the revaluation of faunistic functions (species protection);
- the value of the development of protected biotopes and
- the location in the Natura 2000 area.

The individual approaches used for the eligibility of the real compensation measures follow the principal procedures from State regulation for the eco-account, compiling the compensation list and the standards for replacement measures (eco-account and compensation list regulations of 23 May 2008) and are classified additively. This in addition to the compensation requirements determined for the loss and impairment of habitats and marine fauna which are also classified additively.

### Extent of ecological analysability

The degree of ecological upgrade of habitat function results from the existing situation of the compensation areas as well as the proposed measure. To determine the increase in value of the habitat function by the compensation measure, the value of the compensation measure after 25 years is assumed and the nature conservation value of the existing situation of land on which the measures are to be carried out is to be taken into account.

According to the monitoring description sheet SCI-HT reefs, geogenic reef structures with a conservation status rated at B and C in the northeast of Sagas Bank have been located (cf. LCP, Attachment 12 of the plan approval documents, Section 9.2.2.1 and Attachment 30.4 of the plan approval documents). As there is no comprehensive information available for the whole area pertaining to the quality of the seabed and stone coverage, it is difficult to establish a difference between conservation status B and C. Therefore, they are combined as conservation status B-C. The selection of suitable areas for the revaluation of reef structures is carried out on the benthic habitats located in the investigation area which have been identified in detail. According to the road construction orientation framework (MWAV & MUNF 2004), the only biotope types/ habitats which are suitable for a revaluation are those with nature conservation value of less than 4. The extent of the revaluation increases along with the acceptance of the nature conservation value. The benthic habitats found in the Sagas Bank area have nature conservation values ranging from 3 to 5.

Since the restoration of reef structures after a development time of around 25 years the development of reefs with a nature conservation value of 5 must be accepted, selected areas with a nature conservation value of 3 are awarded a value of 2 and selected areas with a nature conservation value of 4 must be awarded a value of 1.

In order to obtain the maximum benefit from restoring the reef area, areas with a nature conservation value of 3 lying within the B-C areas are specifically selected for the creation of reef areas.

### Revaluation of faunistic functions

The restoration of reef structures leads to a complex functional revaluation caused by the creation of new rearing and breeding areas for mussels and macrophytes (macro algae communities), epibenthic fauna (sponges, marine ascidiae and bryozoans) and fish. With the restoration of reef structures, the positive impacts on the seabed, biodiversity and water quality are linked and this restoration will lead to an improvement of the food supply for waterfowl and the harbour porpoise. Overall, the restoration of reef structures will lead to a mid- to long-term revaluation as a breeding, rearing and feeding ground for fauna in the Sagas Bank area. The revaluation of faunistic functions is classified with a value of 2.

### Development of protected biotopes

Reefs represent a legally protected biotope according to § 30 BNatSchG. The planned restoration measures will lead to a compression and extensive structural revaluation of the reefs due to areas massively devalued by historic stone fishing (see LCP, Section 9.1.3.7, ) and an improvement in the nature conservation value. After the compensation measures have been implemented, a nature conservation value of 5 is achieved, the related revaluation of the protected biotope in the intervention/ compensation assessment with a value of 1 will be considered, since a pre-existing legally protected biotope has increased in value.

### Location value in the Natura 2000 area

The planned measure area is located largely in SCI DE 1733-301 "Sagas Bank", in which the reef habitat type represents a preservation object. The development of the 'reef' preservation object is promoted in the long-term.

Recreating the boulder fields in the area of the Natura 2000 site DE 1733-103 "Sagas Bank" fulfils the requirements for upgrading areas with a B-C conservation status. The intended compensatory measure serves the purpose of achieving a functional upgrade to the areas assessed as having conservation status B-C, and fulfilling the requirements for achieving an 'A' conservation status.

By re-establishing biocenoses on secondary solid substrates, with their positive impact on biodiversity, water quality, fish numbers, etc. the creation of boulder fields makes an important contribution to achieving good conditions in bodies of water (pursuant to the European Water Framework Directive). The measure will contribute - within the meaning of the EU Water Framework Directive and Marine Strategy Directive - to strengthening diversity and the function of the marine ecosystem by introducing supplementary solid substrate as a balance for the historic loss of marine seabed geometries with a value of 2.

#### Eligibility for reef restoration measures (real compensation) reef - summary

The extent of eligibility must be determined according to the aforementioned valuation approaches and the respective results derived in accordance with the following formula:

**Extent of additive eligibility = area x** (Habitat revaluation: Value 2 with an existing nature conservation value of 3 or value 1 with an existing nature conservation value of 4 + revaluation of faunistic functions with a value of 2 + development of protected biotopes with a value of 1 + location in Natura 2000 area with a value of 2) **= compensation value of 7 or 6**.

In the immediate measurement area (see LCP, Attachment 12 of the plan approval documents, Section 9.1.3.7 and Annex IA, Measure no. 8.7 and Attachment 12.2, Sheet 12.1 and Attachment 30.4 of the plan approval documents) only reef areas with a nature conservation value of 3 were identified, which means that the higher compensation value of 7 is applied in this case.

For Measure 8.7 (see LCP, Attachment 12 of the plan approval documents, Annex IA) with a real area of 25.0000 ha results in eligibility of 25.0000 ha x 7 = **175.0000 ha**.

### 7.3.2. Eligibility of nutrient input measures in the Baltic Sea

The derivation of replacement measure used to reduce nutrient input into the (western) Baltic Sea is shown in LCP, Attachment 12 of the plan approval documents, Section 9.1.3.7. The eco-accounts/ measure areas used in the Fehmarnbelt Fixed Link project which meet the demands for reducing nutrient input, are summarised in LCP, Section 9.2.2.2 (see LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 11.1 to 11.4, 11.6 to 11.25 as eco-accounts and Measure 11.5 as a measure area).

The eligibility of measure area 11.5 ("Johannisbek 2") with an area of 2.6691 ha, in accordance with the procedures for the road construction orientation framework (MWAV & MUNF 2004), has an area of 2.5213 ha (see LCP, Attachment 12 of the plan approval documents, Section 11.1.1.5, Table 216).

Since, according to the eco-account and compensation list regulations of 23 May 2008 (in force from 12.06.2013 to 10.06.2018), Appendix I, one eco-point corresponds to a compensation of 1 m², which is the result of the eco-points derived from an eligible compensation area in square metres in a ratio of 1:1. The value of 2,097,964 eco-points (as of April 2016) corresponding to an eligible compensation area of **209.7964 ha**. Therefore, an eligible compensation area, which can be used as a replacement for interventions in the marine area, which totals **212.3177 ha** (measure areas and eco-accounts) is available.

### 7.3.3. Balancing with regard to faunistic function relationships

Disturbance to the marine fauna is also associated with the construction of the immersed tunnel for the Fehmarnbelt Fixed Link. Due to excavation work and the use of construction vessels, impairments to waterfowl life, marine mammals and benthic symbiotic communities cannot be ruled out. The disturbances caused by construction are temporary in nature and will no longer occur after the construction work has been completed.

Significant interventions to faunistic relations caused by the project were found The insignificant impairments caused by general disturbance impacts to the animal species found in the investigation area are considered in the impairment intensities found in the impact zones. The impairments to the benthic fauna are included in the quantitative compensation approach for benthic habitats and are thereby compensated for (see LCP, Attachment 12 of the plan approval documents, Section 11.5.3). For all other fauna elements in the marine area (planktic fauna, marine mammals, fish), resting birds and bird and bat migration, the impairments are identified as disturbances to the marine environment in the impact zones described in LCP, Attachment 12 of the plan application documents Section 11.4.1.3. The compensation requirement for impairments to faunistic functional relations in the marine area (resting birds, marine mammals, fish) in German coastal waters and the German EEZ amounts to a total of 171.6642 ha (see LCP, Attachment 12 of the plan application documents, Section 11.4.1.6, Table 238 and Section 11.5.1.ö,, Table 27, here: Table 242, here: "Impairment of faunistic relationships in the anchoring and 3 km disturbance zone"). In contrast, there is a compensation programme caused by the restoration of reefs amounting to 175.0000 ha (see LCP, Attachment 12 of the plan application documents Section 11.4.3.1).

### 7.3.4. Sum payments for the marine area

Insofar as the impairments to nature and landscape caused by the project do not need to be prevented or compensated or replaced by nature conservation and landscape protection measures in the sense of § 15 Para. 2 BNatSchG in conjunction with § 9 LNatSchG, the sum payments must be determined in accordance with § 15 Para. 6 BNatSchG I.e. in the case of the Fehmarnbelt Fixed Link project, sum payments will accrue if the aforementioned compensation measures do not lead to full compensation.

In the Federal Nature Conservation Act, on principle, to identify the value of compensation money for the production cost estimates is pursued i.e. the value of the compensation payment is defined using the average costs for the omitted compensation and replacement measures, including planning, maintenance and area preparation costs as well as personnel and administration costs (cf. § 15 Para. 6 Point 2 BNatSchG). In the marine area, there exists the issue that practical experience and example costs for compensation measures are only available sporadically and for individual cases.

Accordingly, the project proponents assigned a medium value to the experience values of compensation measures in the onshore area in Schleswig-Holstein which emanates from a mixed calculation of standard market prices in consideration of average planning and, where necessary, required maintenance costs and which is orientated towards average prices for an eco-point (which corresponds to the equivalent of one square metre) for eco-accounts in Schleswig-Holstein in accordance with eco-account regulations. This is estimated at a price of 4.50 €/m² (45,000.00 €/ha).

### 7.3.5. Conclusion

Taking into account all impacts in the marine area and on land, compensation is needed on a total of 559.62 ha. Table 80 shows a breakdown of the requirements for compensation for on-shore and marine impacts.

**Table 80 Determining the need for compensation – Summary**

| Location | Impact on | Need for compensation | Total |
|---|---|---|---|
| Land area | Biotope types | 43.0957 ha and 1,950 m of linear biotopes [1)] | |
| | Soil/ground sealing | 13,3460 ha | |
| | Faunistic functions | Multi-functional | |
| | Abiotic factors of particular significance | Multi-functional | |
| | Landscape | Multi-functional because there is less need for compensation (36.9570 ha) than with biotope types and soil/ground sealing | 58,4417 ha |
| Marine area<br>German coastal waters | Benthic habitats (loss) | 183.8287 ha | |
| | *Benthic habitats (impairment from sedimentation)[3)]* | *(48.1377 ha)[2]* | |
| | Impairment of faunistic relationships in the anchoring and 3 km disturbance zone | 96.2554 ha | |
| | Seabed of general significance,<br>seabed formations of particular significance | 32.2139 ha | |
| | Other abiotic factors | Insignificant | |
| | Landscape | Insignificant | 312.2980 ha |
| Marine area<br>German EEZ | Benthic habitats (loss) | 216.1024 ha | |
| | *Benthic habitats (impairment from sedimentation) [3)]* | *68.6356 ha)[2)]* | |
| | Impairment of faunistic relationships in the anchoring and 3 km disturbance zone | 75.4088 ha | |
| | Seabed geometries of particular significance | 18.9412 ha | |
| | Other abiotic factors | Insignificant | |
| | Landscape | Insignificant | 310.4524 ha |
| **Total need for compensation in ha** | | Land area<br>Marine area<br>**Total** | 55,4417 ha<br>622.7504 ha<br>**681.1921 ha** |

1) Plus 1,950 m of linear biotopes.

2) The compensation requirement for impairments to benthic habitats was not taken into account when calculating the overall compensation requirement, since the sum is lower than the compensation requirement for the impairment to benthic habitats in the anchoring and 3 km disturbance zone. The compensation requirement is thereby covered in a multifunctional manner.

## 7.4. Balancing onshore area

Onshore , 43.0957 ha of land requires biotope type-related compensation and overall compensation is needed along a length of 1,950  m of different linear biotope types, including biotopes protected by law under § 30 BNatSchG in conjunction with § 21, Para. 1 LNatSchG. Because of the new sealing and impairment caused by the project footprint > 5 years as an additional land-based compensation requirement an additional compensation requirement of 13.7526 is necessary.

Compensation – including offsetting in line with species protection legislation – is ensured through measures undertaken near the route and external areas on Fehmarn and measures undertaken within the framework of the recognised eco-account "Gömnitzer Berg" and "Krummsteert/Sulsdorfer Wiek" (see Section 7.1.1). The total area requiring compensation, including the chargeable eco-account area, amounts to 47.0396 ha. The area that can be charged to the eco-account"Gömnitzer Berg" covers 27.0394 ha and to the eco-account "Krummsteert/Sulsdorfer Wiek"  1.1945 ha and there is an area of 20.8023 ha requiring compensation near the route and external areas on Fehmarn Linear biotopes such as rows of trees, avenues of trees and ditches totalling 4,950 m. Additionally, measures with positive impacts on the ecosystem such as near-natural landscaping of reclamation areas (14.75) and unlocking measures (14.75 ha) and unlocking measures (4.2958 ha) will be implemented. The balance of impact/compensation shows that the amount of compensation needed can be covered by the measures envisaged on land. All impacts are therefore compensated for.

## 7.5. Balancing the marine area

The overall compensation requirement for benthic habitats and faunistic functional relationships amounts to 571.5953 ha (German coastal waters: 280.0841 ha, German EEZ: 291.5112 ha). For the seabed there is an additional compensation requirement of 51.1551 ha (32.2139 ha German coastal waters and 18.9412 ha in the EEZ). Thus, the total requirement for the German coastal waters area amounts to a compensation requirement of 312.2980 ha, for the German EEZ 310.4524 ha and the total compensation requirement for the German marine area is therefore **622.7504 ha** (see Table 81).

Overall, the area-equivalent compensation requirement identified, in accordance with § 15 Para. 2 BNatSchG corresponds to those impairments which must be compensated (compensation measures) or replaced (replacement measures) with nature conservation and landscape protection measures. An impairment is considered to be offset as soon as the impaired functions of the ecosystem are restored and the landscape is restored or redesigned as is appropriate. An impairment is considered to be replaced as soon as the impaired functions of the ecosystem in the affected natural region are restored in an equivalent manner.

Based on § 15 Para. 2 BNatSchG in conjunction with § 3 para 9 LNatSchG, it was investigated and show the measures with which the losses attributed to the Fehmarnbelt Fixed Link and impairments to benthic habitats, the seabed information of special significance and faunistic functional relationships in the marine area can be compensated or replaced (real compensation).

After offsetting the compensation measure resulting from the compensation measure of restoration of reefs and the replacement measures on reducing nutrient input into the Baltic Sea, there is a compensation requirement of 235.4327 ha (see Table 81). Payment for this compensation requirement is rendered in cash (sum money payment) in accordance with § 15 para 6 BNatSchG in conjunction with § 9 LNatSchG.

**Table 81 Remaining compensation requirement after offsetting compensation and replacement measures in the marine area**

| | | |
|---|---|---|
| Overall compensation requirement in the German marine area | (see text above) | 622.7504 ha |
| Eligible compensation measures (reef restoration) | (see LCP, Attachment 12 of the plan approval documents, Section 11.4.3.1) | -175.0000 ha |
| Eligible replacement measures (nutrient reduction, Baltic Sea) as eco-accounts (without interest - converted into area) | (see LCP, Attachment 12 of the plan approval documents, Section 11.4.3.2) | -209.7964 ha |
| Eligible replacement measures (nutrient reduction, Baltic Sea) as a measure area | (see LCP, Attachment 12 of the plan approval documents, Section 11.4.3.3) | -2.5213 ha |
| **Remaining compensation requirement (without interest on eco-accounts)** | | **235.4327 ha** |

Interest is paid on the value of measures arising from eco-accounts (see LCP, Attachment 12 of the plan approval documents Section 11.4.3.2). The sum payment is calculated in consideration of the compensation requirement remaining after interest has been paid on measures arising from eco-accounts (see also LCP, Attachment 12 of the plan approval documents, Section 9.1.3.9), with the reservation in accordance with § 141 Para. 3 LVwG (cf. LCP, Attachment 12 of the plan approval documents, Section 9.2.2.2., Table 2), as follows:

Remaining compensation requirement 235.4327 ha x 45,000.00 EUR/ha = **10,594,471.00 EUR**.

As a result, the sum payment comes from the aforementioned amount calculated less interest on the measures resulting from eco-accounts.

Compensation payments, which according to § 15 Para 6 BNatSchG in conjunction with § 9 Para. 6 LNatSchG should wherever possible be used for nature conservation and landscape maintenance measures in the Fehmarnbelt area of unspoiled nature, fully compensates for the impacts. This area is before the D72 natural region in the western Baltic Sea.

The impacts are completely compensated for by the planned nature and landscape conservation measures, as well as the definitive and determined replacement payment, interventions in the marine area are fully compensated.

# 8. Impact assessment for strictly protected species

Details of the conflicts arising from species protection legislation can be found in the impact assessment for strictly protected species (see Attachment 21 of the plan approval documents).

## 8.1. Island of Fehmarn

The table below shows the species/classes affected by species protection legislation and the conflicts (Fehmarn) by way of an overview (only those species/classes which are considered in more depth following the relevance consideration in the impact assessment for strictly protected species, Attachment 21 are included in the table and text section that follow).

**Table 82 Summary of conflicts for species/classes adversely affected and derivation of necessary measures (see Attachment 21 of planning approval documents)**

| Species | Conflict | Measures (no. in LCP, Attachment 12) |
|---|---|---|
| Bats | | |
| Sopranopipistrelle | - Risks to individuals in structures or trees affected by impact (daytime hideouts/temporary accommodation)<br>- Systematically greater risk of collision near the tunnel portal during migration | - Demolition and clearing work during Winter (Dec-Feb) or closure of temporary accommodation following prior control on extension (LCP, Annex IA, Measures no. 0.6)<br>- Adapted lighting at the tunnel portal during operation phase (LCP, Annex IA, Measures no. 5.3) |
| Nathusius' pipistrelle | - Risks to individuals in structures or trees affected by impact (daytime hideouts/temporary accommodation)<br>- Systematically greater risk of collision near the tunnel portal during migration | - Demolition and clearing work during Winter (Dec-Feb) (LCP, Annex IA, Measure 0.6)<br>- Adapted lighting at the tunnel portal during operation phase (LCP, Annex IA, Measures no. 5.3) |
| Common pipistrelle | - Risks to individuals located in structures or trees affected by impact (daytime hideouts, mating/temporary accommodation)<br>- Systematically greater risk of collision near the tunnel portal during migration | - Demolition and clearing work during Winter (Dec-Feb) (LCP, Annex IA, Measure 0.6)<br>- Adapted lighting at the tunnel portal during operation phase (LCP, Annex IA, Measures no. 5.3) |
| Amphibians | | |
| Great crested newt | - Risk of death and injury for the populations in bodies of water FBioAm55, FAm158, FAm160, FAm162, FAm164, FAm166 und FAm171 due to impact on one water body (FAm158) and land habitats | - - Fencing off of impact areas in the aquatic phase (April – start of May) over the entire construction period (LCP, Annex IA, Measures-no. 3.5, nature conservation prevention measure)<br>- Capturing amphibians in the water bodies FBioAm55, FAm158, FAm160 FAm162, FAm164, FAm166 und |

| Species | Conflict | Measures (no. in LCP, Attachment 12) |
|---|---|---|
| | - Loss of one body of water and (temporary) loss of land habitats potentially of existential significance | FAm171, directly following last capturing exercise (no evidence found) (LCP, Annex IA, Measures-no. 3.3), nature conservation prevention measure.<br>- Suitable species-specific ponds, functional controls two years after a body of water is created with regard to current status and development trends (near interventions however, not necessarily preferred, LCP, Annex IA, Measuresno. 4.1). Additional habitat offering for Great Crested Newt before the building measures (LCP, Annex IA, Measure No. 9.5)<br>- Creation of suitable temporary and permanent hideouts on land in parallel to new rail route over a distance of 1,680 m, environmental supervision when creating a hideout (LCP, Annex IA, Measures-no. 1.3, 2.2, 3.5 and 3.6) |
| Breeding birds | | |
| Skylark | - Clutch losses and danger to young birds in the construction area which cannot fly for one breeding pair<br>- Long-term loss of habitats in one area due to operation-related noise load | - Reducing construction time or startling measures used to prevent death and injury (LCP, Annex IA, Measures-no. 0.9)<br>- Ensuring habitat continuity through preferred design of a compensation area (plot 7/1) in the Puttgarden district with the development of damp to mesophilic green spaces and corresponding extensively adapted management (LCP, Annex IA, Measures no. 9.4)<br>- Supervisory monitoring and/or monitoring of success up to five years after end of build (see LCP, Annex IA, Measures-no. 7.1 and Section 9.7) |
| Lapwing | - Not completely ruling out temporary habitat loss or reduced reproductive success in the construction phase for a breeding pair | - No species-specific measures required as the temporary effect does not exceed the materiality threshold § 44 (1) 2 BNatSchG and is therefore does not lead to prohibition. Additionally, by building the replacement habitat with a permanent pioneer character as a CEF measure for the ringed plover (LCP, Annex IA, Measures no. 9.5), which also represents a very attractive habitat structure for plovers, some of the disturbance-related potential impairments are either levelled or expected to be fully compensated |

| **Species** | **Conflict** | **Measures (no. in LCP, Attachment 12)** |
|---|---|---|
| House martin | - Clutch losses and danger to young birds in the construction area which cannot fly | - Temporary demolition and clearing work in Winter (December-February), Measure no. 0.6 |
| Ringed plover | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Permanent habitat loss due to area being built on | - Startling measures in case construction does not start before the breeding season (mid-May) or extend further into the breeding season, LCP, Annex IA Measures no. 7.5<br>- Additionally, by building the replacement habitat with a permanent pioneer character as a CEF measure for the ringed plover, accompanying monitoring to ensure permanent habitat quality via the corresponding protection measures (LCP, Annex IA, Measures no. 9.5 |
| Guild: Not at-risk species of bird which use old tree stocks (GB) | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Long-term loss of habitat due to site being built over and/or clearance work for temporary use of land<br>- Long-term loss of habitat as areas near the route are no longer suitable habitats due to noise | - Restriction on clearance periods (October to mid-March, LCP, Annex IA, Measures-no. 0.6)<br>- Installation of four stock dove bird boxes, with expert support, before impact occurs (LCP, Annex IA, Measures-no. 9.1) near Blankenwisch<br>- Creating replacement habitats by planting shrubs (required in advance, LCP, Annex IA, Measuresno. 3.2, 5.1, 5.2 und 10.1), one-off function check one year after planting |
| Guild: Non endangered bush breeders (G) | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Long-term loss of habitat as areas near the route are no longer suitable habitats due to noise | - Restriction on clearance periods (November to early March, LCP, Annex IA, Measures-no. 0.6)<br>- Creating replacement habitats by planting shrubs (required in advance, LCP, Annex IA, Measures-no. 2.2, 3.2, 5.1, 5.2 und 10.1), one-off function check one year after planting |
| Guild: Not at-risk birds which breed in hollows and nests (B)<br>- | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Loss of nesting sites | - Restriction on clearance and demolition period (September to end of March, LCP, Annex IA, Measures-no. 0.6)<br>- Compensation for loss of nesting sites through stump and stone packing (LCP, Annex IA, Measures-no.1.3, 2.2, 3.5 and 3.6)<br>- Avoidance of disturbing occupied nests when dismantling stump and stone packing through environmental consultation supervision (LCP, Annex IA, Measures-no. 1.3 3.5) |
| Guild: Not at-risk bird species inhabiting open ground, reed beds, | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Long-term loss of habitat as areas near the route are no | - Reducing construction time or startling measures used to prevent death and injury (same as for skylarks, LCP, Annex IA, Measures-no. 0.9) |

| Species | Conflict | Measures (no. in LCP, Attachment 12) |
|---|---|---|
| sedge thickets and corridors of tall shrubs at damp to wet sites (O) - | longer suitable habitats due to noise | - Creating replacement habitats for the yellow wagtail as compensate for skylarks achievable (LCP, Annex IA, Measures-no. 9.4) |
| Guild: Not at-risk bird species inhabiting semi-open sites/ecotones (OG) | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Long-term loss of habitat as areas near the route are no longer suitable habitats due to noise | - Restriction on clearance periods (September to end of March, LCP, Annex IA, Measures-no. 0.6)<br>- Creating replacement habitats by planting shrubs (required in advance, LCP, Annex IA, Measures-no. 3.2, 5.1, 5.2 and 10.1), one-off function check one year after planting |
| Guild: Not at-risk species of bird which use bodies of water (W) | - Clutch losses and danger to young birds in the construction area which cannot fly<br>- Long-term loss of habitats due to one body of water being built over near the Puttgarden junction (FBioAm57) | - Preferential filling of bodies of water used for breeding in winter months before the build (, LCP, Annex IA, Measures-no. 3.7)<br>- Establishment of a substitute habitat by creating a semi-natural small body of water (LCP, Annex IA, Measures-no. 4.1). Function check for species-specific positive development trends two years after body of water is created |

### 8.1.1. Bats

Conflicts pertinent to species conservation are ruled out in the relevance check conducted for the planned project (see Attachment 21 of the plan approval documents, Section 4.2.2.1.1) for the serotine bat, natterer's bat, long-eared bat and Daubenton's bat. As with earlier surveys, the update mapping carried out in 2014/2015 identified only very low numbers of individuals and local frequency rates and only individual contacts in the investigation area.

In the area of the project, only slow-moving vehicles may only travel at a speed of 50 kph maximum during the construction phase. If vehicles are travelling at speeds of ≤ 50 kph, the likelihood of species conservation collision risk for bats increasing is very low (LBV-SH 2011). In this case, access restrictions in accordance with § 44, Para. 1, Point 1 BNatSchG can generally be ruled out with a fair degree of certainty.

Conflicts pertinent to species conservation with the planned project cannot be fully ruled out on the basis of the current data situation for the soprano pipistrelle, nathusius pipistrelle and common pipistrelle. In this regard, an in-depth conflict analysis has been carried out in the ASB (Attachment 21 of the plan approval documents, Section 5.1.1.1 to 5.1.1.3).

Impairment to flight routes considered as a disturbance in the sense of § 44 (1), Point 2 BNatSchG, can be ruled out. For the soprano pipistrelle, Nathusius' pipistrelle, pond bat and common pipistrelle, no flight routes in the sense of the working aid (LBV-SH 2011) were found, since the threshold of ≥ 10 bat contacts was not reached even once within a time interval of 120 minutes (Attachment 30.2 of the plan approval documents).

The planned shrub plantings provided in the LCP in the area where the K 49 crosses the route and the base of its embankments (LCP, Annex IA, Measures 1.2, 2.2, 3.2, 5.1, 5.2) are not required as species conservation prevention measures. Rather, they are designed in such a way that they can be used as a potential guiding structure over the heavily-trafficked routes. The tree-free gaps directly above the existing routes can be regularly overcome by species classified as having low to medium structure dependence i.e. the soprano pipistrelle, nathusius pipistrelle and common pipistrelle.

### Bat migration

In summary, bat migration in the project area on Fehmarn only takes place on a qualitative and quantitative level, which means that conflicts pertinent to species conservation can largely be ruled out. A significantly increased death and injury risk can be ruled out due to the lack of the corresponding area structures. There is also little likelihood of the general risk to life being exceeded due to collision danger ensuing from the increased road and rail transport. On the one hand, the numbers transiting through the route does not imply the presence of a significant migration corridor. On the other hand, giving it such a value however is a decisive factor with regard to the species conservation appraisal of the collision risk for towing animals - similar to how migratory bird species are addressed. In this regard, the residual risk to the general risk to like for migratory bats cannot be completely attributed to transport-related losses.

Likewise, the reduction of woodland stockpiles during the construction phase caused as a result of site clearance will not lead to a significant impairment to bats. This is based on the low number of migrating individuals using these structures and the lack of value given as a central functional element to the bat migration on Fehmarn.

It is only in the areas of the planned tunnel ramps and tunnel portal where conflict situations relevant to species compensation cannot be ruled out. The reason for this lies in the fact that the investigations on the bat migration over the Belt identified high frequencies over the Grüner Brink and Katharinenhof i.e. along the coast. No relevant bat migration was found on the Island of Fehmarn because the migration takes place along the coast and the area of the tunnel portal located on the coast is also frequented by bats. Potential dangers exist only due to possible attraction effects caused by lighting (with the corresponding attractive insect influxes). There are conflicts for the soprano, common and nathusius pipistrelle (see above). These species do not only represent by far the largest share of bat activity during migration periods, they are also potentially affected by the presence of summer populations. All other species of bat found in the North Fehmarn region or which migrate through the Belt area and for which a potential attraction effect caused by unadjusted lighting cannot be ruled out, may be subsumed by this measure planning for the aforementioned species and cannot therefore be addressed separately (e.g. LEIA-reportler's bat, particoloured bat). This is due to their rareness and sporadic occurrence and their (very) low proportion in the overall migration. It is therefore difficult to separate the general risk to life from a sufficiently justifiable systematic danger for these (migratory) species from a purely quantitative perspective (see above). For those species characterised by light sensitivity (e.g. natterer's, pond and Daubenton's bat, cf. LBV-SH 2011), there is not corresponding conflict potential, per se, because these species do not appear in the investigation area on a regular basis and, even then, only as individuals.

### 8.1.2. Amphibians listed in Annex IV of the Habitats Directive

The project only produces conflicts arising from species protection legislation for the great crested newt. One body of water is being built over directly as part of the project. An impact-related and significantly greater risk of death and injury in all life phases of the crested newt is therefore predicted for body of water FAm158. Furthermore, all potential onshore habitats, including potential wintering habitats (woodland areas along the railway and B 207 route and the K 49 south of the embankment) will be significantly impaired by the project. For the bodies of water FBioAm55, FAm160, FAm162, FAm164, FAm166 and FAm171, a risk is only expected in the onshore habitats as a result of potential main migration routes being dissected and the loss of woodland along the B 207/rail route and along the K 49 south of the embankment. The water bodies themselves will not be impaired. The standing stocks of great crested newts in water bodies FAm147 and FAm167 will not be affected by project- and species conservation-related conflicts.

In order to avoid infringements of the prohibitions imposed by § 44, Para. 1, Point 1 BNatSchG from systematically greater risk of death and injury, a mobile amphibian protection fence will be erected over a distance of around 1,680 m during the construction work. Because of this, the risk of death and injury for all great crested newts in the water bodies FBioAm55, FAm158, FAm160, FAm162, FAm164, FAm166 and FAm171, which, when necessary, use the intervention areas as onshore habitats, is reduced to an unavoidable minimum (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 1.3 and 3.5).

The amphibian standing stock for the body of water FAm158 will be captured during the main aquatic phase (before capturing operations begin, structures located in the waters - primarily dead plant material - are removed as a precautionary measure and deposited at the edges of the water body) after which the water body is filled up (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 3.3). In coordination with the MELUR/LLUR on 19.08.2014 and the corresponding approval, capturing exercises commenced in 2015 and should extend to the years up to the time construction begins. As part of the capturing and resettlement exercises, the FAm162 and FAm166 water bodies will be included in order to prevent great crested newts from migrating to the FAm158 water body. This was previously practised in 2015. In addition to this, beginning from 2016, the water body FAm171 will be included in the capturing exercises since the standing stocks of great crested newts, according to Runge et al. (2010) could traverse the 500 m distance to the FAm158 water body. Based on the new data obtained from the update mapping (Attachment 30.2 of the plan approval documents), which showed water bodies populated by great crested newts within a 500 m radius of the rail and road embankment, from 2016 capturing exercises will also be carried out for the three water bodies FBioAm55, FAm160 and FAm164 (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure no. 3.3)

The complete loss of body of water FAm158 will be compensated for by the creation of a new substitute body of water which is spatially connected to the crested newt waters, thereby creating a high potential for settlement (LCP, Annex IA, Measure no. 4.1).

The application of the ban on access according to § 44 (1), Point 3 BNatSchG, triggered by the intervention-related loss of significant onshore habitats (winter hideouts) would suggest

that no alternative habitats could be found in average walking distance of the most outlying, structure-poor surrounding area. The avoidance of the project-related loss and/or the impact- and measures-related interruption in functionality of potentially existential overwintering habitats (strips of woodland along the current B 207/rail route) will take place before the impact and/or after the construction site has been fenced off before the terrestrial phase (from mid-July). Temporary winter shelters for great crested newts will be built along the mobile amphibian protection fences. These will be replaced by permanent structures at the end of the construction phase. So that the dismantling of the temporary winter structures will not therefore entail an increased danger potential for the newts using said structures, they must be dismantled during the aquatic phase (April to the end of June). In this time period, there is a high probability that no great crested newts will be found in the onshore habitats. If they cannot be dismantled in this period, the temporary winter structures must be removed before the increased escapement into the onshore habitats (from mid-July), until they are fully dismantled and the permanent winter structures have been installed in the same season (at the latest by mid-September). In order to ensure that, under these circumstances, the newts temporarily migrating to these winter structures do not suffer an increased mortality risk in the low-coverage agricultural areas (predation, desiccation), temporary shelters must also be assembled in front of the fence (towards the breeding waters). To do this, roughly every 30 m on the fence (in total around 58 on roughly 1,650 m of track 7+300 to 8+980) bright, at least 1m x 1 m shelters must be provided on the ground surface (LCP, Attachment 12 of the planning approval documents of the plan approval documents, Annex IA, Measures no. 1.3 and 3.5).
As soon as the temporary winter hideouts are dismantled, permanent structures of 1,170 m along the new rail route and at the new body of water to be created. When building the temporary winter shelters, the aforementioned measures and periods intended to prevent the risk of death and injury must be adhered to (LCP, Attachment 12 of the plan approval documents, Annex IA, Measures no. 2.2 and 3.6).

### 8.1.3. Breeding birds

A total of 48 breeding bird species must be taken into account according to species protection legislation. Of these, following the relevance check (see SPC, Attachment 21), the skylark is subject to a single-species study. The other species of breeding birds are studied as part of six breeding bird guilds.

#### Single-species study

*Skylark*

With a view to balancing out the consequences resulting from interventions and permanent project-related impairments to skylarks, it is not helpful to compare the strong use dependence of the species and, therefore, the use-dependent change in districts in a general manner against the overall possibility of evasion. Despite the use-dependent settlement dynamics, a permanent reduction in area availability should, if necessary, be compared against future losses in habitats. For this reason, the adjusted stock and the corresponding distribution of areas are used as a status quo for the purposes of the assessment.

In order to avoid project-related deaths from the start of the breeding season (15 March onwards), measures will be taken (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 0.9) to impede construction and presence of nests. Alternatives to startling measures include limiting the construction times and/or a coordinated construction time schedule to avoid a significantly increased risk of death and injury. This would involve construction work (including ground work) only being undertaken outside the breeding season (mid-March) and continued non-stop until the end of July. A third option is to set up opaque structures at least 3m in height (e.g. mobile fencing elements) on the affected areas which could potentially be suitable for colonisation by skylarks (and other open land species) by avoiding areas with heavy vertical structuring. Such elements must be installed before the start of the breeding season (mid-March – July) and must be built before disturbance-intensive building work begins or dismantled again at the end of the standard breeding season (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 0.9).

Project-related disturbances cannot be ruled out for three breeding pairs (chainage-km 8+600 railway, chainage-km 8+160 road and chainage-km 7+970 railway). Of these, two grounds are found in the intervention areas, but are not directly impacted. However, disturbances to these breeding pairs caused during the construction phase, located as they are around 80 to 85 m away from the construction site, cannot be ruled out. One of the grounds is within the temporary area for the construction site.

After the end of the construction phase, potentially disturbed grounds, at least the one located at chainage-km 8+600 (railway) can be used again. In the case of the ground located at chainage-km 8+160, permanent habitat loss caused by noise pollution can be ruled out. There will be an impact on skylarks according to § 44 (1), Point 2 BNatSchG caused by significant disturbances.

The planned project will cause a 10% reduction in habitat quality for two habitats in accordance with the requirements stipulated by Garniel & Mierwald (2010), which will corresponds to a permanent loss of **one** habitat pair due to project-related noise load. To compensate for the permanently claimed skylark habitat, the plot 7/1, which is located west of Puttgarden in the district of Puttgarden, and which has an area of 5.75. will be developed as the preferred compensation area (CEF measure) (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 9.4).

The entry into force of species conservation entry bans according to § 44, Para. 1 BNatSchG, can be avoided by considering the measure planning presented.

*Lapwing*

There are no habitats within or in the immediate vicinity of the intervention area. The closest habitat centre for the lapwing in the vicinity of the intervention area (road) is located approx. 50 m away and, therefore, is separated from the area by Nieland ditch. There is no chance of collisions with construction vehicles because of the low speeds. The railway route is over 130 m away and the planned B 207 route is located west of the current railway and road embankment. Permanent habitat losses for the lapwing caused by the project can be ruled out. Access prohibitions under § 44, Para. 1, Points 1 and 3 BNatSchG do not apply.

Project-related disturbances with startling effects owing to the proximity of the habitat centre to the intervention area (50 m) cannot be ruled out for one breeding pair. Where there are disturbances with a potentially affected breeding pair, this can generally lead to evasions into undisturbed areas and Nachbruten (translator's note: can't find this word). In addition, before interventions begin, a habitat which is also attractive to plovers will be created during the construction phase as a pioneer habitat to the west of Puttgarden (permanent replacement habitat for ringed plovers, LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 9.5). There will be an impact on ringed plovers according to § 44, Para. 1, Point 2 BNatSchG caused by significant disturbances.

*House martin*

Given that the house martin breeds in the immediate vicinity of the route, there is a risk that nestlings will be killed or nests will be destroyed in a potential site clearance during the standard breeding season (end of April - start of September). In order to avoid risk of death and injury, demolition works must take place outside the standard breeding season (end of April to start of September). The temporary restrictions on demolition works applied for bats are also suitable for avoiding conflict potential for the house martin (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 0.6).

Since the location of the colony is directly affected by construction activities, it cannot be assumed that there will be construction- and operation-related disturbances to the affected colony. If construction commences during breeding season, the measures implemented to avoid deaths will also prevent certain disturbances, since there will be no settlements in the construction area.

While the route is being planned, a new railway and road underpass under the K 49 is planned, which could potentially be made available as a location for house martins. The breeding grounds located under the current bridge construction must be classified as facultative use. The immediate surroundings contain several appropriate habitats. It also cannot be ruled out that the new bridge construction can be used in the same way as this one is. Therefore, there is no compensation requirement for the affected habitat in the sense of § 44 Para. 5 BNatSchG.

The entry into force of species conservation entry bans according to § 44, Para. 1 BNatSchG, can be avoided by considering the measure planning presented.

*Ringed plover*

In the beach area between the planned tunnel portal and to the west of Marienleuchte, the update mappings found a ringed plover habitat which needs to be taken into consideration as part of the design to ensure that permanent as well as temporary construction-related effects are considered.
The result is the project-induced loss of a ringed plover habitat. Since the location is directly used during the construction phase of the project, there will be temporary impairments caused by acoustic and visual stimuli, but it will also stop design-related loss.

Given that the house martin breeds in the immediate vicinity of the intervention area to the north of the tunnel portal, startling measures must be employed during the standard breeding season (mid-May - start of August) in order to avoid the direct killing of nestlings and the destruction of nests during potential site clearance. A startling exercise must be carried out within the species-specific breeding season over the whole area of the affected beach section located to the south of Puttgarden breakwater. If the ringed plover (or any other potential breeding bird species such as oystercatchers) is found, disturbance-intensive startling tactics must be employed at least twice per day. If construction begins outside the breeding season, these measures need not be adopted (LCP, Annex IA, Measure 7.5). An entry ban according to § 44, Para. 1, Point 1 BNatSchG, can be avoided by considering the species conservation measure.
Due to the permanent loss of habitat caused by intervention, a replacement habitat will be developed as a substitute for the affected habitat as part of a CEF measure. To do this, an area of historic farmland 5.3 ha in area located to the west of Puttgarden will be developed and maintained for this species. This replacement habitat is around 1.7 km from the current habitat centre on the beach to the east of the breakwater. The spatial link between the replacement habitat and the affected habitat is ensured by the high species-specific mobility (LCP, Attachment 12 of the plan approval documents, Annex IA, Measure 9.5).
The entry into force of species conservation entry bans according to § 44, Para. 1, Point 3 BNatSchG, can be avoided by considering the measure planning presented.

**Breeding bird guilds**

To avoid infringements of the prohibition on killing and injuring imposed by § 44 Para. 1 no. BNatSchG in the breeding bird guilds of birds which are not endangered and use old tree stocks (GB), bushes and other wooded structures (G), and breed in hollows and shelters in buildings (B) and not endangered bird species in half-open locations and ecotones (OG) clearance and/or demolition work must be carried out outside the breeding season (LCP; Annex IA, Measure 0.6). To avoid death and injury to yellow wagtails as the representative of the breeding birds guild of not endangered bird species which breed in open landscape, reedbeds, reed marshes and forb communities in damp to wet locations (O) and not endangered species which breed in half-open locations and eco-tones (OG) , a restriction on building times or startling measures similar to that used for the skylark must be carried out (LCP, Annex IA, Measure 0.9). In terms of the breeding bird guild of not endangered species associated with water (W) the Eurasiancoot will be affected by the project. To avoid the access ban according to § 44, Para. 1, Point 1 BNatSchG for not endangered species of bird associated with water the water bodies FBioAm57 and, as a precaution, FBioAm56 will be filled during the winter months for not endangered species of bird associated with water (LCP, FBioAm57 and, as a precaution, FBioAm, Annex IA, Measures 2.1 and 3.7).

In terms of the six guilds of breeding birds studied, there are no disturbances of relevance to population in accordance with Art. 44, Para.1, Point 2 BNatSchG.

The following table below provides an overview of the breeding pairs/
areas affected in the long term and the compensation needed as a result of impact on the breeding areas of guilds of breeding birds not at risk (see ASB, Attachment 21 of the plan approval documents, Section 5.2.1.2).

**Table 83 Overview of areas of breeding bird guilds affected**

| Breeding bird guild | Breeding pairs/areas affected | |
|---|---|---|
| Not at-risk species of bird which use old tree stocks (GB) | 12 areas | Blue tit 1<br>Spotted flycatcher 5<br>Stock dove 2<br>Hawfinch 1<br>Great tit 3 |
| Not at-risk species of bird which breed in shrubs and other woody structures (G) | 72 areas | Blackbird 4<br>Chaffinch 4<br>Willow warbler 1<br>Garden warbler 4<br>Icterine warbler 5<br>Green finch 3<br>Dunnock 9<br>Lesser whitethroat 9<br>Blackcap 7<br>Wood pigeon 9<br>Robin 5<br>Song thrush 2<br>Winter wren 3<br>Chiffchaff 7 |
| Not at-risk birds which breed in hollows and nests on or in buildings (B) | 2 areas | White wagtail 2 |
| Not at-risk bird species inhabiting open ground, reed beds, sedge thickets and corridors of tall shrubs at damp to wet sites (O) | 4 areas | Reed bunting 1<br>Yellow wagtail 2<br>Reed warbler 1 |
| Not at-risk bird species inhabiting semi-open sites/ecotones (OG) | 28 areas | Common redpoll 1<br>Linnet 5<br>Whitethroat 12<br>Pheasant 4<br>Yellowhammer 2<br>Cuckoo 1<br>Goldfinch 3 |
| Not at-risk species of bird which use bodies of water (W) | 4 areas | Eurasian coot 1<br>Mallard 3 |

In order to avoid long-term loss of habitat in accordance with § 44, Para. 1. Point 3 BNatSchG within the guilds, compensation is provided for the impairments to habitats affected and adequate substitute habitats created. For breeding bird guilds GB, G and OG, the planting of woodland, which does not necessarily have to take place before the build but is planned as part of the project, can act as substitute habitats (LCP, Attachment 12 of the plan approval documents; Annex IA, Measures no. 3.2, 5.1, 5.2, 10.1). In addition, the species profit from other woodland plantings which are not held as original species conservation measures (LCP Attachment 12 of the plan approval documents, Annex IA, Measure no. 1.1, 1.2, 2.3, 3.1). The noise-related reduction of habitat suitability for replacement habitats near the route is considered as part of the scope of the replacement habitats. To avoid long-term loss of habitat for the stock dove (guild GB), nesting aids are provided in the vicinity (LCP, Attachment 12 of the plan approval documents Annex IA, Measure 9.1). The substitute habitats planned for the skylark are also suitable for the yellow wagtails affected such that long-term loss of habitat is avoided (LCP Attachment 12 of the plan approval documents, Annex IA, Measure 9.4). A new body of water is created for the breeding bird guild W (LCP Attachment 12 of the plan approval documents, Annex IA, Measure 4.1). The stump and stone packings, created as temporary and long-term habitat compensation for the crested newt (LCP Attachment 12 of the plan approval documents, Annex IA, Measures no. 1.3, 2.2, 3.5, 3.6) also serve as an avoidance measure for the white wagtail. The systems of gaps and/or niches produced in the heaps provide adequate nesting sites for the white wagtail (B).

## 8.2. Marine area

As for the land area of Fehmarn, only those species/classes which are highlighted with regard to conflicts arising from species protection legislation following the relevance check in the SPC (Attachment 21 of the plan approval documents) are considered below.

### 8.2.1. Atlantic sturgeon

The European sturgeon (*Acipenser sturio*) is extinct in the Baltic Sea according to the Red List for Fish and Cyclostomes in Germany (Thiel et al. 2013). However recapture data from various sources has shown evidence of sturgeon sightings over the last few years in the southern marine area of the island of Fehmarn (two individual sightings). Sightings were also made along the coast of Schleswig-Holstein (five individuals) and in the Kiel Canal (seven individuals). The appearance of individual Atlantic sturgeon in the Fehmarnbelt region during construction project cannot be ruled out, even if it is just an individual sighting.

It is assumed that the Atlantic sturgeon will become aware of the construction activities early on and evade them. Therefore, species conservation conflicts with the Atlantic sturgeon in connection with water extracted as part of the seawater desalination plant and ballast of tunnel elements can be ruled out. The injury or death of an animal is ruled out.

The only possible disturbance to this fish species will be in connection with migration (here this is essentially between pasture areas). Impairment of spawning activity and larvae can be ruled out (no river basin districts with spawning potential in the Fehmarnbelt area). Impairment is restricted to a barrier effect caused by the project as a result of sediment disturbance and noise emission. The sturgeon is very well adapted to increased sediment suspension since this fish species, due to its lifestyle, which includes foraging through the upper ground layers in the search for nutrients as well as its long migration in rivers, makes it extremely well adapted to heightened concentrations of turbid materials. A barrier effect caused by suspended sediment is therefore not expected. There is no information currently available on the sturgeon's hearing capacity. Given the lack of connection between the air bladder and otoliths, it can be assumed however that this species is no more sensitive to construction-related noise than, for example, the cod or the herring. Accordingly, when compiling the impact assessment (cf. Attachment 15 of the plan approval documents, EIA-REPORT, Volume IV B, Section 8.3.9), for the latter two fish species, no impairment was found for the Atlantic sturgeon with regard to construction-related noise emission.

Since the propagation areas used by the Atlantic sturgeon are found in watercourses, in no way can they be "damaged or destroyed" as defined in species conservation legislation. The sturgeon has no specific "resting places". During the phase spent in the sea, there are no known "resting places" in which the animals congregate at sensitive points of their lifespans. Therefore, "damage or destruction" in the sense of species conservation legislation is ruled out.

### 8.2.2. Harbour porpoise

The harbour porpoise is a species listed in Annex IV of the Habitats Directive and is of relevance to studies given its regular occurrence in the Fehmarnbelt.

Infringements of the prohibitions imposed by Art. 44 (1) no. 1 BNatSchG (prohibition on killing and injuring) could only arise through noise emissions. Other impact factors only affect the animals indirectly. Noise emissions may arise from dredging work for the tunnel trench and from shipping as well as sheet piling.

At high intensity, underwater noise can lead to the injury and death of marine mammal species. For the harbour porpoise, temporary hearing damage has been identified at around 165 dBSEL (Tougaard et al. 2015). To avoid injury, the BMU's noise protection concept (2013) has defined a limit for impulse sound (vibrations) of 160 dBSEL and 190 dBpeak, which must fall below 750 m from the source. Furthermore, it must be ensured that there are no marine mammals residing in the area of high noise emissions in order to avoid injury. Even when the limit is not exceeded, there are precautionary measures for the neighbouring area which must be met.

When building the immersed tunnel, noise emissions are primarily caused by the continued emissions given off by construction ships. These emissions are overwhelmingly deep frequency and low intensity. These emissions present no danger of damaging marine mammals since they can avoid these small areas of high noise intensity. During the construction works for the Puttgarden temporary harbour, around 330 sheet piles need to be driven. For the noise emissions caused by these activities, the environmental impact statement (Attachment 15 of the plan approval documents) takes the source level of 202 dB re 1μPa as its basis. At 750 m from the construction site, a level of 154 dBSEL is reached, which means that the requirements of the BMU's noise protection concept are met.

Since the limit of 160 dBSEL at 750 m is not exceeded, there is no need to apply noise emission reduction measures. However, as a precaution, avoidance measures will be used to scare harbour porpoises away from the area surrounding the construction site. Firstly, a series of piles are to be driven using a ramp-up procedure in which the pile driving energy increases gradually, so that the maximum sound levels are not immediately reached and animals can distance themselves from the area close to where piles are being driven. On the other hand, harbour porpoises will be kept away from the area surrounding the construction site by using pingers (see also LCP, Attachment 12, Annex IA, Measure Sheet 8.1 $M/V_{Ar}$). It will also be investigated whether the planks can be driven, which would mean lower noise emissions.

Damage to individuals caused by spontaneous flight behaviour, which could lead to the separation of mother and calf pairs, is ruled out since the planned works will not cause any sudden, far-reaching noise emissions.

A disturbance effect is caused by the permanent ultrasound of excavators and construction ships of an approaching ship or - if the works are stationary - by a harbour porpoise approaching the working area. The noise emissions can lead to an area being used less or avoided by harbour porpoises when the porpoises evade a ship or working area. These evasion movements, due to the low noise emissions, are very localised i.e. a few hundred metres, and, at normal swimming speeds, a harbour porpoise can execute them in very little time. Therefore there is no likelihood of a flight reaction, such as would be feared during pile driving, in the context of permanent ultrasound from excavators and ships' engines.

Therefore conflicts according to § 44 Para. 1, Point 1 BNatSchG are ruled out.

The construction-related noise emissions may result in disturbances to harbour porpoises over small areas. Noise emissions caused by excavation work and the increased ship traffic resulting from this, in addition to the increased noise emissions caused by the works associated with building the immersed tunnel are not subject to any defined threshold criteria, which means there are no regulations governing noise emissions generated by individual ships.

The behavioural reactions of harbour porpoises are evaluated in two stages in the evaluation criteria of the EIA-REPORT (see also EIA-REPORT, Attachment 15, Volume III, Section 5.2.10.1, Table 5-112): Up to a noise level of 150 dB, an impairment is evaluated as medium ("The noise levels are high enough to lead to behavioural disturbances"), and up to 144 dB as low ("The noise levels are high enough to lead to expectations of some marginal behavioural reactions."). The categories were defined on the basis of studies carried out on both pulsed noise and permanent noise. The latter was based partly on a study conducted into the reaction of harbour porpoises to excavation work in the Westerland III sand dredging area (Brandt et al. 2008, Diederichs et al. 2010), and studies on the reaction of harbour porpoises and other marine mammals to ships which made an assessment of ship noise possible. The studies carried out on the Westerland III sand dredging area from which, since 1985, some 1 million $m^3$ of sand per year has been extracted and taken to the mudflats of the whale protection area of the Schleswig-Holstein national park using a suction dredger, have shown that harbour porpoises would avoid the area surrounding the excavator when it was in use. However, it could not be confirmed whether there was any difference between the use of the sand dredging area when compared against reference locations. The study also showed that a localised and brief interruption may have been a reaction to noise emissions given off by the sand dredger but showed no influence on how the harbour porpoise used the area in general. The studies conducted for the Fehmarnbelt Fixed Link make it possible to categorise disturbance effects caused by ship noise and the assessment criteria: The ambient noise in the Fehmarnbelt, which is mainly dominated by shipping noise, exceeds an average of 130 dB (L50) in many areas (see the noise maps, EIA-REPORT, Attachment 15, Volume II B, p. 631 et seq.). A level of 140 dB is frequently exceeded at several stations (L95 up to 142 dB), because the noise emissions from larger ships, such as for example the Scandline ferries that use the Fehmarnbelt, still cause a level of 140 dB at a distance of 2 km (EIA-REPORT, Attachment 15, Volume II B, Fig. 3-308). The influence of shipping traffic in the Fehmarnbelt on harbour porpoise populations and their distribution is nonetheless small and statistically almost negligible. Even for the area of the ferry line between Rödby and Puttgarden and the T route that traverses it, the methods used, which involved counting aircraft and ferries and acoustic recordings, did not succeed in establishing any decrease in frequency in the harbour porpoise population. Even though the distance of shipping routes was a significant factor in some statistical analyses, the effect was small and is not reflected in lower stocks in the area of shipping lines. There is no doubt that harbour porpoises react with aversion to shipping noises, however observations indicate that this reaction is short-lived and only has a small local impact.

Minimisation of areas affected by underwater noise to reduce disruptive effects and to avoid a barrier effect from noise emissions in the Fehmarnbelt for the harbour porpoise (Annex IA, Measure Sheet 8.4 M/$V_{Ar}$). Tunnel trench noise emissions of > 144 dB occur on average in 9% of the area and in specific cases 16% of the area between Fehmarn and Lolland which could disruptively impact harbour porpoises. (see Attachment 22.5 of the attached plan approval documents). Thus, marine mammals are able to pass through the area at any time and the disturbance is limited to a restricted area.

The number of animals affected is low. Overall, figures show that between 0.1 and 1.0 individuals were affected by excavation works in Winter and Summer (Attachment 22.5 of the plan approval documents). When simultaneous pile driving is carried out to build the working harbour, up to 3.5 harbour porpoises (Summer) may also be affected (EIA-REPORT, Attachment 15 of the plan approval documents, Volume IV, Section 8.3.10.1.3, p. 3054). Figures show that between 0.2 and 1.3 harbour porpoises will be affected by immersing the tunnel elements and filling the tunnel trench (Attachment 22.5 of the plan approval documents). These figures vary in relation to the specific construction sections, and seasonally depending on the given population. The maximum number of impacted harbour porpoises corresponds, at most, to 0.07% of the summer population in the Fehmarnbelt region. Also to be considered in this regard is that, within those areas impacted by noise emissions of > 144 dB, no total displacement of the population occurs. The 144 dB isophone defines the area in which the lowest detectable yet still verifiable response occurs, but where the harbour porpoises are still found even if in reduced numbers. The number of impaired harbour porpoises according to the substantiating modelling is lower than the figure used as a basis in the EIA-REPORT. This meant that the working area was reduced in size and the construction ships were reduced in number.

It is therefore assumed that the project-related, additional disturbance will not drive away sufficient harbour porpoises to affect their population (1% of the local Fehmarnbelt population). Moreover, this disturbance will only be caused during the construction phase and its effects will only be felt locally. Upon completion of building activities, the impairment will cease. In addition, the superordinate function of the area as a rest and reproduction zone and for migration is not impaired.

There therefore arise no conflicts of relevance to species protection legislation in the sense of the prohibition according to § 44 (1) Point 2 BNatSchG between the planned project and the harbour porpoise.

Direct impairments on the harbour porpoise and/or its habitats from traces of sediment are not expected. In contrast, the distribution of harbour porpoises is mainly dependent on the presence of the fish they eat. The project will not result in any significant changes to the composition of fish in the area and indirect impairments on the harbour porpoise can therefore be ruled out. Furthermore, the area impaired by the project is not considered an essential hunting habitat because the distribution of prey fish is not limited to this area. The effect of hydrodynamic parameters on the harbour porpoise is comparatively low. Essential habitats are not therefore lost and an infringement of the access prohibition imposed by Art. 44 para1 no. 3 BNatSchG does not arise.

### 8.2.3. Migratory and resting birds

**Migratory birds**

A total of 235 species of migratory birds are included in the group of migratory birds for the conflict analysis.

The influence of construction ships on low-flying migratory birds is limited to a very small area and is therefore rated as only low. No significant increase in the general risk to life for the otherwise highly-trafficked Fehmarnbelt is predicted. In order to avoid collisions, light reduction measures will be implemented on the construction site in the marine area, which will reduce light emission during both standard operations and weather conditions where collisions are known to occur more frequently (see Attachment 12, LBP, Annex I, Measure Sheet 8.5 $M/V_{Ar}$). The risk of collision is within the range experienced generally and there is therefore no infringement of the prohibitions imposed by § 44 Para. 1, Point 1 BNatSchG (prohibition on killing) for migratory birds.

The construction ships operate in two working areas at the same time (LCP, Attachment 12 of the plan approval documents, Annex I, Measure Sheet 8.4 $M/V_{Ar}$)and, therefore, do not present continuous barriers across the Fehmarnbelt, which means that low-flying migratory birds can fly around any ships which may present an obstacle.. Infringements of the prohibitions imposed by § 44 Para. 1, Point 2 BNatSchG (prohibition on disturbance) do not therefore exist for migratory birds.

### Resting birds

The details provided above for "migratory birds" also apply to construction-related collisions with ships. Infringements of the prohibitions imposed by Art. 44 Para. 1 no. 1 BNatSchG (prohibition on killing) do not therefore exist for resting birds.

According to the environmental impact assessment, the effects on the marine phytobenthos resulting from project-induced suspended material loads result in a slight reduction in macroalgae and seaweed biomass of no more than 5 to 10%. Local impairments on the zoobenthos from the sedimentation of suspended materials are rated as low to medium and depend on the thickness and duration of the layer of sediment. The impact on fish fauna are classed as being low and unverifiable for birds. Systematically greater killings should therefore be ruled out and there is therefore no infringement of the prohibitions imposed by § 44 Para. 1, Point 1 BNatSchG for resting birds.

According to the EIA-REPORT report (Section 5.3.11, Attachment 15, Volume III), birds are driven out by direct disturbances (construction work) and indirect disturbances (sedimentation, suspended materials) and studies must therefore be carried out into infringement of the prohibitions imposed by § 44 Para.1, Point 2 BNatSchG.

The matter of whether central habitats for species are also lost from the use of land and disturbances must also be investigated. A study of the various prohibitions is undertaken for species for which a presence of national significance was established in the LCP investigation area in the SPC relevance check (Attachment 21). Project-related impairments are predicted for a total of 14 species:

**Grebe (red- and black-throated divers**

- According to the results of the spatial modelling carried out for the LCP investigation area, 5 grebes will be temporarily driven out of the immersed tunnel's impact zone during the construction phase. Because construction works have been limited to a maximum of two construction areas (see Annex IA, Measure Sheet 8.4 M/ $V_{Ar}$), the number of grebes driven out and areas disturbed is further reduced because the information in the EIA-REPORT was selected in a very precautionary way. Since it has been proven that the maximum flight distance for grebes is around 2 km from an approaching ship (inter alia, Schwemmer et al. 2011), a precautionary disturbance area 3 km in width from the route was calculated. The actual disturbance area for grebes is lower however (Attachment 15 of the plan approval documents, EIA-REPORT, Section 5.2.11.6, p. 1993). Furthermore, using a pre-emptive approach, it was estimated that all birds would be completely expelled if they were within the 3 km-wide disturbance area on either side of the route (Attachment 15 of the plan approval documents, EIA-REPORT, Volume III, Section 5.2.11.6, p. 1994). However, this is a precautionary requirement since it is unlikely that no birds would reside within the disturbance area over the whole course of the construction period. Thus, by employing the avoidance measure (see Attachment 12 of the plan approval documents, Annex IA, Measure Sheet 8.4 M/ $V_{Ar}$), the number of expelled grebes is further reduced and there are less than five displaced individuals. Under these circumstances, a significant deterioration in the conservation status of the local population of 1,711 grebes is not expected. Less than 0.3% of the local population will be displaced. There therefore arise no conflicts of relevance to species protection legislation in the sense of the prohibition according to § 44 Para 1 Point 2 BNatSchG between the planned project and the grebe.
- Roosting sites for the grebe cannot be defined in the LCP investigation area because this is not one of the main areas in which they are found. On the contrary, they display avoidance behaviour in the route area (Attachment 15 of the plan approval documents, EIA-REPORT, Volume IV, Section 8.3.11.1.6, p. 3199 et seq., Figures 8-253

and 8-254). These areas can therefore be ruled out as being of major significance to the function of a roosting area. Since grebes do not breed in Schleswig-Holstein, the function as a propagation area can also be ruled out. In terms of §. 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the grebe.

**Great crested grebe**

- According to the spatial modelling for the LCP investigation area, 77 great crested grebes will be temporarily driven out of the immersed tunnel's impact zone during the construction phase.
- Around Fehmarn great crested grebes are found very close to the coast. They exist in very large numbers in the north and east in particular but their distribution may be very different depending on the ice conditions experienced in winter.
- According to habitat models, great crested grebes can be found in shallow waters with weak currents. It can be assumed that such areas will remain undisturbed and available to the great crested grebe even during construction work, e.g. the areas near the coast around Staberhuk in the east or Altenteil in the west which are already sometimes used by the birds.
- Because construction works have been limited to a maximum of two construction areas, the number of great crested grebes displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for great crested grebes (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 $M/V_{Ar}$).
- The impairment on fish stocks in the areas outside the construction route is only very slight, such that the feeding grounds for the great crested grebe will continue to exist in areas outside the disturbance zone.
- The conservation status of the great crested grebe in Schleswig-Holstein is good (MLUR 2009); it is not assumed that the conservation status of the local population of great crested grebe will be significantly worsened by the disturbances.
- There are therefore no conflicts of relevance to species protection legislation in accordance with Art. 44 para1 no. 2 BNatSchG.
- Great crested grebes are found along the north and east coasts of Fehmarn; populations of resting birds may however be found in other areas depending on how the winter progresses so one single roosting site in the marine area cannot be defined.
- Because it is assumed that great crested grebes will be able to use areas suited to their habitat requirements during the construction work, this work and the use of land will not result in destruction or damage to roosting sites in the sense of Art. 44 (1) no. 3 BNatSchG.

**Red-necked grebe**

- According to the spatial modelling for the LCP investigation area, 16 red-necked grebes will be temporarily driven out of the immersed tunnel's impact zone during the construction phase.
- Red-necked grebes are found to the north and west of Fehmarn and are not restricted to areas close to the coast to the same extent that great crested grebes are.
- According to habitat models, red-necked grebes can be found in areas with lower salinity, weak currents and greater depths of water. It can be assumed that such areas will remain undisturbed and available to the red-necked grebe even during construction work, e.g. the bodies of water to the west of Fehmarn where average densities of red-necked grebes already exist all year round.
- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of red-necked grebes displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for red-crested grebes (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 $M/V_{Ar}$).
- The impairment on fish stocks in the areas outside the construction route is only very slight, such that the feeding grounds for the red-necked grebe will continue to exist in areas outside the disturbance zone.

- Since the conservation status of the red-necked grebe in Schleswig-Holstein is good (MLUR 2009) and only the relatively small number of 16 birds will be temporarily driven out of the impact zone, it is not assumed that the conservation status of the local population of red-necked grebe will be significantly worsened by the disturbances. There are therefore no conflicts of relevance to species protection legislation in accordance with § 44 Para. 1 no. 2 BNatSchG.
- Because red-necked grebes exist over relatively large areas in the north and west of Fehmarn, one single roosting site in the marine area cannot be defined.
- Because it is assumed that red-necked grebes will be able to use areas suited to their habitat requirements during the construction work, this work and the use of land will not result in destruction or damage to roosting sites in the sense of Art. 44 (1) no. 3 BNatSchG.

**Cormorant**

- According to onshore counts for the LCP investigation area, 250 cormorants will be temporarily driven out of the immersed tunnel's impact zone during the construction phase.
- During the course of the 2015 plausibility studies, up to 970 cormorants were found on the breakwaters. These birds roost on the harbour structures in Puttgarden in particular. For those birds which roost on the breakwaters of Puttgarden harbour, it is worth noting that they are already roosting in areas with a regular and high proportion of ships transiting. By building the working harbour, which will take 26 weeks. Driving sheet piles will last for a total of four weeks as well as increased ship transport. It must be accepted that there will be disturbances to roosting Cormorants during this time. However, Cormorants are relatively flexible in their choice of roosting habitats and also use other manmade structures such as breakwaters, harbour breakwaters and sandbanks (see above). Berndt et al. Berndt et al. (2005) state that fish trap piles can also be used for roosting and these can be found relatively evenly spaced all the way round the island of Fehmarn. It is therefore assumed that such roosting areas will remain available to cormorants outside the disturbance zone during the construction work. Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of cormorants displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for cormorants (see Attachment 12, LCP, Attachment 12 of the plan approval documents, Annex IA, Measure Sheet 8.4 $M/V_{Ar}$).
- The impairment on fish stocks in the areas outside the construction route is only very slight, such that the feeding grounds for the cormorant will continue to exist in areas outside the disturbance zone.
- Because the conservation status of the cormorant in Schleswig-Holstein is good (MLUR 2009), it is not assumed that the conservation status of the local population of cormorant will be significantly worsened by the disturbances. There are therefore no conflicts of relevance to species protection legislation in accordance with § 44 Para. 1 no. 2 BNatSchG.
- Even if the cormorants will sometimes be driven away from their roosting sites on the harbour breakwaters, these structures will not be built over and their quality as a roosting habitat for cormorants will not be affected in the long term. The disturbances created by the four weeks of pile driving will not lead to the complete abandonment of the roosting area. When the pile driving has come to an end, the harbour breakwaters can be used again. In addition, there will be newly-created breakwaters which can be used as possible roosting spots for cormorants. In terms of § 44 Para. 1.Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the cormorant because no roosting sites will be damaged or destroyed.

**Eurasian wigeon**

- According to onshore counts for the LCP investigation area, 1,000-1,500 widgeons will be temporarily driven out of the immersed tunnel's impact zone during the construction phase.
- It must be assumed that the widgeons that live near the Puttgarden ferry harbour are already tolerant of disturbance to a certain extent given the regular nature of ferry traffic. During construction work for coastal sections of the immersed tunnel, it is assumed that the widgeons to the west and east of the ferry harbour on the coast can move further

west (e.g. Wallnau-Altenteil transect and Altenteil up to 3 km west of Puttgarden, where there are already large numbers of widgeon, Kieckbusch 2010) and eastwards (3 km to the east of Puttgarden to Staberhuk where widgeons are also counted on a regular basis, Kieckbusch 2010). Alternatively, they can even use the protected areas of Orth Bay, Wallnau, Fastensee, Salzensee or Burger Binnensee, which are home to up to several thousand widgeons (Kieckbusch 2010), as an alternative habitat.

- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of cormorants displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for the Eurasian wigeon (see LCP, App Attachment 12 of the plan approval documents, Annex I, Measure Sheet 8.4 M/$V_{Ar}$).
- On Fehmarn widgeons use various habitats (shallow coastal waters, inland bodies of water and agricultural areas) and can therefore also move into different habitats. Because widgeons are found in many different places on Fehmarn and just one sub-section of 3 km to both the west and east of the Puttgarden ferry harbour will not be available to widgeons for certain periods due to construction-related disturbances, the conservation status of widgeons in Schleswig-Holstein is considered good (MLUR 2009) and other sources also cite a large and increasing overwintering population for the Baltic Sea, it is not assumed that the conservation status of the local population of widgeon will be significantly worsened by the disturbances. The conservation status of wigeons in Schleswig-Holstein is classed as being favourable (MLUR 2009) and other sources cite a large and growing hibernating populating for the Baltic Sea (see above). There are therefore no conflicts of relevance to species protection legislation in accordance with § 44 Para. 1 no. 2 BNatSchG.
- Resting widgeons are certainly found in the area of land used for the project, but these areas are not assumed to be of essential significance to the function of a roosting area because the birds can probably move to other areas and the area of land use does not represent a key distribution point for the wigeon . Damage to or destruction of roosting sites in the sense of Art. 44 para1 no. 3 BNatSchG is therefore ruled out.

**Pochard**

- Seven-hundred pochards will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) during the construction phase as a result of visual disturbances including noise and light. Precise numbers of pochards driven out of the LCP investigation area cannot be calculated because pochards tend to search for food in the marine area at night and roost in inland bodies of water during the day.
- During the day up to 70 pochards have been recorded in the LCP investigation area in the Puttgarden harbour (AKVSW 2010). Given their presence in the very busy harbour, these birds have some tolerance of disturbance and are found in an area relatively screened off from the construction work. The pochards which search for food at night will however avoid the construction area. However, given the fact that these birds travel back and forth between the roosting and feeding areas during the day, it is assumed that these pochards can respond relatively flexibly to disturbances and can use undisturbed roosting sites around Fehmarn (e.g. Orth Bay, Fehmarnsund).
- The largest number of pochards roosting during the day can be found near the Burger Binnensee and Wallnau. These roosting areas are a good distance away from the impact area. The results of telemetric studies into tufted ducks, which are used here because data is not available on pochards, show firstly that none of the tufted ducks tagged in the Fehmarnsund used the impact area and secondly that most only covered short distances between the roosting areas and feeding grounds. These results can be transferred to pochards. This means that the impact zone is not important to the pochards which search for food at night.
- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of pochards displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for pochards (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 M/$V_{Ar}$).

- Because the conservation status of the pochard in Schleswig-Holstein is also good (MLUR 2009), it is not assumed that the conservation status of the local population of pochard will be significantly worsened by the disturbances. There are therefore no conflicts of relevance to species protection legislation in accordance with § 44 Para. 1 no. 2 BNatSchG.
- The important roosting sites of Burger Binnensee and Wallnau are outside the LCP investigation area; no impacts from the project will arise here and these roosting sites will be retained in their current form.
- In terms of the roosting pochards from the Puttgarden harbour in the LCP investigation area, firstly they are already using the harbour despite the disturbances occurring there and must therefore be relatively tolerant of disturbance. Secondly, there will hardly be any additional project impacts in the harbour basin itself because the route and reclamation areas are outside this area and ship transport will be processed at the newly-built working harbour. No pochard roosting sites in the sense of § 44 Para. 1 no. 3 BNatSchG will be damaged or destroyed.

**Tufted duck**

- During the construction phase, 7,100 tufted ducks will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of visual disturbances including noise and light. Precise numbers of tufted ducks driven out of the LCP investigation area cannot be calculated because tufted ducks tend to search for food in the marine area at night and roost in inland bodies of water during the day.
- During the day up to 276 tufted ducks have been recorded in the LCP investigation area, mostly in the Puttgarden harbour (AKVSW 2010). Given their presence in the very busy harbour, these birds have some tolerance of disturbance and are found in an area relatively screened off from the construction work. That being said, the tufted ducks which search for food at night will avoid the construction area. However, given the fact that these birds travel back and forth between the roosting and feeding areas every day, it is assumed that these tufted ducks can respond relatively flexibly to disturbance and can use undisturbed roosting sites around Fehmarn (e.g. Orth Bay, Fehmarnsund).
- The largest number of tufted ducks roosting during the day can be found near the Burger Binnensee, Albertsdorfer Niederung, Flügger ponds, and near the Fehmarnsund bridge and Sulsdorf brook (own recordings, Berndt et al. 2005, Kieckbusch 2010). 2005, Kieckbusch 2010). These roosting areas are a good distance away from the impact area. The results of telemetric studies into tufted ducks show firstly that none of the tufted ducks tagged in the Fehmarnsund used the impact area and secondly that most only covered short distances between the roosting areas and feeding grounds. This means that the impact zone is not important to the tufted ducks which search for food at night.
- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of tufted ducks displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for tufted ducks (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 M/$V_{Ar}$).
- Because the conservation status of the tufted duck in Schleswig-Holstein is also good (MLUR 2009), it is not assumed that the conservation status of the local population of tufted duck will be significantly worsened by the disturbances. There are therefore no conflicts of relevance to species protection legislation in accordance with § 44 Para. 1, Point 2 BNatSchG.
- The important roosting sites at Burger Binnensee, Albertsdorfer Niederung, Flügger ponds, Fehmarnsund bridge and Sulsdorf brook are outside the LCP investigation area. They will not be affected by the project and these roosting sites will be retained in their current form.

- In terms of the roosting tufted ducks from the Puttgarden harbour in the LCP investigation area, firstly they are already using the harbour despite the disturbances occurring there and must therefore be relatively tolerant of disturbance. Secondly, there will hardly be any additional project impacts in the harbour basin itself because the route and reclamation areas are outside this area and ship transport will be processed at the newly-built working harbour. In terms of § 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the tufted duck because no roosting sites will be damaged or destroyed.

**Common eider**

- During the construction phase, 12,114 eider ducks will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of direct visual disturbances including noise and light and indirect impacts such as water turbidity from suspended materials and changes to the feeding grounds from suspended materials and sedimentation. Consequently, 4,003 eider ducks will be driven out of the LCP investigation area.
- The reference parameter for preventing deterioration is the national population of 130,00 resting eider ducks. Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of common eiders displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for common eiders (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 $M/V_{Ar}$).
- The potential, project-related disturbances in the construction phase on the German side of the Fehmarnbelt affecting around 4,000 eider ducks will therefore impact temporarily on a maximum of 2.9% of the national population. It is expected that most of the birds driven out of the impaired area will redistribute to other parts of the Fehmarnbelt, which will not necessarily lead to a deterioration in the conservation status of the local population if the birds find suitable feeding and roosting habitats elsewhere and these habitats have not yet reached full capacity. To analyse this, an individual-based model was used in the environmental impact assessment. This predicts the effect of these birds being driven out and redistributed in the investigation area.
- The most important results of the modelling show that most of eider ducks driven out of the Fehmarnbelt by disturbance and increased water turbidity will find feeding and roosting habits in other areas. Given a total population of 250 000 eider ducks in the Fehmarnbelt, this means that of the 12,114 ducks driven out of the entire Fehmarnbelt, 600 (0.08% of the biogeographical population) will have to leave the model system. Another effect of the ducks being driven out is that their body weight may fall slightly in the middle of winter. Simulations used in the individual-based model also showed that the habitat capacity in the Fehmarnbelt for eider ducks is considerably greater than the number of birds which actually use the area. Based on the forecasts of the individual-based model, construction of the immersed tunnel will not have any effect on the population of eider ducks which overwinter in the Fehmarnbelt and the impairment is not therefore considered of relevance to the population. A long-term deterioration in the conservation status of the local population of eider duck is not therefore expected. Consequently, there are no conflicts arising from species protection legislation in the sense of §. 44 Para. 1 no. 2 BNatSchG.
- It is virtually impossible to define roosting sites for the eider duck in the LCP investigation area. Although there is a high density in the waters west of Fehmarn, it is not possible to derive territorially delimited resting areas from this. These areas can be ruled out as being of major significance to the function of a roosting area. The important resting areas on the mud and sand flats Sagasbank, Stoller Grund, Albue-Bank, Hyllekrog and Gedser Rev) all lie outside the landscape conservation plan study area. There are no flatlands with high densities of Eider ducks, which would enable the spatial isolation of resting areas within the impact area of the project.
- For those Eider ducks present in the impact area of the LCP investigation area, it is worth noting that the resting areas can be relocated during construction works and can then be re-established when construction works end e.g. on the new, flat coastal region in front of the land reclamation area. This is because the Fehmarnbelt's habitat capacity, in accordance with the results of the individual-based model (IBM) has not yet been reached (see Attachment 15, EIA-REPORT, Volume IV B, Section 8.3.11.1.9, p. 3244 et seq.) In

terms of § 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the Eider duck.

**Long-tailed duck**

- During the construction phase, 745 long-tailed ducks will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of direct visual disturbances including noise and light and indirect impacts such as water turbidity from suspended materials and changes to the feeding grounds from suspended materials and sedimentation. Consequently, 108 long-tailed ducks will be driven out of the LCP investigation area.
- The reference parameter for preventing deterioration is the national population of 10,000 resting long-tailed ducks. The potential, project-related disturbances in the construction phase on the German side of the Fehmarnbelt affecting around 100 long-tailed ducks will therefore impact temporarily on a maximum of 1% of the national population.
- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of long-tailed ducks displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for long-tailed ducks (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 M/$V_{Ar}$).
- It is expected that most of the birds driven out of the impaired area will redistribute to other parts of the Fehmarnbelt, which will not necessarily lead to a deterioration in the conservation status of the local population if the birds find suitable feeding and roosting habitats elsewhere and these habitats have not yet reached full capacity. Because the long-tailed duck is more flexible in its choice of food than the eider duck and the results of the individual-based model for the eider duck showed that the Fehmarnbelt's habitat capacity is considerably greater than the number of eider ducks actually using the Fehmarnbelt, it can be assumed that resting long-tailed ducks can also move to areas outside the area affected.
- As stated above, the long-tailed duck is found mainly in areas well away from the coast such as Sagasbank, Flüggesand and Stoller Grund and to the east of the Fehmarnsund, all of which are well away from the impact zone. The 108 long-tailed ducks that will be driven out could move to these areas. A deterioration in the conservation status of the local population of long-tailed duck is not therefore expected. There is therefore no conflict arising from species protection legislation in the sense of § Art. 44 Para. 1 no. 2 BNatSchG.
- Roosting sites for the long-tailed duck cannot be defined in the LCP investigation area because this is not one of the main areas in which they are found. These areas can be ruled out as being of major significance to the function of a roosting area. The resting areas located on the flatlands Flüggesand, Sagasbank, Stoller Grund are all outside the LCP investigation area..
- There are no flatlands with high densities of long-tailed ducks, which would enable the spatial isolation of resting areas within the impact area of the project. For long-tailed ducks found within the impact zone of the project, it can be assumed that theroosting areas will moveduring construction workbe relocatedand can then be re-established once this is complete, e.g. in the new shallow coastal areas produced off the reclamation areas. In terms of § 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the long-tailed duck.

**Common scoter**

- During the construction phase, 726 black scoters will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of direct visual disturbances including noise and light and indirect impacts such as water turbidity from suspended materials and changes to the feeding grounds from suspended materials and sedimentation. Consequently, 539 black scoters will be driven out of the LCP investigation area.
- The reference parameter for preventing deterioration is the state-wide population of 100,000 resting black scoters. The potential, project-related disturbances in the construction phase on the German side of the Fehmarnbelt affecting around 539 black scoters will therefore impact temporarily on a maximum of 0.5% of the national population.

- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of common scoters displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for common scoters (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 $M/V_{Ar}$).
- It is expected that most of the birds driven out of the impaired area will redistribute to other parts of the Fehmarnbelt, which will not necessarily lead to a deterioration in the conservation status of the local population if the birds find suitable feeding and roosting habitats elsewhere and these habitats have not yet reached full capacity. Because black scoters have similar feeding preferences to eider ducks and the results of the individual-based model for the eider duck showed that the Fehmarnbelt's habitat capacity is considerably greater than the number of eider ducks actually using the Fehmarnbelt, it can be assumed that resting black scoters can also move to areas outside the area affected.
- As stated above, the black scoter is found mainly in areas well away from the coast such as Sagasbank, Flüggesand and Stoller Grund, in the south of the eastern Bay of Kiel special conservation area and in the south of the Baltic Sea east of Wagrien special conservation area, most of which are well away from the area affected by disturbance. The 539 black scoters that will be driven out could move to these areas. A deterioration in the conservation status of the local population of black scoter is not therefore expected. There is therefore no conflict arising from species protection legislation in the sense of § 44 (1) no. 2 BNatSchG.
- It is virtually impossible to define roosting sites for the black scoter in the LCP investigation area. Although there is a high density in the waters northwest of Fehmarn, it is not possible to derive territorially delimited resting areas from this. These areas can be ruled out as being of major significance to the function of a roosting area. The important roosting areas stated above which are found on the flatlands Sagasbank, Flüggesand and Stoller Grund, in the south of the eastern Bay of Kiel special conservation area and in the south of the Baltic Sea to the east of Wagrien special conservation area) are all outside the LCP investigation area.
- There are no flatlands with high densities of common scoters, which would enable the spatial isolation of resting areas within the impact area of the project. For common scoters found within the impact zone of the project, it can be assumed that the roosting areas will move during construction work be relocated and can then be re-established once this is complete, e.g. in the new flatcoastal areas produced off the reclamation areas. In terms of § 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the common scoter..

**Velvet scoter**

- According to the Environmental Impact Study, during the construction phase, only individual velvet scoters will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of direct visual disturbances including noise and light and indirect impacts such as water turbidity from suspended materials and changes to the feeding grounds from suspended materials and sedimentation.
- The velvet scoter occurs primarily on the northwestern tip and further west in the LCP investigation area. As a result, with regard to the LCP investigation area, at most only a few individuals will be displaced. Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of velvet scoters displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for velvet scoters (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 $M/V_{Ar}$). It is expected that most of the birds, whose numbers are low in any case, driven out of the impaired area will find broadly suitable feeding and roosting habitats elsewhere and these habitats have not yet reached full capacity.
- A deterioration in the conservation status of the local population of velvet scoter is not therefore expected. There therefore arise no conflicts of relevance to species protection legislation in the sense of the prohibition according to § 44 (1) Point 2 BNatSchG between the planned project and the Velvet Scoter.
- It is virtually impossible to define roosting sites for the velvet scoter in the LCP investigation area. Although there is an increased number of velvet scoters on the north west tip

of Fehmarn, it is not possible to derive territorially delimited resting areas from this. These areas can be ruled out as being of major significance to the function of a roosting area. The area around the north west tip of Fehmarn is over 10 km away from the route and lies outside the area where project impacts will occur. In terms of § 44 (1), Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the velvet scoter.

**Common goldeneye**

- During the construction phase, 92 common goldeneyes will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of direct visual disturbances including noise and light and indirect impacts such as water turbidity from suspended materials and changes to the feeding grounds from suspended materials and sedimentation. Consequently, 42 common goldeneyes will be driven out of the LCP investigation area.
- However, because roughly four times as many common goldeneyes were recorded during the counts in the middle of winter than resulted from the spatial modelling, it can be assumed that roughly four times as many common goldeneyes will be driven out. This would mean that around 170 common goldeneyes are driven out of the LCP investigation area. The reference parameter for preventing deterioration is the national population of 14,000 resting common goldeneyes. The potential, project-related disturbances in the construction phase on the German side of the Fehmarnbelt affecting around 170 common goldeneyes will therefore impact temporarily on a maximum of 1.2% of the national population.
- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of common goldeneyes displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for common goldeneyes (see Attachment 12, LCP, Annex I, Measure Sheet 8.4 M/$V_{Ar}$).
- Common goldeneyes are mainly found in areas of shallow water. Because they also have a relatively wide feeding range, it can be assumed that such areas will remain undisturbed and available to common goldeneyes even during construction work, e.g. the coastal sections to the west and east of the planned crossing which are already used. It can also be assumed that new areas of shallow water will form off the reclamation areas and that these can be used by common goldeneyes. Because the conservation status of the common goldeneye in Schleswig-Holstein is also ranked as good (MLUR 2009), it is not assumed that the conservation status of the local population will be significantly worsened by the disturbances. There are therefore no conflicts arising from species protection legislation in the sense of § 44 Para. 1 no. 2 BNatSchG. According to Berndt et al.
- Because common goldeneyes are relatively evenly distributed along the coast of Fehmarn, one single roosting site in the marine area cannot be defined. Because it is assumed that common goldeneyes will also be able to use areas suited to their habitat requirements during the construction work, this work and the use of land will not result in destruction or damage to roosting sites.
- In addition, new areas of shallow water will form off the reclamation areas which can be used by common goldeneyes. In terms of Art. 44 para1 no. 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the common goldeneye because no roosting sites will be damaged or destroyed.

**Red-breasted merganser**

- During the construction phase, 1,026 red-breasted mergansers will be temporarily driven out of the entire immersed tunnel's impact zone (not just the LCP investigation area) as a result of direct visual disturbances including noise and light and indirect impacts such as water turbidity from suspended materials and changes to the feeding grounds from suspended materials and sedimentation. Consequently, 74 red-breasted mergansers will be driven out of the LCP investigation area. The potential, project-related disturbances in the construction phase affecting around 74 red-breasted mergansers will therefore impact temporarily on a maximum of 4.9% of the national population (1,500 red-breasted mergansers). Red-breasted mergansers are found in the waters around Fehmarn, mainly along the entire north coast from east of Puttgarden to Staberhuk.

- The details of the habitat modelling show that red-breasted mergansers are mainly found in shallow waters and they appear to make relatively even use of all the island's coastal waters and inland lakes. It can therefore be assumed that red-breasted mergansers will find sufficient suitable undisturbed habitats during the construction work, e.g. in the coastal section between the Klausdorf campsite and Staberhuk, but also the sections to the south of Staberhuk where the birds already exist in lower numbers. In addition, new areas of shallow water will form off the reclamation areas which can be used by red-breasted mergansers. Consideration should also be given to the fact that the number of resting birds in winter depends on the ice conditions.
- Because construction works have been limited to a maximum of two construction areas with stationary machinery and a free-moving excavator located outside the working areas, the number of Red-breasted Mergansers displaced, in comparison with the figures given in the EIA-REPORT, is much lower and, at the same time, ensures more retreat areas for the Red-breasted Merganser (see LCP, Attachment 12 of the plan approval documents, Annex I, Measure Sheet 8.4 M/VAr).
- The impairment on fish stocks in the areas outside the construction route is only very slight, such that the feeding grounds for the red-breasted merganser will continue to exist in areas outside the disturbance zone.
- Because the conservation status of the red-breasted merganser in Schleswig-Holstein is also good (MLUR 2009), it is not assumed that the conservation status of the local population will be significantly worsened by the disturbances. There are therefore no conflicts arising from species protection legislation in the sense of § 44 Para. 1 no. 2 BNatSchG. According to Berndt et al.
- Because red-breasted mergansers are found along the north (to the east of Puttgarden) and east coasts of Fehmarn and the populations of resting birds may move around depending on how the winter progresses, one single roosting site in the marine area cannot be defined. Because it is assumed that red-breasted mergansers will also be able to use areas suited to their habitat requirements during the construction work, this work and the use of land will not result in destruction or damage to roosting sites.
- In addition, new areas of shallow water will form off the reclamation areas which can be used by red-breasted mergansers. In terms of § 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the red-breasted merganser because no roosting sites will be damaged or destroyed.

**Herring gull**

- Onshore counts show that populations of herring gull of national importance do exist in the LCP investigation area, but according to the EIA report (Section 5.3.11, Attachment 15, Volume III) only small numbers will be driven out by disturbance. This is due to the fact that herring gulls are not generally sensitive to shipping; in fact they often follow ships. The distribution of herring gulls is therefore also often linked to the presence of ships, which makes it hard to define roosting areas.
- Because the conservation status of the herring gull in Schleswig-Holstein is good (MLUR 2009) and because herring gulls are hardly affected by disturbance, it is not assumed that the conservation status of the local population will be significantly worsened by the disturbances. There are therefore no conflicts arising from species protection legislation in the sense of § 44 Para. 1 no. 2 BNatSchG.
- According to Berndt et al. (2005) resting areas for herring gulls lie on the large sandbanks off the Grüner Brink, the Wallnau ponds, on the stone breakwaters at the harbour entrance at Burgstaaken, on the spit of sand at the Wulfener Hals and on the island in the Salzensee.
- The only roosting site close to the planned FBFL is the sandbanks off the Grüner Brink. But these are also outside the area of land used and are therefore at some distance from the route so it cannot be assumed that this roosting site will be damaged or destroyed in the sense of § 44 Para. 1 no. 3 BNatSchG.

**Great black-backed gull**

- The results of onshore counts show that populations of great black-backed gull of state-wide importance do exist in the LCP investigation area, but according to the EIA report (Section 5.3.11, Attachment 15, Volume III) only small numbers will be driven out by disturbance. This is due to the fact that great black-backed gulls are not generally sensitive to shipping; in fact they often follow ships. The distribution of great black-backed gulls is therefore also often linked to the presence of ships, which makes it hard to define roosting areas.

- Because the conservation status of the great black-backed gull in Schleswig-Holstein is good (MLUR 2009) and because great black-backed gulls are hardly affected by disturbance, it is not assumed that the conservation status of the local population will be significantly worsened by the disturbances. There are therefore no conflicts arising from species protection legislation in the sense of § 44 Para. 1 no. 2 BNatSchG.
- Due to the similar ecology, the roosting sites of great black-backed gulls probably exist in the same locations as those of herring gulls (see above), so the information provided for them applies here too. In terms of § 44 Para. 1, Point 3 BNatSchG, there are therefore no conflicts of relevance to species protection legislation for the great black-backed gull because no roosting sites will be damaged or destroyed.

# 9. Cross-border effects

The following section describes all cross-border effects of an FBFL in the form of an immersed tunnel. Cross-border effects may occur between the originating states (Germany and Denmark) and between the originating states and neighbouring states. Neighbouring states are all those states which border one of the two originating states and those states which do not share a border with them but lie in the area affected by the project. The following neighbouring states are relevant to the FBFL: Sweden, Poland, Finland, Estonia, Latvia, Lithuania, the Russian Federation and Norway.

Cross-border effects resulting from the construction, installation and operation of the immersed tunnel will be shown. Those effects which are considered relevant for the impact assessment are described (see descriptions of project effects in Section 5.2 of the EIA report, Attachment 15, Volume III for impacts/effects already ruled out). By way of summary, the following cross-border impacts exist outside Germany and Denmark:

The release of sediment causes cross-border deposits in the Arkona Basin on Swedish territory. Given the very small amounts involved, however, this is considered insignificant. Cross-border effects in the Fehmarnbelt may result in local impairments on waterfowl (eider duck) cod, whiting and herring fish species in neighbouring states. However,cross-border impacts are rated as insignificant. Details of how this appraisal was reached are provided in the following sub-sections. The environmental factors of Fehmarn and Lolland are described in terms of all environmental factors and the other factors are described individually.

## 9.1. Human beings

The impact assessment (Section 8.3.1.1 of the EIA report, Annex 15, Volume IV B) has evaluated impacts on the environmental factor of human beings in the marine area resulting from loss and/or limitation, noise and visual disturbances to water sports areas and impairments on angling from the loss of and/or impairments to fishing grounds. Most of these impairments arise in the coastal areas of Lolland and Fehmarn and are not cross-border in nature as they are so far away from areas affecting adjoining neighbouring states. Cross-border effects are in principle conceivable between Germany and Denmark in the centre of the Fehmarnbelt at the border itself. However, since there are plenty of other opportunities for water sports enthusiasts and offshore anglers in both the German and Danish parts of the Fehmarnbelt, there are no major cross-border effects between Germany and Denmark. Cross-border effects in neighbouring states are not expected either. Effects on the environmental factor of human beings on Fehmarn and Lolland are limited to the investigation areas on each island and are not therefore cross-border (Sections 8.3.1.2 and 8.3.26 of the EIA report, Attachment 15, Volumes IV B & C).

## 9.2. Hydrography and water quality

Aspects of the immersed tunnel (permanent: reclaimed land, channels for working harbour and protective coverings; temporary: working harbour) result in a loss of space and functional impairments of the hydrography. The impairments of the function elements have been evaluated both individually and as a whole in the impact assessment (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.2). Changes to the water level, salt content, temperature and stratification are very low and can therefore be ignored. For example, the permanent change in water exchange near the Darss Sill is just - 0.01%. However, there are functional impairments for the function elements of speed of current and sea state, with the highest values occurring near the working harbour channels. The maximum permanent change in current speed near the surface is to be expected to occur locally at the reclaimed land on Lolland and amounts to 0.08 m/s. All area losses (temporary 359 ha and permanent 343 ha) and functional impairments arise in the coastal areas off Fehmarn and Lolland. There are therefore no significant cross-border impacts on the hydrography in the aforementioned neighbouring states or between Germany and Denmark. Impacts on the hydrography of Norway can be fully ruled out

The water quality has been evaluated in the impact assessment (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.2) using the function elements of visible depth and concentration of oxygen. Impacts on the water quality resulting from changes in the previously described hydrography can be ruled out. There will, however, be a functional impairment on the water quality as a result of suspended materials released during dredging work in the construction phase. Changes to the dissolved oxygen resulting from increased concentrations of suspended materials will be negligible. Impairments on the visible depth (increase in turbidity) will be greatest in the first two years of the construction phase. The visible depth will be reduced locally by up to 40-50% along the coast of Lolland and in the Rødsand lagoon. The reduction in visible depth in German waters is less than 8% and is limited to the central part of the Fehmarnbelt.

Traces of turbidity from dredging work in Kriegers Flak and Rønne Banke are limited to the excavation areas and the area around them (EIA-REPORT, Attachment 15, Volume V, Section 9.1). No impacts on visible depth in the centre of the Baltic Sea resulting from the release of sediment are expected. In terms of water quality, overall cross-border impacts between Germany, Denmark and neighbouring states are considered insignificant.

## 9.3. Seabed morphology and sediments

Impacts on the seabed morphology and sediments may result from temporary use of sea areas and permanent loss of seabed areas and from sedimentation resulting from dredging work and backfilling the seabed in the construction area and release of sediments in the sand excavation areas (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.3). Impairments on the seabed from changes in hydrography can be ruled out (EIA-REPORT, Attachment 15, Volume III, Section 5.2.3).

Use and loss of seabed areas does not occur across borders. Sedimentation impairs sickle-shaped seabed geometries in the area of the route. The seabed geometries are expected to be fully regenerated in around 30 years. The layer of sedimentation in parts of the seabed without geometries is too low to change the characteristics of the seabed morphology. Impacts are therefore already ruled out in Section 5.2.3 (EIA-REPORT, Attachment 15, Volume III). For the sake of completeness, it should, however, be noted that there will be impacts resulting from cross-border deposits in the Swedish part of the Arkona Basin, where deposits of up to 1 mm over a period of six years can be ignored compared with the natural rate of sedimentation of 2 mm/year (EIA-REPORT, Attachment 15, Annex B, Section 0.3.4.1). In the areas of the Rønne Banke and Kriegers Flak where sand will be excavated, the highest rates of sedimentation (8-9 mm) will occur no more than 1 km away in the German and Danish areas and the lower rates of sedimentation (<3 mm) no more than 10 km away (EIA-REPORT, Attachment 15, Volume V, Section 9.1).

Overall cross-border sedimentation between Germany and Denmark will be minimal, but cannot be ruled out in the event of fast currents. Cross-border impacts from sedimentation in Sweden are rated as insignificant. No instances of cross-border impacts from sedimentation exist in the other neighbouring states.

## 9.4. Coastal morphology

Impacts on the coastal morphology include use of seabed areas and impairments on function resulting from changes to the hydrography. In the Fehmarnbelt region these only occur locally along the coast of Lolland and Fehmarn and do not occur across borders (EIA-REPORT, Attachment 15, Volume IV, Section 8.3.4). Changes to wave conditions due to increased water depth in the Kriegers Flak and Rønne Banke sand excavation areas are a long way from the coast (Møn and Bornholm are at a distance of around 30 km) so will not impair the coastal morphology (EIA-REPORT, Attachment 15, Volume V, Section 9.1).

## 9.5. Planktic flora and fauna

Impacts on the planktic fauna and flora result from increased concentrations of suspended materials and sedimentation of the sediments released by dredging work (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.5).

Sedimentation impairs an area of 76 ha (tunnel trench: 16 ha, Rødsand lagoon: 60 ha) where the survival rates of benthic stages of zooplankton, especially the eggs of copepod, may be reduced.

Increased concentrations of suspended materials impair plankton through turbidity along the coast of Lolland and in parts of the Rødsand lagoon. The temporary adverse effects are quantified using the following modelled parameters: The temporary impairments are quantified using the following modelled parameters: chlorophyll a content (reduction in Rødsand lagoon of max. 10%, along the coast of Lolland maximum 3-4%), phytoplankton biomass (10% reduction in western part of Rødsand lagoon, maximum reduction along the coast of Lolland 1-4%) and primary production (along the route near the coast of Lolland up to 25%, viewed over the entire area maximum 2-3%).

No cross-border impacts between Germany, Denmark and neighbouring states are forecast for plankton.

## 9.6. Benthic flora

In the Fehmarnbelt there are losses of benthic flora resulting from use of seabed areas (80 ha construction-related and 218 ha installation-related). The areas used (298 ha) are virtually all in Danish coastal waters and in the Danish EEZ. In the German region the loss is 0.22 ha (EIA-REPORT, Attachment 15, Vol. IV B Section 8.3.6).

Furthermore, plant communities will experience the following adverse effects: Suspended materials released during dredging will result in turbidity and reduce the amount of light available for photosynthesis and therefore for growth of the benthic flora. Biomass will be reduced on a total area of 16,788 ha. Sedimentation of the sediments released during dredging on 764 ha will reduce biomass by covering the free surfaces of benthic plants needed for active photosynthesis and the absorption of nutrients. Impairments from the installation-dependent hard substrate (80 ha) will firstly increase the potential for additional algae biomass to be created and secondly increase the potential for non-native species to move in.

The impacts on the benthic flora communities are rated as insignificant and not cross-border. The *Furcellaria* community, for example, is widespread throughout the Baltic Sea from Skagerrak to the Bottensee such that the loss does not put at risk the community's continued existence or function in the Baltic Sea and cross-border environmental impacts can therefore be ruled out.

Within the sphere of influence at Rønne Banke and Kriegers Flak, no or only limited benthic macroalgae and visible concentrations of microalgae (on the surface of the seabed) were recorded. The impacts are therefore very limited in terms of area and do not cross national borders (EIA-REPORT, Attachment 15, Volume V, Section 9.1).

By way of conclusion, there are no cross-border impacts on the benthic flora between Germany, Denmark and neighbouring states.

## 9.7. Benthic fauna

The benthic fauna in the Fehmarnbelt is impaired by the same factors as the benthic flora. Installation-related losses occur on 355 ha (mainly the reclaimed land areas) and construction-related losses on 230 ha (especially parts of the route in the marine area, Attachment 15, Volume IV, Section 8.3.7, EIA-REPORT).

Suspended materials from the sediments released during dredging result in turbidity which temporarily reduces the biomass of benthic fauna on a total area of 57,941 ha. The severity of the impact is largely low and occurs in front of the coast of Lolland and smaller areas in front of the coast of Fehmarn. Sedimentation of the sediments released during dredging will result in a temporary biomass reduction on 11,872 ha in both German and Danish parts of the Fehmarnbelt. The severity of the impairment is mainly low. Serious impairments only arise in smaller areas (DE EEZ = 0.5 ha, DK = 15 ha). Twenty-three hectares of hard substrate will be introduced for installations as stone packings for reclaimed areas of land and as a protective layer in shallow water and 181 ha will also be affected as a construction-related protective layer on the tunnel elements.

In terms of benthic fauna, losses may arise at Rønne Banke and Kriegers Flak in the areas used to extract sand (Attachment 15, Volume V, Section 9.1, EIA-REPORT). There will be no major impairments to the benthic fauna from suspended materials and sedimentation outside the extraction areas.

By way of conclusion, there are no cross-border impacts on the benthic fauna between Germany, Denmark and neighbouring states.

## 9.8. Benthic habitats

Benthic habitats are impaired by habitat loss (229 ha construction-related, 355 ha installation-related), turbidity from suspended materials (58,867 ha) and sedimentation (10,265 ha) (Attachment 15, Volume IV B, Section 8.3.8, EIA-REPORT). As with benthic fauna and flora, the impacts of the immersed tunnel and sand excavation do not cross borders.

## 9.9. Fish

The habitats and functional spaces of fish communities and species are impaired by the following project impacts of an immersed tunnel: Use of seabed areas, turbidity from suspended materials and sedimentation, noise and indirect project impacts resulting from impairments on macrophytes as a habitat for juvenile stages.

Installation-related use of seabed areas in the Fehmarnbelt leads to impairment and loss of functional spaces (e.g. migration) for fish communities and species and their different stages of life (maximum 386 ha). The impairments mainly affect areas near the coast and most especially shallow water communities/species, including the sea stickleback (Red List) and the life stages of species that use shallow waters (e.g. areas where cod and flatfish bring up their young). The severity of the impairment ranges from high to low. The severity of the impairments in the construction phase is medium to low and again mainly impacts on areas of shallow water. The areas impacted make up a proportionately small share of the areas of shallow water in the Fehmarnbelt.

Impairments resulting from suspended materials and sedimentation in the construction phase affect the immobile stages of the fish communities/species in particular. Most of the index species studied have pelagic eggs and larvae, which are distributed through large parts of the investigation area and are therefore only impaired slightly. Substrate-spawning fish (species from shallow water communities) are only slightly affected. Impairments on the search for food and migration are also only low.

Construction- and operation-related impairments on habitats and/or functional spaces (including migration) resulting from noise and indirect effects (e.g. impairments on macrophytes) are low or non-existent for all species.

All impacts on the fish fauna described in the impact assessment (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.9) are limited to the Fehmarnbelt. For the sake of completeness, the details of cross-border impacts provided below also include insignificant impacts outside the Fehmarnbelt. In particular, impairments on species which migrate through the Fehmarnbelt are relevant and could have an indirect cross-border impact. These relate to impairments (caused by noise and suspended materials) on migration of the spring-spawning herring from its spawning grounds near Rügen to feeding grounds in the Skagerrak. In turn, this could theoretically impair the Norwegian and Polish populations. Noise and suspended materials also impair the spawning migration of cod and the survival of its locally occurring development stages, which may theoretically impact on cod recruitment in Swedish and Polish waters. Impacts from noise and suspended materials on whiting migrating from the areas where their young are raised in the Baltic Sea back to the North Sea could affect the whiting population outside the project area. As mentioned, the severity of impacts has been rated locally as low and in neighbouring states as insignificant.

The consequences of sedimentation in the central parts of the Bay of Mecklenburg and Arkona Basin, rated as insignificant, rank among the impacts on the environmental factor fish outside the Fehmarnbelt which cannot be ruled out but are considered insignificant. The Bay of Mecklenburg and the Arkona Basin are important spawning areas for flatfish and cod. An impairment on the eggs and larvae of these species cannot be ruled out but is considered to be insignificant.

Sand extraction at Rønne Banke and Kriegers Flak results in a temporary loss of benthic fauna as food for fish. However, in terms of the total feeding area, the area affected is small and insignificant. Impacts resulting from suspended materials, sedimentation and noise are also insignificant because they are limited temporally and spatially.

In summary, it cannot be ruled out that there will be cross-border impacts for the fish environmental factor between Germany, Denmark and neighbouring states. However,cross-border impacts are rated as insignificant.

## 9.10. Marine mammals

The marine mammals which occur in the Fehmarnbelt, harbour porpoise and seal (harbour seal and grey seal), are impaired by noise, use of seabed area, habitat changes and barrier effects (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.10).

Noise impairments will occur during the construction phase and may cross the border between Germany and Denmark. They will only affect a small number of seals which sometimes search for food in the area in question. A maximum of the 0.30%/0.31% respectively of the local summer/winter populations of harbour porpoises will be affected. Noise will not therefore impact on the populations of marine mammals.

Habitat will be lost on a total of 5.84 $km^2$ of area (construction- and installation-related), the largest share being lost near the coast. This is the equivalent of an impairment of 0.08% of the local population of harbour porpoises in the Fehmarnbelt, or 0.008% of the total population in the Kattegat, Belt Sea and western Baltic Sea. Impairments on seals resulting from habitat loss and on marine mammals due to barrier effects and changes to habitat in the Fehmarnbelt are low (e.g. habitat change due to effects on fish, the food of the harbour porpoise). Impairments on the populations of harbour porpoise and seals are not therefore expected.

Marine mammals are only sporadically found in the Rønne Banke and Kriegers Flak sand excavation areas and impairments at these sites are therefore estimated to be low (EIA-REPORT, Attachment 15, Volume V, Section 9.1).

Outside the German and Danish areas there are no cross-border impacts on marine mammals. The cross-border impacts between Germany and Denmark are negligible.

## 9.11. Resting birds

Impairments caused by barrier effects and the risk of collision in the Fehmarnbelt are low for all species of the environmental factor of resting birds studied and are limited to the construction phase (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.11). Impairments from displacement triggered by loss of habitat (use of seabed areas), change of habitat (sedimentation, suspended materials) and disturbance are also low for breeding waterfowl. For non-breeding waterfowl, the consequences are construction-related and will result in very severe impairments on the eider duck (total of 12,114 displaced individuals), severe impairments on the pochard and tufted duck (total of 717 and 7,163 displaced individuals) and a medium impairment on the widgeon and red-breasted merganser (total of 1,500 and 1,026 displaced individuals). The installation-related impairment caused by displacement is also high for the pochard and tufted duck (total of 710 and 7,100 displaced individuals). The construction- and/or installation-related impairment caused by displacement for all other species studied is low.

The impact assessment shows that most of the displaced non-breeding waterfowl will find feeding and roosting opportunities in other parts of the Fehmarnbelt. Consequently, local displacement will in fact amount to a redistribution of birds within the Fehmarnbelt. For the eider duck, which with 12,114 individuals (1.59% of the biogeographical population) is the species most affected in the construction phase, the redistribution is calculated to result in an additional mortality of 0.08% of the biogeographical population. The impairments from the immersed tunnel will not therefore impair the populations of the environmental factor of resting birds and there will not therefore be any significant cross-border effects between Germany, Denmark and neighbouring states.

At Rønne Banke and Kriegers Flak, the noise impairments on species sensitive to noise are insignificant given the small number of birds affected (e.g. < 0.02 ‰ of the biogeographical population of the long-tailed duck) (Section 9.2 EIA report, Attachment 15, Volume V). Impairments on feeding grounds are limited to 10 $km^2$ or 9 $km^2$, which constitutes only a small proportion of the feeding resources available in the areas. Impairments on birds are therefore insignificant and do not cross borders.

## 9.12. Biodiversity (marine area)

For the environmental factor of biodiversity (marine area), the impacts are based on the individual sub-factors. The assessment of biodiversity is reflected in the respective impact assessments of the sub-factors and is taken into account accordingly in these. Major cross-border impairments on biodiversity in the Fehmarnbelt between Germany and Denmark can be ruled out. There are also no cross-border impacts on biodiversity in the neighbouring states.

## 9.13. Landscape (marine area)

Impacts on the marine landscape in the Fehmarnbelt result from the loss of (partial) landscapes and landscape elements (32.83 ha construction-related and 348.75 ha installation-related) as well as visual and sensory impairments on landscapes including dissection (365.72 ha construction-related and 8.9 ha installation-/operation-related). Only landscapes near the coast are affected and not the open sea. There are therefore no cross-border impacts on the landscape between Germany, Denmark and the neighbouring states.

## 9.14. Cultural heritage and other material assets (marine area)

Protection measures undertaken before the start of construction mean that there are no impairments on the German or Danish side from the working harbour off Lolland in terms of the historic wreck located near the route as a cultural item and also no impairment on the underwater cable as a material asset (EIA-REPORT, Attachment 15, Volume IV B, Section 8.3.14). Given the tight spatial limits of potential impacts on cultural heritage and other material assets, no far-reaching impacts are forecast. There are also no cultural or material assets within the areas recommended for sand excavation near Kriegers Flak and Rønne Banke (EIA-REPORT, Attachment 15, Volume V, Section 9.1). In terms of the environmental factors of cultural heritage and other material assets, there are no cross-border effects between Germany, Denmark and neighbouring states.

## 9.15. Fehmarn

Other than the environmental factor of human beings already mentioned and the environmental factor of climate/air mentioned below, impacts for Fehmarn have been studied for the environmental factors of soil, water, fauna, flora, biodiversity, landscape and cultural heritage and other material assets (Sections 8.3.15-21 EIA report, Attachment 15, Volume IV C). The impacts on Fehmarn are restricted to the island's investigation area and are not therefore cross-border between Germany, Denmark and neighbouring states.

## 9.16. Bird migration

The immersed tunnel will only result in slight construction-related impairments on bird migration (EIA-REPORT, Attachment 15, Volume IV C, Section 8.3.22). These can be attributed to barrier effects and risks of collision from shipping, to which migratory birds have low sensitivity. The impairments from shipping are localised and are not cross-border.

Compared with the entire bird migration area, the areas affected by sand excavation are small and the risk of collisions with excavation vehicles is insignificant and not cross-border (Section 9.2 EIA, Attachment 15, Volume V).

## 9.17. Bat migration

Impairments on the bats migrating across the Fehmarnbelt from disturbances, losses of and changes to habitats and from barrier effects can be ruled out (see EIA-REPORT, Attachment 15, Volume III, Section 5.2.23). However, there is a traffic-related risk of collision for migrating bats in the illuminated ramp areas and the tunnel portals. The severity of these impairments is rated as medium for the soprano pipistrelle and Nathusius' pipistrelle (see EIA-REPORT, Attachment 15, Volume IV C, Section 8.3.23). Because, however, the additional mortality will not impact on population, cross-border impacts on bat migration between Germany and Denmark are rated as insignificant. There are no cross-border impacts on bat migration in the other neighbouring states.

## 9.18. Climate/air

In terms of air quality, impacts resulting from deposits of dust and harmful substances have been evaluated in the impact assessment (EIA-REPORT, Attachment 15, Volume IV, Section 8.3.24). Breaches of limit values ($NO_2$, $PM_{10}$ and $PM_{2,5}$) only occur in the operating phase in the direct area around the tunnel portals and do not therefore cross the border between Germany, Denmark and neighbouring states.

## 9.19. Interactions

Interactions in the land areas do not cross borders. Because of the water in the Fehmarnbelt, there are numerous interactions within the environmental factors, between them and between neighbouring and/or separate ecosystems (EIA-REPORT, Attachment 15, Volume IV C, Section 8.3.25). Wherever such interactions exist, they have been analysed and taken into account in the impact assessments of the relevant environmental factors (e.g. impairments on plankton, which represent an important feeding resource for the benthic fauna). Other interactions are not considered. Cross-border impacts of interactions in the Fehmarnbelt between Germany and Denmark have been evaluated as insignificant. There are no cross-border interactions in neighbouring states.

## 9.20. Lolland

Other than the environmental factors of human beings and climate/air already mentioned, impacts for Lolland have been studied for the environmental factors of soil, water, fauna, flora, biodiversity, landscape and cultural heritage and other material assets (EIA-REPORT, Attachment 15, Volume IV C, Section 8.3.26). The impacts on Lolland are restricted to the island's investigation area and are not therefore considered cross-border between Germany, Denmark and neighbouring states.

# 10. Mapping the impacts on European conservation areas of the Natura 2000 network

## 10.1. Summary of the Natura 2000 preliminary impact assessments

In accordance with § 34 BNatSchG in conjunction with Art. 6 para3 of the Habitats Directive, studies should be undertaken to establish whether the FBFL project as an immersed tunnel may result in significant impairments on Natura 2000 areas for the elements applicable to the conservation objectives.

In the Natura 2000 preliminaryassessment (FFH-VVP) it is investigated to what extent the significant impairments caused by the immersed tunnel to the following six German Natura 2000 areas can obviously be ruled out (see Figure 47):

- GGB DE 1532-321 "Sundwiesen Fehmarn"
- SCI DE 1532-391 "Coastal strip west and north Fehmarn"
- SCI DE 1533-301 "Staberhuk"
- SCI DE 1631-392 "Marine area of the Eastern Bay of Kiel"
- GGB DE 1631-393 "Coastal landscape north side of the Wagrien Peninsula"
- SCI DE 1632-392 "Coastal landscape off Großenbrode and coastal marine areas"

In addition, an FFH preliminary assessment was carried out into raw materials reclamation on the Danish Rønne Banke and the Kriegers Flak area as well as the ship transport linked thereto. The following Natura 2000 areas were considered:

- GGB DE 1249-301 "Western Rönnebank"
- GGB DE 1339-301 "Kadetrinne"
- GGB DE 1652-301 "Bay of Pomerania with Oderbank".

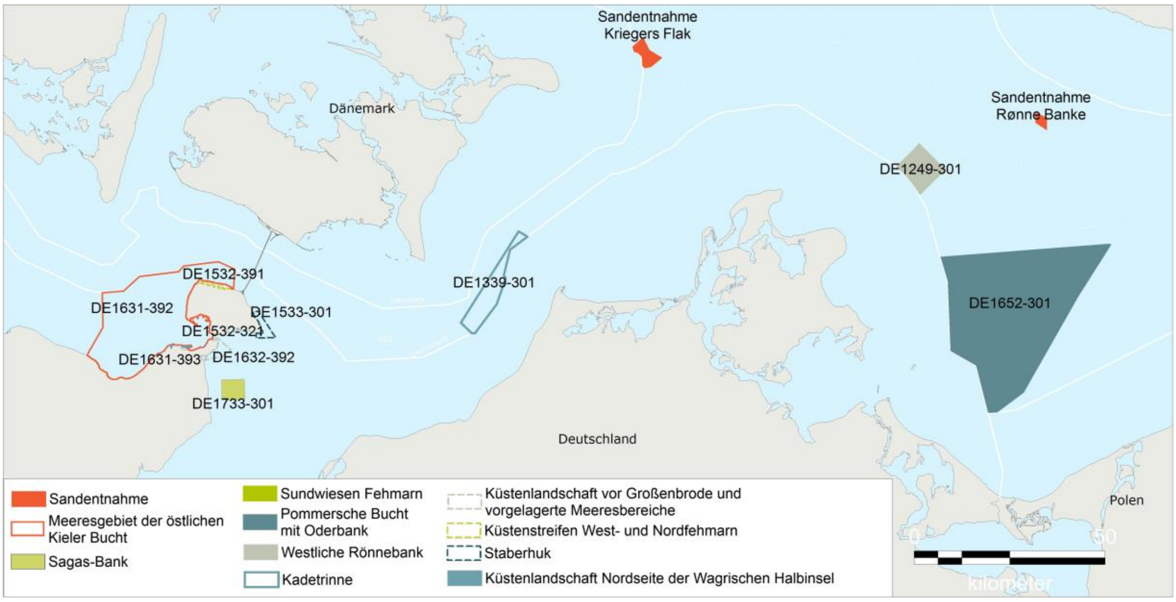



**Figure 47 Location of the Natura 2000 areas studied in the preliminary assessment**

| | |
|---|---|
| Dänemark | Denmark |
| Sandentnahme Kriegers Flak | Sand extraction Kriegers Flak |
| Deutschland | Germany |
| Sandentnahme Rønne Banke | Sand extraction Rønne Banke |
| Polen | Poland |
| Sandentnahme | Sand extraction |
| Meeresgebiet der östlichen Kieler Bucht | Eastern Bay of Kiel marine area |
| Sundwiesen Fehmarn | Sundwiesen Fehmarn |
| Pommerche Bucht mit Oderbank | Bay of Pomerania with Oderbank |
| Westliche Rönnebank | Western Rönnebank |
| Kadetrinne | Kadetrinne |
| Küstenlandschaft vor Grossenbrode und vorgelagerte Meeresbereiche | Coastal landscape at Grossenbrode and upstream marine areas |
| Küstenstreife West- und Nordfehmarn | Coastal strip West and North Fehmarn |
| Staberhuk | Staberhuk |
| Küstenlandschaft Nordseite der Wagrischen Halbinsel | Coastal landscape north side of the Wagrien Peninsula |

The preliminary assessment focuses on "construction-related", "installation-related" and "operation-related" impacts.

Different types of potential impacts were examined, in particular drifting of sediment, noise and disturbance due to the construction and operation of an FBFL, barrier effects/risk of collision and morphological changes to the seabed.

For all areas considered, the preliminary assessment shows that significant impairments can obviously be ruled out.

## 10.2. Summary of the Natura 2000 impact assessments

Natura 2000 impact assessments were carried out on both neighbouring EU Special Protection Areas (BSG) and the SCIs directly impacted:

- SCI DE 1332-301 "Fehmarnbelt"
- BSG DE 1530-491 "Eastern Bay of Kiel"
- BSG DE 1633-491 "Baltic Sea east of Wagrien"
- SCI DE 1733-301 "Sagas Bank"

In the hearings procedure, objections were raised against the zoning of SCI DE 1631-392 "Eastern Bay of Kiel marine area". The project proponents have therefore decided to study the impact of the project with an area expanded further east of the official zoning as a precautionary measure. In this regard, the project proponents are assuming that this could be a "potential Natura 2000 area". If an area is classed as being a "potential Natura 2000 area", a project is only permitted under the conditions laid out in Article 6, Para. 3 and 4 of the Habitats Directive. Therefore, at the very least a Natura 2000 preliminary impact assessment must be carried out. Accordingly, a Flora and Fauna Habitat Impact Study was scheduled for the SCI area DE 1692-392 "Eastern Bay of Kiel marine area including potential expansion areas".

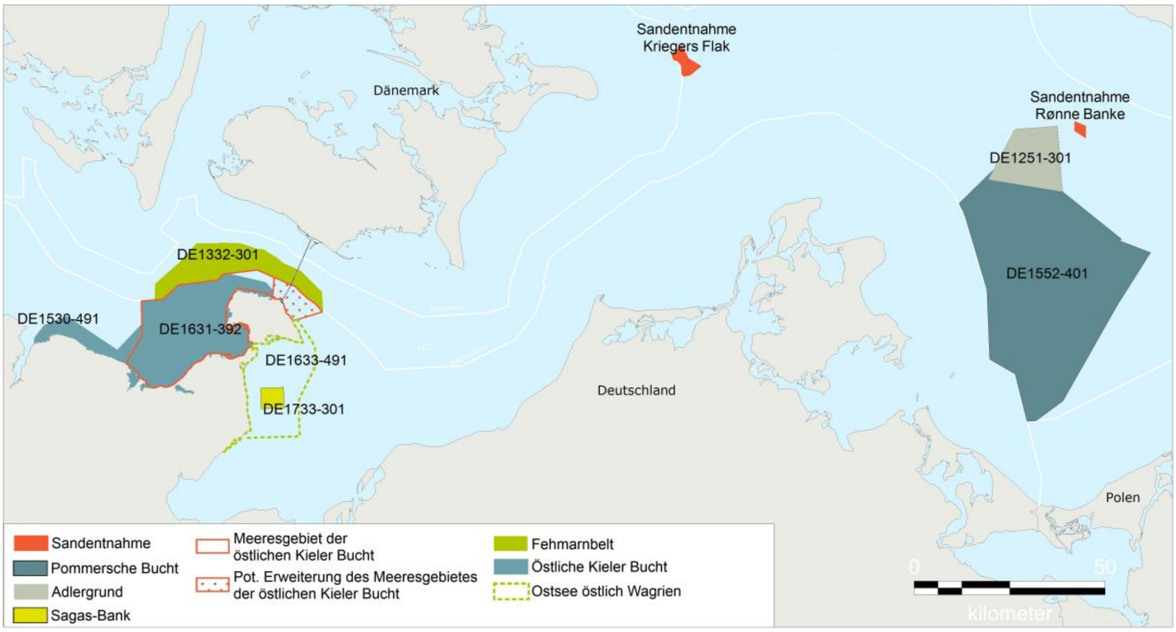



**Figure 48 Location of the Natura 2000 areas studied in the preliminary assessment**

| | |
|---|---|
| Dänemark | Denmark |
| Sandentnahme Kriegers Flak | Sand extraction Kriegers Flak |
| Deutschland | Germany |
| Sandentnahme Rønne Banke | Sand extraction Rønne Banke |
| Polen | Poland |
| Sandentnahme | Sand extraction |
| Pommersche Bucht | Bay of Pomerania |
| Meeresgebiet der östlichen Kieler Bucht | Eastern Bay of Kiel marine area |
| Pot. Erweiterung des Meeresgebietes der östlichen Kieler Bucht | Potential Expansion of the marine area of the Eastern Bay of Kiel |
| Östliche Kieler Bucht | Eastern Bay of Kiel |
| Ostsee östlich Wagrien | Baltic Sea east of Wagrien |

In addition, an FFH preliminary assessment was carried out into raw materials reclamation on the Danish Rønne Banke as well as the ship transport linked thereto. The following Natura 2000 areas were considered: (see Figure 49):

- GGB DE 1251-301 "Adlergrund"
- BSG DE 1552-401 "Bay of Pomerania"

.

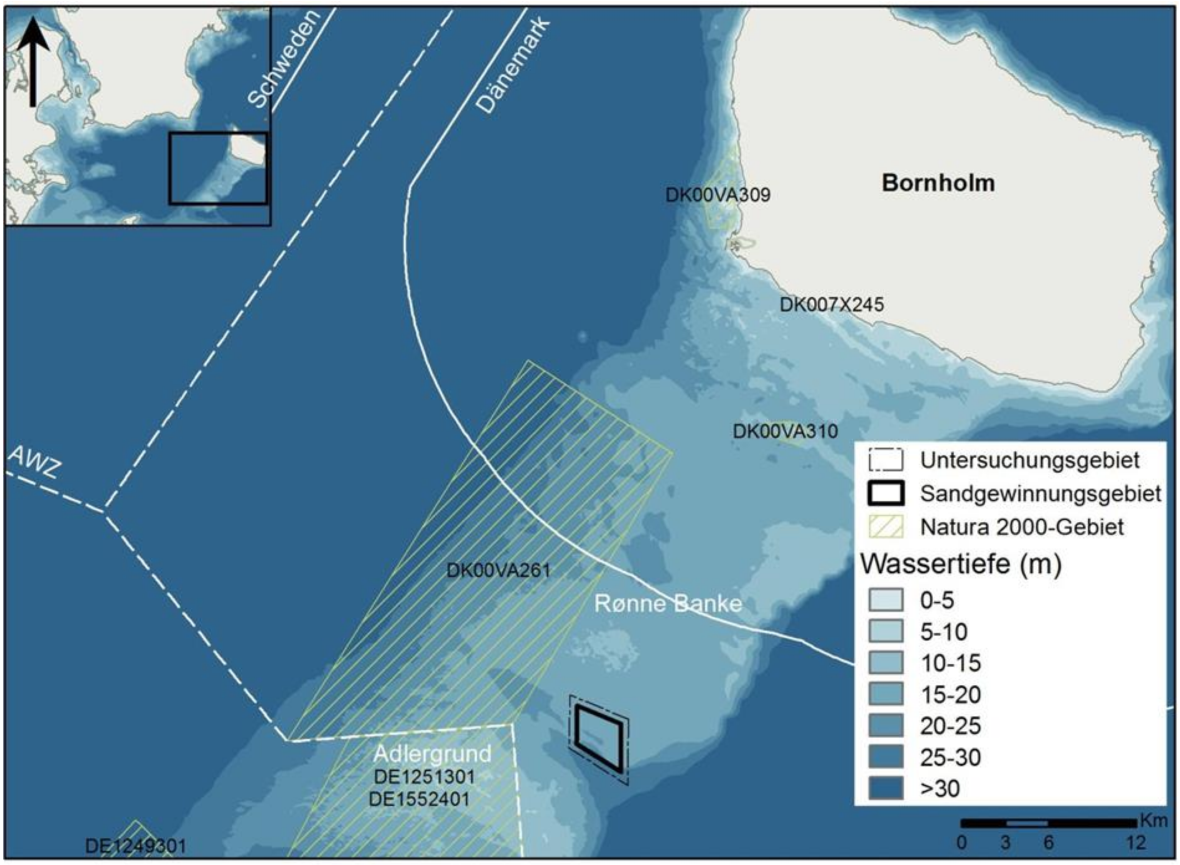



**Figure 49** Natura 2000 areas near the Rønne Banke sand cultivation area

| | |
|---|---|
| Schweden | Sweden |
| Dänemark | Denmark |
| AWZ | EEZ |
| Untersuchungsgebiet | Investigation area |
| Sandgewinnungsgebiet | Sand reclamation area |
| Natura 2000-Gebiet | Natura 2000 area |
| Wassertiefe (m) | Water depth (m) |

The results of the aforementioned Natura 2000 impact assessments mentioned are summarised below.

The fundamental data source for both inventory and assessment and the assessment of impairments is the Environmental Impact Assessment (EIA, Attachment 15 of the plan approval documents.

### 10.2.1. Natura 2000 impact assessment for SCI DE 1332-301 "Fehmarnbelt"

The immersed tunnel crosses the SCI DE 1332-301 "Fehmarnbelt". Dredging work will stir up sediments from the seabed and add these to currents. There will be an increased concentration of suspended material and the released particles will be deposited. This may potentially result in damage to the benthic flora (especially macroalgae) and fauna. Significant impairments can be ruled out due to the fact that **habitat types 1110** and **1170** are approx. 12 and 14 km respectively away from the tunnel route and given the restricted times for which the impacts will exist.

Significant impairments on the **harbour porpoise** as a species of Annex II of the Habitats Directive by underwater noise caused by pile driving can be ruled out on the basis of the calculation of the impact radii expected. "Also, with regard to project-related disturbances caused by dredging work and ship movements, barrier effects of dredging work taking place on various sections at the same time and drifting of sediment, significant impairments to the harbour porpoise can be ruled out."

**Table 84 Concluding evaluation of impairments in GGB DE 1332-301 "Fehmarnbelt“**

–: no impairment

| Representative site components | Impairments | | | | Evaluation of impairment (Immersed tunnel) |
|---|---|---|---|---|---|
| | ba | to | be | | |
| LRT 1110: Sandbanks | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | – |
| | | x | | Impairments due to building works. | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| LRT 1170: Reefs | x | | | Impairment for benthic flora (macroalgae) due to increased suspended sediment concentration and sediment deposits | not relevant |
| | | x | | Impairments due to building works. | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| Harbour porpoise (*Phocoena phocoena*) | x | | | Displacement/disturbance resulting from pile driving | – |
| | x | | | Displacement/disturbance resulting various construction works/excavation work | not relevant |
| | x | | | Barrier effects (many simultaneous construction works) | not relevant |
| | x | | | Reduction of available food due to impairment for fish due to increased suspended sediment concentration and sediment deposits | not relevant |

| | | | | | |
|---|---|---|---|---|---|
| | | x | | Barrier effects due to building works. | – |
| | | | x | Disturbances (noise, vibrations, light): | – |
| Harbour seal (*Phoca vitulina*) | x | | | Displacement/disturbance resulting from pile driving | – |
| | x | | | Displacement/disturbance resulting from various construction works/ excavation work | not relevant |
| | x | | | Barrier effects (many simultaneous construction works) | not relevant |
| | x | | | Reduction of available food due to impairment for fish due to increased suspended sediment concentration and sediment deposits | not relevant |
| | | x | | Barrier effects due to building works. | – |
| | | | x | Disturbances (noise, vibrations, light): | – |

The impacts of the project do not extend to the harbour seal rest areas in the Rødsand lagoon. The Fehmarnbelt trench near the SCI is not one of the preferred feeding grounds of harbour seals. Construction-related disturbances on harbour seals looking for food or young migrating animals may affect individual animals no more than sporadically so significant impairments are ruled out.

When assessing potential accumulative impacts, no reliably foreseeable interacting plans or projects could be found which could impact in terms of the ability to record project-related impairments.

Overall, significant impairments on SCI DE 1332-301 "Fehmarnbelt" in terms of its elements applicable to the conservation objectives by the FBFL (immersed tunnel) project can be ruled out.

### 10.2.2. Natura 2000 impact assessment for SAC DE 1530-491 "Eastern Bay of Kiel"

The project lies outside the SAC DE 1530-491 "Eastern Bay of Kiel" and passes no closerthan 2,000 m to the edge of the conservation area. A direct impairment of the species of bird listed in the standard data sheet and their habitats from being built over can be ruled out with certainty as part of the Natura 2000 impact assessment.

Parts of the SPA are within the 3km disturbance zone of the tunnel works. Here, in particular for the **diving ducks** which are particularly sensitive to disturbances (Common Pochards, Common Goldeneyes, and Greater Scaups) and**sea ducks** (Common Eiders, Long-Tailed Ducks and Common Scoters), impairments are to be expected.

Likewise for the diving and sea ducks, habitat changes resulting from water turbidity and which are likely to result in restricted ability to find food, as well as loss of habitat due to sediment drift, which can lead to a loss or displacement of prey animals, are to be expected. The maximum numbers of individuals driven from the area as a result of the three impact factors are lower than the materiality threshold which is locally set at a criterion of 1%. We must therefore rule out substantial adverse effects.

For the **common terns** which breed at Grünen Brink (common and little terns) and **mergansers (red-breasted mergansers)**, impairments as a result of water turbidity and the displacement of small fish as a result of sediment spill are registered, but due to their local nature and temporary character, they cannot lead to any substantial impairments for these species, nor to any impairments to the conservation objectives. An expert assessment has deemed that the installation- and operation-related impairments are fundamentally not capable of causing a significant impairment on the species listed in the standard data sheet and their habitats and/or the habitat characteristics required to conserve the species (p. Table 85).

**Table 85 Concluding evaluation of impairments in SPA DE 1530-491 "Eastern Bay of Kiel"**

Explanation:

ba: construction, to: Annex, be: Operation-dependent impairment

–: no impairment

| Representative site components | Impairments | | | | Evaluation of impairment (immersed tunnel) |
|---|---|---|---|---|---|
| | ba | to | be | | |
| diving ducks | x | | | Disturbances (noise, vibrations, light movement): | not relevant |
| | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | Impairments arising from water turbidity (reduced access to food) | not relevant |
| | | x | | No impairments | – |
| | | | x | No impairments | – |
| Sea ducks | x | | | Disturbances (noise, vibrations, light movement): | not relevant |
| | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | Impairments arising from water turbidity (reduced access to food) | not relevant |
| | | x | | No impairments | – |
| | | | x | No impairments | – |
| Red-breasted merganser (*Mergus serrator*) | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits (displacement of prey) | not relevant |
| | x | | | Impairments arising from water turbidity (reduced access to food) | not relevant |
| | | x | | no impairments | – |

| | | | | | |
|---|---|---|---|---|---|
| | | | x | no impairments | – |
| Com-mon tern | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits (displacement of prey) | not relevant |
| | x | | | Impairments arising from water turbidity (reduced access to food) | not relevant |
| | | x | | no impairments | – |
| | | | x | no impairments | – |

Overall, significant impairments on SAC DE 1530-491 "Eastern Bay of Kiel" in terms of its elements applicable to the conservation objectives by the FBFL (immersed tunnel) project can be ruled out.

### 10.2.3. Natura 2000 impact assessment for SAC DE 1633-491 "Baltic Sea east of Wagrien"

The project is outside the SAC DE 1633-491 "Baltic Sea east of Wagrien". It passes no closer than 5,500 m to the edge of the conservation area. A direct impairment of the species of bird listed in the standard data sheet and their habitats from being built over can be ruled out with certainty as part of the Natura 2000 impact assessment.

Likewise for the **diving** (tufted ducks and greater scaups) and **sea ducks** (eider and long-tailed ducks and common scoters), habitat changes resulting from water turbidity and which are likely to result in restricted ability to find food, as well as loss of habitat due to sediment drift, which can lead to a loss of prey animals, are to be expected. The maximum numbers of individuals driven from the area as a result of named factors are lower than the materiality threshold which is locally set at a criterion of 1%. We must therefore rule out substantial adverse effects.

In the Sagas Bank area, which lies within the SPA, a conservation analysis-based compensatory measure should be implemented with the goal of reproducing the reef structure. In order to reduce disturbances of wintering or migrating resting birds (in particular eider ducks, long-tailed ducks and common scoters) as a result of shipping connected with the implementation of this measure, the implementation will be effected outside the resting time from 15.10. to 15.04 (see, Annex IA, Measure 8.7) Substantial impairments to wintering resting and migrating birds should thus be excluded.

An expert assessment has deemed that the installation- and operation-related impairments are fundamentally not capable of causing a significant impairment on the species listed in the standard data sheet and their habitats and/or the habitat characteristics required to conserve the species.

**Table 86 Concluding evaluation of impairments in SPA DE 1633-491 "Baltic Sea east of Wagrien"**

Explanation:
ba: construction, to: Annex, be: Operation-dependent impairment
–: no impairment

| Representative site components | Impairments | | | | Evaluation of impairment (immersed tunnel) |
|---|---|---|---|---|---|
| | ba | to | be | | |
| diving ducks | x | | | Disturbances (noise, vibrations, light movement): | not relevant |
| | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | Impairments arising from water turbidity (reduced access to food) | not relevant |
| | | x | | no impairments | – |
| | | | x | no impairments | – |
| Sea ducks | x | | | Disturbances (noise, vibrations, light movement): | not relevant |
| | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | Impairments arising from water turbidity (reduced access to food) | not relevant |
| | | x | | no impairments | – |
| | | | x | no impairments | – |

Overall, significant impairments on SAC DE 1633-491 "Baltic Sea east of Wagrien" in terms of its elements applicable to the conservation objectives by the FBFL (immersed tunnel) project can be ruled out.

### 10.2.4. Habitats Directive impact assessment GGB DE 1251-301 "Adlergrund"

The sand dredging area lies outside the BSG in the Danish EEZ. The distance between the sand dredging area and the BSG is roughly 5 km (see Figure 49).

Impacts on SCI habitat types (HT) can only be caused by sediment drifting into the GGB. However, due to the modelling, the possibility of suspended sediments entering is very low and it can be safely ruled out that the compliance objectives with regard to **LRT 1170 and 1110 (reefs, sand banks)** will be impaired.

Impairments to the species in Annex II of the Habitats Directive (**harbour porpoise and grey seal**) from acoustic stimuli (noise) caused by the distance between the sand dredging area and the GGB can also be safely ruled out.

As a precautionary measure and as a constituent element of risk management, a measure to prevent impairment of the conservation area is implemented which stipulates the transport route to the Fehmarnbelt. According to this, ships (suction dredgers) will not cross the "Adlergrund" area. The distance to the conservation area located to the south of the transport route is at least one nautical mile (cf. Annex IA, Measure Sheet 8.8). Ships' positions can be monitored in real time using AIS (*Automatic Identification System*).

### 10.2.5. Habitats Directive impact assessment BSG DE 1552-401 "Bay of Pomerania"

The sand dredging area lies outside the bird conservation area in the Danish EEZ. The distance between the sand dredging area and the BSG  (a sub-section of the "Adlergrund", cf. Section 10.2.4) is roughly 5 km.

Impacts on habitat elements which are important to **sea birds** can only be caused by sediment drifting into the closed area. However, due to the modelling, the possibility of suspended sediments entering is very low and it can be safely ruled out that the compliance objectives and protection purpose with regard to habitat elements (specifically flatlands with reefs and sandbanks used by sea ducks as their preferred feeding grounds) will be impaired.

Disturbances caused by acoustic stimuli and shipmovement/ optical stimuli can also be ruled out due to the distance between the sand dredging area and the special protection area.

As a precautionary measure and as a constituent element of risk management, a measure to prevent impairment of the conservation area is implemented which stipulates the transport route to the Fehmarnbelt. According to this, ships (suction dredgers) will not cross the "Bay of Pomerania" special protection area (with the "Adlergrund" sub-area). The distance to the conservation area located to the south of the transport route is at least one nautical mile (cf. Annex IA, Measure Sheet 8.8). Ships' positions can be monitored in real time using AIS (*Automatic Identification System*).

### 10.2.6. Natura 2000 impact assessment for GGB DE 1692-392 "Marine area for Eastern Bay of Kiel incl. potential expansion areas"

The Natura 2000 preliminary assessment laid out with the original application documents for the "Marine area in Eastern Bay of Kiel" SCI shows that the significant impairments to the "Marine area in Eastern Bay of Kiel" SCI can obviously be ruled out (cf. Attachment 19 of the plan approval documents, Part B II, Section 5). The preliminary assessment is based on the zoning in the official area demarcation provided by the MELUR.

It is the opinion of the project proponents that the zoning for the SCI "Marine area in the Eastern Bay of Kiel" should not be queried. With regard to the objections against the zoning, which were raised during the consultation procedure, the project proponents are however studying the impact of the project with an area expanded further east of the official zoning as a precautionary measure. In this regard, the project proponents are assuming that this could be a "potential Natura 2000 area". If an area is classed as being a "potential Natura 2000 area", a project is only permitted under the conditions laid out in Article 6, Para. 3 and 4 of the Habitats Directive. Therefore, at the very least a Natura 2000 preliminary impact assessment must be carried out.

When considering a precautionary expansion of the protected area, a direct tunnel crossing of the potential SCI is ruled out.

The area serves to preserve the marine habitats of sandbanks which are only slightly covered by seawater (HT 1110), vegetation-free mud flats sandflats and muddy sand (HT 1140), large, shallow inlets and bays (shallow water areas and seagrass meadows) (HT 1160) and reefs (HT 1170) as well as the habitat of the harbour porpoise, which is found regularly in the protected area.

Extensive dredging work will stir up sediments from the seabed and add these to currents. There will be an increased concentration of suspended material (turbidity plumes) and the released particles will be deposited. This may cause damage to vegetation (particularly macro algae/ phytobenthos = phytal) and the less mobile, seabed-dwelling animals (zoobenthos) which live in the infauna and epifauna. The impacts expected to be caused by sedimentation and suspended sediments affect all habitat types. However, as a result of their intensity and duration, in addition to the good regeneration capacity of benthic flora and fauna, it is not appropriate to say that these will significantly impair habitat types.

In addition, there is no cause for concern since there are no permanent stockpile changes to the characteristic fish and bird species. Any possible dislocation effects or reduced usability of habitats is restricted to the construction area itself. After the completion of the construction works, the HT areas will once again be fully available for use as habitats. Significant impairments can therefore be safely ruled out.

Significant impairments on the harbour porpoise as a species of Annex II of the Habitats Directive by underwater noise caused during pile driving can be ruled out on the basis of the calculation of the impact radii expected. Also, with regard to project-related disturbances caused by dredging work and ship movements, barrier effects of dredging work taking place on various sections at the same time and drifting of sediment, significant impairments to the harbour porpoise can be ruled out.

**Table 87 Concluding evaluation of significant impairments to the GGB DE 1692-392 "Marine area for Eastern Bay of Kiel incl. potential expansion areas"**

Explanation

ba: construction, to: Annex, be: Operation-dependent impairment
–: no impairment

| Representative site components | Impairments | | | | Evaluation of impairment (immersed tunnel) |
|---|---|---|---|---|---|
| | ba | to | be | | |
| LRT 1110: Sandbanks | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | impairment for key species | not relevant |
| | | x | | Impairments due to building works. | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| LRT 1140: Vegetation-free sand flats, mudflats | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |

| | | | | | |
|---|---|---|---|---|---|
| and muddy sands | | | | | |
| | x | | | impairment for key species | not relevant |
| | | x | | Impairments due to building works. | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| LRT 1160: Large shallow inlets and bays | x | | | Impairment for benthic fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | impairment for key species | not relevant |
| | | x | | Impairments due to building works. | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| LRT 1170: Reefs | x | | | Impairment for benthic flora (macroalgae) due to increased suspended sediment concentration and sediment deposits | not relevant |
| | x | | | impairment for key species | not relevant |
| | | x | | Impairments due to building works. | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| Harbour porpoise (*Phocoena phocoena*) | x | | | Displacement/disturbance resulting from pile driving | not relevant |
| | x | | | Displacement/disturbance resulting various construction works/excavation work | not relevant |
| | x | | | Barrier effects (many simultaneous construction works) | not relevant |
| | x | | | Reduction of available food due to impairment for fish due to increased suspended sediment concentration and sediment deposits | not relevant |
| | | x | | Barrier effects due to building works. | – |
| | | | x | Disturbances (noise, vibrations, light): | – |

When assessing potential accumulative impacts, no reliably foreseeable interacting plans or projects could be found with impacts that could be reliably foreseen and which , when combined with the Fehmarnbelt Fixed Link project, were liable to cause significant impairment to the area.

Overall, significant impairments to the GGB DE 1692-392 "Marine area for Eastern Bay of Kiel incl. potential expansion areas" in those areas which are relevant to conservation goals, which are caused by the Fehmarnbelt Fixed Link project can be ruled out.

### 10.2.7. Habitats Directive impact assessment GGB DE 1733-301 "Sagas Bank"

The shortest distance between the SCI and the Fehmarnbelt Fixed Link is around 27km. The locations of habitat types (habitat type1110 "Sand banks", LRT 1170 "Reef") are located at a similar distance. Effects based on the impact of plant and works cannot therefore arise there;

only construction-related effects which could lead to substantial impairments in the conservation area should be investigated, where these are relevant to conservation goals.

Due to this distance, the most powerful indirect effects or processes which could be expected to arise and create impairments for the habitat in question during the construction phase would result from drift and deposit of stirred-up sediments. Significant impairments can in any case surely be ruled out due to the fact that SCI is located away from the construction site, and also given the restricted times for which the impacts will exist.

Impairments on the harbour porpoise as a species of Annex II of the Habitats Directive by underwater noise caused during pile driving can be ruled out on the basis of the distance.

The compensatory measures for reproduction of reefs (see Annex IA, Measure 8.7) affects the LRT 1170 as well as the harbour porpoise during production, as a result of temporarily and locally increased shipping. The measures aim to upgrade the currently-devastated reef, by increasing the proportion of solid substrate and structural diversity by delivering stones. By means of this measure, no surfaces or substantial structures of the LRT 1170 should be lost. We can clearly therefore rule out substantial adverse effects. The disturbances caused by planned shipping will be substantially limited to the area where the measures are to be implemented (0.8% of the conservation area). The animals will therefore have adequate space to move into within the conservation area during the time period in question. It is clear then that no change or reduction in population will arise. Significant impairments for the harbour porpoise can therefore be safely ruled out.

When assessing interacting plans and projects, no plans or projects could be found which could be of relevance in terms of the ability to record project-related impairments. It is to be established that no cumulative affects are to be expected and that the project will not lead to substantial impairments for the SCI.

Significant impairments to the GGB DE 1733-301 "Sagas Bank" can therefore be safely excluded overall.

**Table 88 Outcome of the Natura 2000 preliminary impact assessment GGB DE 1733-301 "Sagas-Bank"**

Explanation
ba: construction, to: Annex, be: Operation-dependent impairment
no impairment

| **Representative site components** | **Impairments (ba = construction-related, an = plant-related, be = operation-related)** | | | | **Evaluation of impairment (immersed tunnel)** |
|---|---|---|---|---|---|
| | **ba** | **to** | **be** | | |
| LRT 1110: Sandbanks | x | | | Impairments for benthic flora and fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | | x | | Impairments arising from changes to coastal morphology | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| LRT 1160: Large shallow inlets and bays | x | | | Impairments for benthic flora and fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | | x | | Impairments arising from changes to coastal morphology | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| LRT 1170: Reefs | x | | | Impairments for benthic flora and fauna due to increased suspended sediment concentration and sediment deposits | not relevant |
| | | x | | Impairments arising from changes to coastal morphology | – |
| | | | x | Impairments arising from potential run-off of nitrogen | – |
| Harbour porpoise (*Phocoena phocoena*) | x | | | Disturbance resulting from pile driving | – |
| | x | | | Barrier effects (many simultaneous construction works) | not relevant |
| | x | | | Disturbance resulting from shipping | not relevant |
| | | x | | Barrier effects (due to building works) | – |
| | | | x | Disturbances (noise, vibrations, light): | – |

### 10.2.8. Conclusion

Overall, significant impairments on German Natura 2000 areas in terms of their elements applicable to the conservation objectives by the FBFL (immersed tunnel) project can be ruled out.

Significant impairments resulting from interactions with other plans and projects can also be ruled out.

# 11. Information about gaps in knowledge and difficulties

There are no gaps in knowledge and problems of relevance for any of the aspects studied.

Uncertainty does exist as a result of the methods used and the biology of the species (see Section 11 EIA report, Attachment 15, Volume V). In spite of using methods corresponding to the very latest technologies and sciences, these uncertainties are unavoidable. Some of the gaps in knowledge can be closed using supplementary methods. Residual gaps in knowledge are considered in the impact assessment, for example through the use of the precautionary principle, which ensures that gaps in knowledge do not significantly impact on the statements made in the impact assessment.

A detailed list of the existing gaps in knowledge is made in Section 11 of the EIA report (Attachment 15 of the plan approval documents, Volume 5) and Section 12 of the LCP (Attachment 12 of the plan approval documents).