FINAL REPORT

# Navigational Risk Assessment of Aflandshage and Nordre Flint offshore wind farms

## HOFOR Vind A/S

**Report No.:** 2020-2, Rev. H
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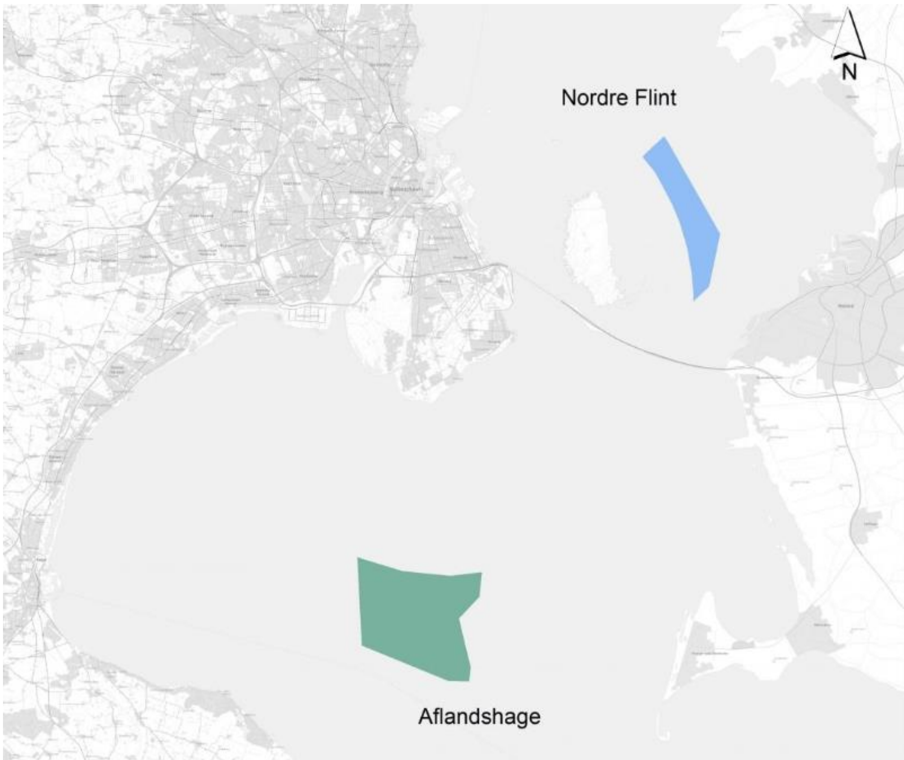

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| Prepared by: | Verified by: | Approved by: |
|---|---|---|
| Johnsrud, Hans Jørgen<br>Digitalt signert av Johnsrud, Hans Jørgen<br>Dato: 2021.09.30 11:17:50 +02'00' | Digitalt signert av Krugerud, Christine<br>Dato: 2021.09.30 11:05:43 +02'00' | Digitally signed by Hoffmann, Peter Nyegaard<br>Date: 2021.09.30 11:43:01 +02'00' |
| Hans Jørgen Johnsrud<br>Senior Consultant | Christine Krugerud<br>Consultant | Peter Hoffmann<br>Head of Section Safety Risk & Reliability |



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| A | 2020-10-23 | First draft issue | HAJOH | LSNI | |
| B | 2020-12-03 | Updated windfarm layout | HAJOH | LSNI | |
| C | 2020-12-07 | 2nd draft issue | HAJOH | LSNI | |
| D | 2020-12-10 | Final issue | HAJOH | LSNI | |
| E | 2021-06-21 | Updated layout of Aflandshage Wind Farm, draft | HAJOH | KRUGER | |
| F | 2021-06-24 | Updated layout of Aflandshage Wind Farm, final | HAJOH | KRUGER | |
| G | 2021-09-07 | Updated based on comments | KRUGER | HAJOH | PHOFF |
| H | 2021-09-30 | Updated maximum capacity of OWF from 250 to 300 MW and large turbine capacity from 10 to 11 MW | KRUGER | HAJOH | PHOFF |

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# [NOTE: REVISED TURBINE LAYOUT]

This Risk Assessment report was originally based on two layout concepts for each of the Nordre Flint and Aflandshage offshore windfarms (OWF's), as per July 2020;

- Layout with small turbines ("small turbine layout")
- Layout with large turbines ("large turbine layout")

Further, the risk assessment was performed such that it will represent a conservative assumption for all possible turbine layouts i.e. both with regards to turbine size and location of the turbines within the offshore wind farm area. The conservative approach was intentionally chosen to overestimate uncertain risks in order to be confident that they are not underestimated.

The "small turbine layout" was chosen to represent this conservative scenario, since it is assumed to result in the highest likelihood of collision. It was noted that the "large turbine layout" would take up approximately the same area, but the lower number of turbines would present fewer obstacles to the ship traffic, which would lead to a reduced potential of ship collisions. The layout of the turbines in the Risk Assessment is according to the layout for small turbine size.

After the original Risk Assessment report was delivered, HOFOR made several changes in the windfarm layouts. There were some changes in the turbine positions and in addition an intermediate sized turbine layout was introduced. The number of turbines in the layout for the small turbine size is the same for Aflandshage OWF (45 turbines) and reduced by one turbine from 29 to 28 turbines for Nordre Flint OWF. The new turbine layouts for each of the two wind farm projects were:

- Small turbine layout (update of existing small turbine layout, and reduced number of wind turbines for Nordre Flint OWF)
- Intermediate turbine layout (new layout)
- Large turbine layout (update of existing large turbine layout)

Since the changes in turbine positions were relatively small for Nordre Flint OWF, it was decided to keep the original risk calculations and make a qualitative assessment of the layout changes. In the following subsection starting on page 5, a qualitative assessment of the layout changes for Nordre Flint OWF is presented.

During the authority consultation for Aflandshage OWF, the Danish Maritime Authority (DMA) commented that HOFOR should increase the distance from the easternmost wind turbines to the southbound TSS lane. Several turbines that were located close to the southbound TSS lane, were relocated further away from the TSS resulting in significant layout changes. Therefore, new risk calculations have been made for the small turbine layout in June 2021 which are presented in the present document. Furthermore, it was decided that no adjustments to the HAZID report were needed, as all hazards are still relevant.

For Aflandshage OWF the layouts discussed in the remainder of this document are the most up-to-date layouts as of June 2021.

## Qualitative assessment of potential impact on traffic and risk for Nordre Flint OWF

Figure 1 presents the new turbine positions for small (green), intermediate (yellow), large (red) layouts for Nordre Flint OWF. Figure 2 shows a comparison of the old layout (blue) vs new layout (green) for small turbine layout on Nordre Flint OWF.

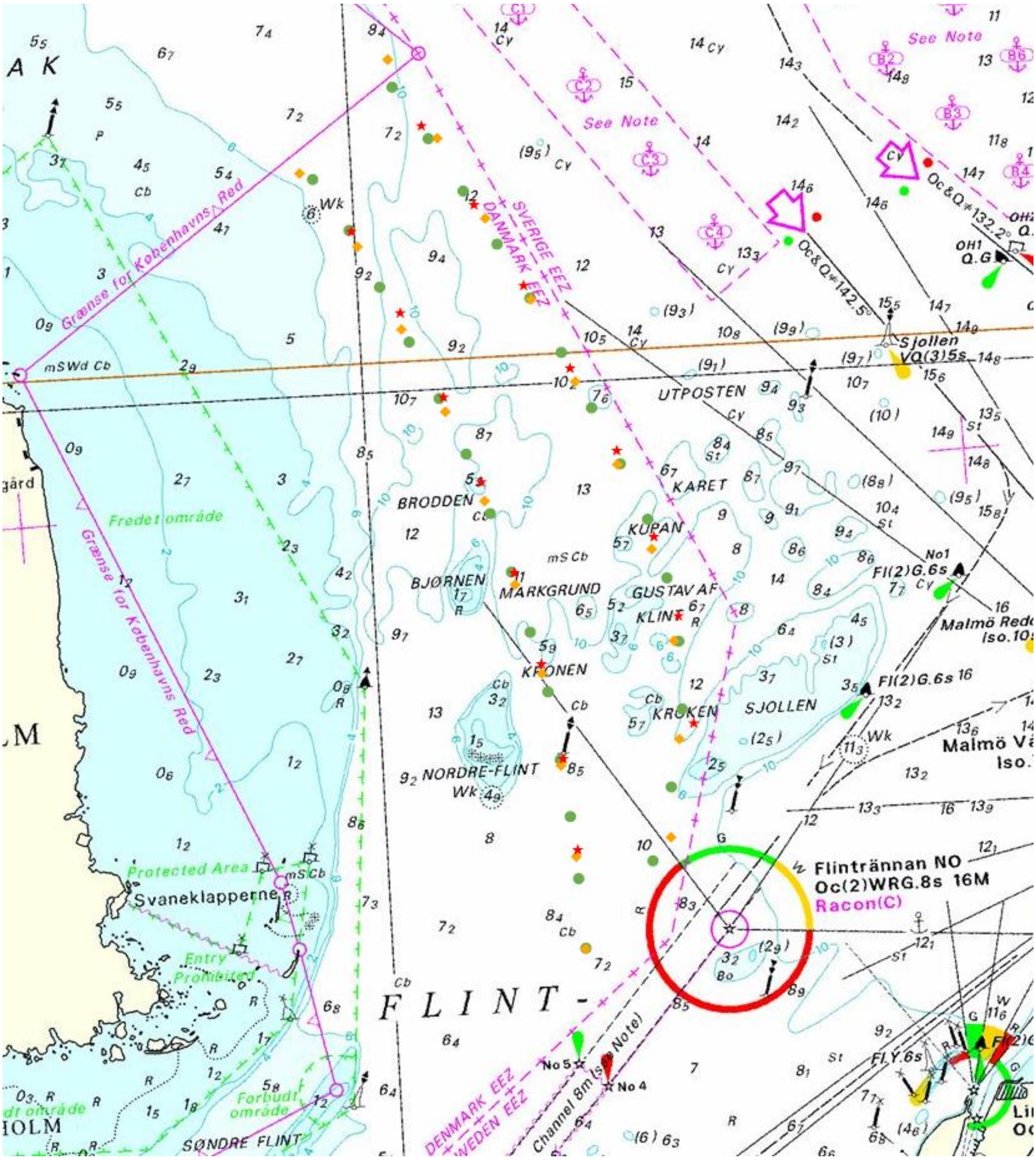


Figure 1 Nordre Flint: New turbine layouts for small (green), intermediate (yellow), large (red).

As seen in Figure 2, the most significant change is that the number of wind turbines have been reduced to 28 from 29 as well as the most southern turbine being placed further north (away from the Flintchannel). In addition, the most north-eastern turbine is moved a bit further north-west.

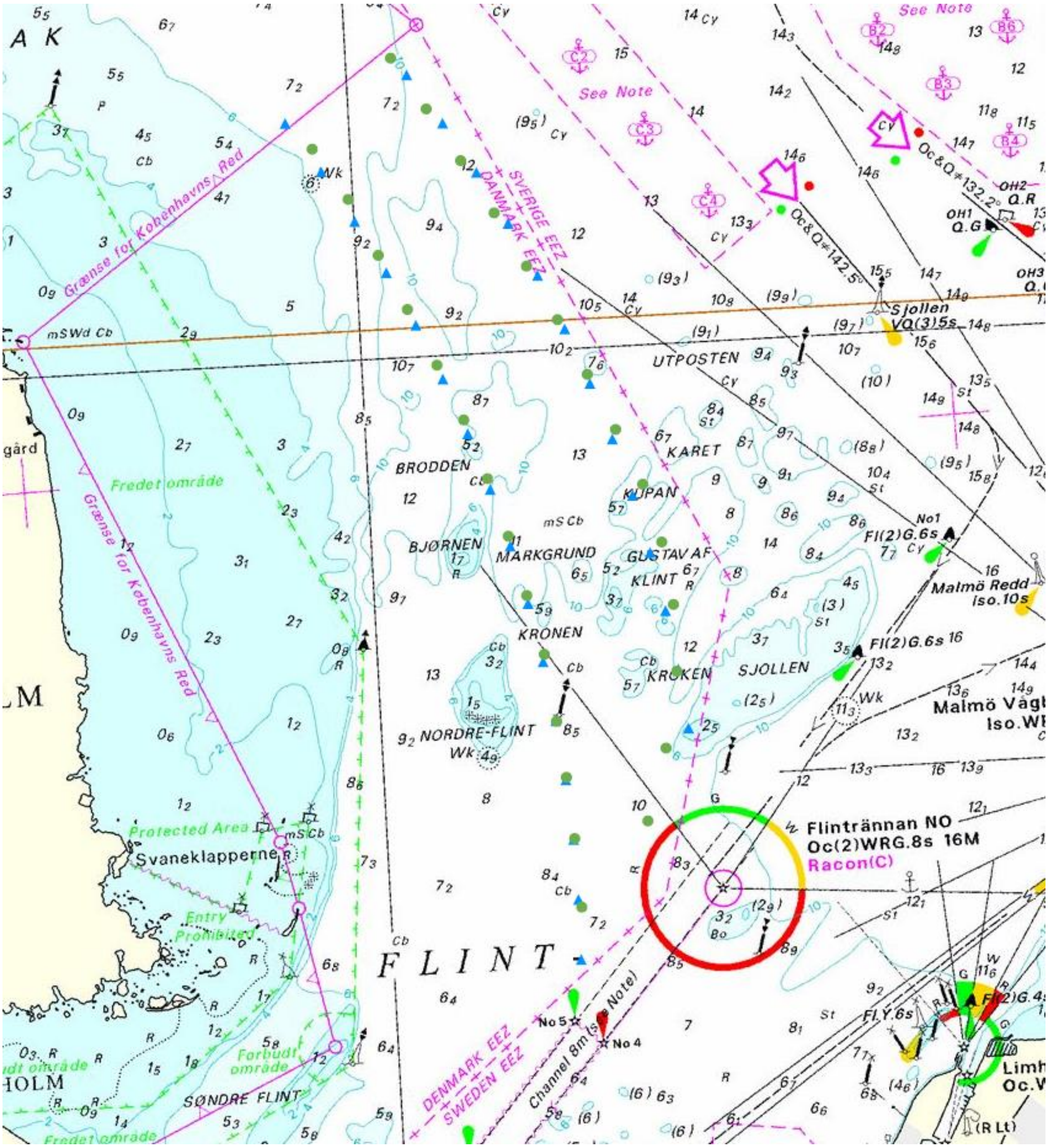


**Figure 2 Nordre Flint: Comparison of old layout (blue) vs new layout (green) for small turbine layout.**

The most significant change is that the number of wind turbines has been reduced to 28 from 29, as well as the most southern turbine being placed further north (away from the Flintchannel). Relocation of the most southern turbine (WTG 16) away from the Flintchannel will have a risk reducing effect on the ship-turbine collision frequency, both for drifting and powered impact. The distance from WTG 16 to the outer line of the Flintchannel was about 350 m, which equals to 1.2 ships length (using the ship with max length of 300 m). With the new layout the distance to the closest turbine will be approximately 670m, which equals to more than 2 times the ship length.

In the old layout (as calculated in this report) the frequency of ship-turbine collision was already very low. The calculation of risk for the Flintchannel only, based on the "small turbine layout", showed a ship-turbine collision frequency of 1.2E-04, which equals to one accident every 8,000 years. This is mainly due to the limited fairway width of the Flintchannel, approximately 360m. Officers on watch sailing this channel will have great attention and focus due to the very shallow waters on both sides. There are also fixed structures (lateral marks with light) at two locations in the Flintchannel.

Due to the already low accident frequency, relocating the most southern turbine position would therefore have minor effect on the frequency calculations. However, it would contribute positively to two risk factors that is difficult to quantify:

- It will leave more space available for evasive manoeuvres, although this channel does not have much space for evasive manoeuvres, as it is already shallow waters on each side.
- Perceived risk from sailors and officers on watch; the turbines and blade may distract attention or possibly make them to sail further away from the turbines, potentially affecting other crossing or head-on traffic.

Another noteworthy change in the Nordre Flint OWF is that the most north-eastern offshore wind turbine position is moved about 240 m north-west. However, this is assessed to have negligible impact on the risk. The traffic is assumed to shift further north with approximately the same distance as the turbine is moved. Hence, the traffic is assumed to relocate accordingly and ensure safe distance to the turbines.

The overall conclusion is that the new layouts for Nordre Flint OWF will have a lower or an equivalent level of risk in terms of ship-turbine collision, as compared to the old layouts. Potential impacts on ship-ship collision and grounding risk due to the new layouts are also assessed to be on the same level as the old layout. However, the relocation of the southern turbine further away from the Flintchannel could arguably reduce risk; making more space for evasive manoeuvres and reduce navigators perceived risk.

**************Note end*******************

# SUMMARY

The objective of this navigational risk assessment is to assess how, where and how much the offshore wind farm projects at Aflandshage and Nordre Flint impact the maritime traffic, and to assess the potential changes in risk of collisions and groundings caused by the projects. The methodology applied when estimating the navigational risk is a standard risk assessment approach, based on the guidelines of the International Maritime Organisation (IMO) for Formal Safety Assessment (FSA).

The risk assessment started with a hazard identification session, carried out on 6th of August 2020 in Copenhagen, Denmark. The composition of the Hazard Identification (HAZID) team reflected the different stakeholders in the field, as well as different professions, so that the team covered as broadly as possible in order to ensure that all relevant risks were identified. The hazards were taken further to a quantitative risk assessment. The IALA 'IWRAP tool' was used to quantify the navigational risk based on Automatic Identification System (AIS) data. In addition, Vessel Monitoring System (VMS) data was used to assess fishing activities in particular.

All risk results were presented in terms of annual accident frequency, which is the expected number of accidents per year. For some of the key figures, the return period is also given. In addition, a qualitative consequence assessment has been made.

There are no governing quantitative risk acceptance requirements for the establishment of offshore wind farms. In Denmark the approval of the navigational risk level is done on a case-by-case process by the Danish Maritime Authority (DMA). Therefore, the risk evaluation cannot make a definite conclusion on whether the risk is within any defined acceptable limits. Instead, accident frequencies are presented and discussed. Based on this it can be judged by DMA if the navigational risk associated with the wind farms is readily acceptable.

Based on the results of the HAZID and the quantitative risk assessment, several risk reducing measures for Aflandshage and Nordre Flint OWF are proposed, see chapter 6.

The following sections summarized the main findings:

### Aflandshage Offshore Wind Farm

No significant disruption of the normal commercial traffic patterns is expected during construction, operation, or decommissioning. The traffic that will be most affected by the offshore wind farm is sailings between Drogden and Stevns area, mostly dominated by pleasure crafts, and traffic between Avedøre and waters off Falsterbo area, mostly general cargo ships. These vessels will need to keep safe distance by re-routing around the wind farm.

The accident frequency, prior to OWF establishment, for ship-ship collision is calculated to be 4.4E-2 and for grounding calculated to be 1.51E-1. The total change in accident frequency due to the wind farm establishment is low; 2.9 % increase for ship-ship collision and a 3.3 % decrease in frequency for grounding. The main reason why the ship-ship accident frequency increases is because of merged commercial traffic and the Crew Transfer Vessel (CTV) voyages. Note that the number of trips added, and the choice of CTV route, was a conservative estimate. The main reason why the grounding frequency decreases is due to that some of the traffic that sailed through the wind farm area, passing the coast of Stevns is now routed closer to the middle of the sound between Denmark and Sweden. Further distance from the coast means reduced grounding risk.

The ship-turbine accident frequency is calculated to 1.02E-3. This is equivalent to a ship-turbine collision happening 1 in every 984 years. The traffic that contributes most to this risk is traffic in southbound TSS lane, dominated by general cargo ships, passenger/roro and product/chemical tanker. In the HAZID and the risk assessment there has been special attention on wind turbines close to the southbound TSS lane.

Based on the distances between the wind farm and the traffic patterns/routes, we see no cumulative risk effects that would affect the navigational risk near the Aflandshage, or the other offshore wind farms in the region, in any negative way.

No significant disruption of Search and Rescue (SAR) operations at sea is expected, as the spacing between the turbines (approx. 500 m) and the minimum distance between the Highest Astronomical Tide (HAT) and the lower wing tip (approx. 20 m) will allow for rescue boats to sail in between turbines and through the wind farm.

According to the terminology used in the Environmental Impact Assessment (EIA) for degree of impact, the establishment of Aflandshage OWF is assessed to have the lowest impact category (low).

### Nordre Flint Offshore Wind Farm

No significant disruption of the normal commercial traffic patterns is expected during construction, operation, or decommissioning. The types of vessels that will be most affected by the offshore wind farm is pleasure crafts and fishing vessels. These vessels will need to keep safe distance by re-routing around the wind farm.

The accident frequency, prior to OWF establishment, for ship-ship collision is calculated to be 1.3E-2 and for grounding calculated to be 8.4E-2. The total increase in accident frequency due to the wind farm establishment is low; 1.1% increase for grounding and 2.8% for ship-ship collisions. However, pleasure crafts sailing the waters between the wind farm and Saltholm will experience an increase in grounding frequency. Therefore, risk mitigation measures should be evaluated for this traffic, see recommendations proposed. If the proposed risk mitigation measures are implemented, the increase in risk can be reduced (either fully or partial, pending on actual measures implemented). The primary reason why the ship-ship accident frequency increases is because of the CTV voyages. Note that the number of trips added, and the choice of CTV route, was a conservative estimate.

The ship-turbine accident frequency is calculated to 4.4E-4. This is equivalent to a ship-turbine collision happening 1 in every 2,286 years. The traffic that contributes most to this risk is pleasure crafts (that needed to re-route around the wind farm) and traffic in the Flintchannel, mostly dominated by passenger/roro, oil product/chemical tankers and general cargo ships. In the HAZID and the risk assessment there has been special attention on wind turbine WTG 16, which is the turbine that is closest to the commercial shipping lane in Flintchannel.

Based on the distances between the wind farm and the traffic patterns/routes, we see no cumulative risk effects that would affect the navigational risk near the Nordre Flint OWF, or the other offshore wind farms in the region, in any negative way.

No significant disruption of Search and Rescue (SAR) operations at sea is expected, as the spacing between the turbines (approx. 500 m) and the minimum distance between the Highest Astronomical Tide (HAT) and the lower wing tip (approx. 20 m) will allow for rescue boats to sail in between turbines and through the wind farm.

According to the terminology used in the Environmental Impact Assessment (EIA) for degree of impact, the establishment of Nordre Flint OWF is assessed to have the lowest impact category (low).

# ABBREVIATIONS AND TERMS

## Abbreviations

| | |
|---|---|
| AIS | Automatic Identification System |
| AtoN | Aids to navigation |
| CTV | Crew Transfer Vessel |
| DEA | Danish Energy Agency |
| DMA | Danish Maritime Authority |
| EIA | Environmental Impact Assessment |
| ETA | Estimated time of arrival |
| FSA | Formal safety Assessment |
| GT | Gross tonnage |
| HAT | Highest Astronomical Tide |
| HAZID | Hazard Identification |
| IALA | International Association of Marine Aids to Navigation and Lighthouse Authorities |
| IMO | International Maritime Organisation |
| ISO | International Organization for Standardization |
| IWRAP | IALA Waterways Risk Assessment Program |
| LNG | Liquefied natural gas |
| LPG | Liquefied petroleum gas |
| MMSI | Maritime Mobile Service Identity |
| NM | Nautical mile |
| OWF | Offshore Wind Farm |
| PEC | Pilot exemption Certificate |
| RORO | Roll-on/Roll-off |
| SAR | Search and Rescue |
| SPS | Significant Peripheral Structure |
| SWIFT | Structured What-If Technique |
| TSS | Traffic separation scheme |
| VMS | Vessel monitoring system |
| VTS | Vessel Traffic Services |

## Risk terms

| | |
|---|---|
| **Collision** | Ship-ship collision: Striking or being struck by another ship, regardless of whether under way, anchored or moored.<br><br>Ship-turbine collision: Ship striking the wind turbine or offshore substation (powered or drifting vessel). Collision with a fixed object may also be defined as 'allision'. |
| **Grounding** | Powered grounding: Grounding while under power, due to navigational error or technical fault.<br><br>Drift grounding: Grounding while not under control, typically due to loss of propulsion and/or power in adverse weather. |
| **Hazards** | Physical situations which have the potential to cause harm. The word "hazard" does not express a view on how likely it is that the harm will occur. A major hazard is a hazard with potential to cause significant damage or multiple fatalities. |
| **Likelihood** | May be expressed either in terms of a frequency (the rate of events occurring per unit time) or in terms of a probability (the chance of the event occurring in specified circumstances). |
| **Consequence** | Refers to the expected effects of an event occurring. |
| **Safety** | The inverse of risk. The higher the risk of any level of harm from an activity, the lower is its safety. Complete safety, as implied by the colloquial definition of safety as "the absence of risk", is a worthwhile goal for engineers, but is practically impossible in an intrinsically hazardous activity. A realistic target is to reduce the risk of accidents until the safety of the activity is acceptable, bearing in mind the benefits which it brings. |
| **Risk** | Combination of likelihood and consequence of accidents. More scientifically, it is defined as the probability of a specific adverse event occurring in a specific period or in specified circumstances. The distinction between "hazard" and "risk" is important, although in colloquial use, and in popular dictionaries, risk and hazard are treated virtually as synonyms. |
| **Risk Management** | The systematic application of management policies, procedures and practices to the tasks of analysing, evaluating and controlling risk. This is equally applicable to technological and other risks. |

# 1 INTRODUCTION

## 1.1 Background

The Danish Energy Agency (DEA) has granted permission to conduct feasibility studies for two offshore wind projects located in Øresund; the Nordre Flint project and the Aflandshage project. The results of the feasibility studies will be compiled in an Environmental Impact Assessment (EIA). Part of the EIA is a navigational risk assessment.

## 1.2 Objective

The objective of this navigational risk assessment is to assess how, where and how much the offshore wind farm project impacts the maritime traffic, and to assess the potential changes in risk of collisions and groundings caused by the project.

## 1.3 Scope and boundary limits

The scope of work includes a navigational risk assessment for the Aflandshage and Nordre Flint offshore wind farm project. The offshore wind farm project in this study includes the wind turbines, support structures, substations with topside and support structure and power cables.

The assessment reviews the following phases:

- Operation
- Construction and decommissioning

The following is not part of scope for this study:

- Occupational hazards such as; falls, burns, poisoning, suffocation and asphyxiation during maintenance and/or during crew transfers to/from the turbine.
- Detailed consequence modelling following turbine impact from ships or leisure boats (e.g. injuries/fatalities, loss of material asset, environmental damage and /or loss of production).
- Detailed anchor drops, and dragging anchor and bottom gear, calculations and impact assessments.
- Structure impact analysis (e.g. finite element modelling)
- Assessment of implications on marine navigation and communication equipment (e.g. radar)
- Terrorist or deliberate acts of sabotage are unpredictable and difficult to include in a quantified study and is therefore not included.
- Emergency preparedness evaluations and assessment, incl. Search and Rescue (SAR) evaluations.

# 2 GENERAL METHODOLOGY

The methodology applied when estimating the navigational risk is a standard risk assessment approach, schematically indicated in Figure 2-1, based on the guidelines of the International Maritime Organisation (IMO) for Formal Safety Assessment (FSA). The FSA methodology is a process intended for rule making purposes. For this study rule making is not the objective, therefore the steps 'risk control options' and 'cost benefit assessment' are excluded from scope of work.


**Figure 2-1 Risk assessment process.**

## 2.1 Hazard identification

### 2.1.1 Objective

A comprehensive identification of hazards is critical since hazards that are not identified will be excluded from further assessment. The objectives of the hazard identification are:

- To identify hazards associated with the defined operations(s), and to assess the sources of the hazards, events or sets of circumstances which may cause the hazards and their potential consequences.
- To generate a comprehensive list of hazards based on those events and circumstances that might lead to possible unwanted consequences within the scope for the risk assessment process.

### 2.1.2 Method

Hazard Identification (HAZID) is a systematic process to identify accidental events. The hazard identification is a qualitative review of possible accidents that may occur in order to select failure cases for quantitative modelling.

The HAZID was based on the SWIFT (Structured What-If Technique) and involved a series of keywords/guidewords for the systematic identification of potential hazards and major incidents. DNV GL used a combination of guidewords from industry guidelines (ISO 17776) and our experience to generate the guideword list. The detailed methodology to be applied in the HAZID workshop follows the steps outlined below:

- Identification of HAZID nodes (ship routes).
- Node briefing (traffic composition).
- Identification of hazards, their causes and consequences.
- Identification of preventive and mitigating measures.
- Determination of severity, likelihood and risk.
- Identification of potential recommendations.

A semi-quantitative risk evaluation using a risk matrix was performed to highlight the specific hazards and areas where the Risk Assessment should have particular focus. The risk ranking also cover hazards that may be difficult to quantify in the quantitative risk assessment.

A full method description, including the frequency and consequence classes for risk ranking, are provided in the HAZID report for Aflandshage and Nordre Flint offshore wind farms (DNV GL Report No.: 2020-0940) [2].

### 2.1.3 HAZID team

The workshop for Aflandshage and Nordre Flint was carried out on 6th of August 2020 in Copenhagen, Denmark. The composition of the HAZID team reflected the different stakeholders in the field, as well as different professions, so that the team covered as broadly as possible in order to ensure that all relevant risks were identified. Table 2-1 lists the participants as well as their organisation.

**Table 2-1 Workshop participants (HAZID team).**

| Name | Organisation |
|---|---|
| Flemming Sparre Sørensen | Nautisk Konsulent, Søfartsstyrelsen, Sikre Farvande |
| Morten Bækmark | Søfartsstyrelsen, Sikre Farvande |
| Signe Krøll Olesen | Energistyrelsen |
| Søren Keller | Energistyrelsen |
| Christian Lerche | Direktør, Dansk Sejlunion |
| Kjell Holst | Svenska Båtunionen |
| Robert Lundsten | Svenska Båtunionen |
| Thomas Elm Kampmann | Køge Havn |
| Uffe Christiansen, Harbour Master | Copenhagen Malmö Port |
| Olle Lewis | Sjöfartsverket |
| Jens Heine Grauen Lersen | Svenska Seglarförbundet |
| Emilie Lindström | Svenska Seglarförbundet |
| Christian Kopp Pedersen | Chef VTS Øresund, VTS Øresund - Søværnets Overvågningsenhed |
| Ole Behrendt | Maritim sagsbehandler, VTS Øresund - Søværnets Overvågningsenhed |
| Nijs Jan Duijm (chairman) | DNV GL |
| Lasse Sahlberg-Nielsen (scribe) | DNV GL |
| Stig Balduin Andersen | HOFOR Vind A/S |
| Mia Tang Engelhardt | HOFOR Vind A/S |
| Niels Borup Svendsen | NIRAS A/S |
| Bent Sømod | NIRAS A/S |

After the HAZID workshop, meetings with stakeholders that could not attend the workshop were carried out. This included:

- Video-meeting with DanPilot (pilot service of the Danish state)
- Written feedback from Finnlines (operating the line between Malmö and Travemünde).

## 2.2 Modelling of risk and input data

The objective of this stage is to assess the probability/frequency of initiating events occurring. The initiating events to be analysed are determined by the hazard identification as specified in the previous chapter. The frequency analysis is based on acknowledged mathematical models typically used for such analyses and with input based on Automatic Identification System data (AIS data) and Vessel monitoring system (VMS) data.

Ship traffic nearby and through the planned offshore wind farms is modelled by using the IALA Waterways Risk Assessment Program (IWRAP) software. The analysis is based on AIS data collected for the whole calendar year of 2019.

### 2.2.1 IWRAP tool

The applied calculation tool IWRAP MKII version 6.4.0 (hereinafter referred to as IWRAP) is a part of the IALA Recommendation [IALA O-134] on risk management. This tool has been used in numerous ship traffic and navigational risk assessments in Northern Europe (North Sea, Baltic and Øresund).

IWRAP calculates the probability of collision or grounding for a vessel operating on a specified route. The applied model for calculating the frequency of grounding or collision accident involves the use of a so-called causation probability that is multiplied onto a theoretically obtained number of grounding or collision candidates. The causation factor models the probability of the officer on the watch not reacting in time given that he is on collision course with another vessel (or – alternatively – on grounding course).

A description of the ship traffic constitutes the central input for a navigational risk assessment. AIS data provides a detailed geographic and temporal description of the ship traffic in a region and has been used as the primary data basis.

Because the predominant part of the ship traffic is following navigational routes – which can be more or less well defined – the modelling of the ship traffic and the associated models of the risk of collisions and groundings usually adopts a route-based description of the traffic. The ship traffic description based on AIS is thus subsequently used as basis for definition of the routes in the probabilistic model in IWRAP.

A full method description of IWRAP can be found on the IWRAP Mk2 Wiki site [3]. Project settings and parameters for the model is found in Appendix A.

### 2.2.2 AIS data

AIS is used as base data to quantify ship movements within the analysis area. Together with ship data, it is the most important data source for the risk calculations. High-resolution AIS data has been used, meaning that the resolution of the data corresponds to a new registered AIS point every 30 seconds. AIS data from 2019 has been used, since this provides the most relevant and up-to-date traffic patterns in the area.

The regulation requires AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size. These ships carry the mandatory type A AIS transceiver.

A large portion of smaller fishing vessels and pleasure crafts do not carry AIS transceiver. These vessels will therefore be omitted from the risk quantification. However, an increasingly share of the larger pleasure crafts carry the low-cost alternative of AIS transceiver type B. This type does not transmit as often as the class A type (for commercial ships) and the coverage is also reduced. Due to that so many pleasure craft owners are now using type B makes this a valuable dataset for risk assessments, enabling to make representable traffic patterns and routes for recreational activities.

### 2.2.3 VMS data

VMS is a satellite-based monitoring system which at regular intervals provides data to the fisheries authorities on the location, course and speed of vessels. VMS is nowadays a standard tool of fisheries monitoring and control [4]. VMS data for the analysis area has been collected from the period 2015-2019.

The VMS data is not added to the AIS data, because ships movements can both be registered in the AIS and the VMS data, potentially doubling the dataset. Mapping and filtering unique ship movements would be a lengthy process and may not give so much added value compared to its additional cost. Therefore, the VMS data is utilised as an additional source of information for fishery activities.

### 2.2.4 Ship data and classification

Ship movement data from AIS is combined with ship particulars data from DNV GL's ship database. For some ships there will still be a lack of information after this automatic process, for instance lack of; IMO number, vessel type, length, width or depth. Review of the data has shown that vessels with unknown vessel type are predominantly pleasure craft. That is why unknows are placed in the pleasure craft vessel category.

Where data is still missing, new data has been entered manually based on available information from online ship traffic directories. In the dataset with ship information for this study area there are 8,278 ships. The proportion of vessels with a lack of information was small, only 0.7% missing. It is therefore considered a reasonable assumption that missing information in the dataset for ship information has an insignificant effect on the modelled accident frequency.

Classification of ships into main ship types are shown in Table 2-2. Classification of ships into size categories are shown in Table 2-2.

**Table 2-2 Classification of ship types.**

| Main ship type | Example sub ship types |
|---|---|
| **Oil tankers** | Asphalt/Bitumen Tanker, Bunkering Tanker, Crude Oil Tanker, Coal/Oil Mixture Tanker, Shuttle Tanker. |
| **Product/chemical tankers** | Products Tanker, Alcohol Tanker, Molasses Tanker, Vegetable Oil Tanker, Chemical Tanker, Edible Oil Tanker, Latex Tanker, Chemical/Products Tanker, Vegetable Oil Tanker. |
| **Gas tankers** | LPG/Chemical Tanker, CO2 Tanker, LNG Tanker, LPG Tanker. |
| **Bulk carriers** | Bulk Cement Storage Ship, Bulk Carrier, Self-discharging, Bulk Cement Carrier, Urea Carrier, Laker Only, Ore/Oil Carrier, Ore Carrier. |
| **General cargo ships** | General Cargo/Tanker, General Cargo Ship, Self-discharging, General Cargo/Tanker (Container/oil/bulk - COB ship), Heavy Load Carrier. |
| **Container ships** | Container Ship (Fully Cellular), Container Ship (Fully Cellular with Ro-Ro Facility). |
| **Passenger/Roro** | Passenger Ship, Passenger Ship Inland Waterways, General Cargo/Passenger Ship, Passenger/Ro-Ro Ship (Vehicles), Ro-Ro Ship (Vehicles/Rail). |
| **Cruise ships** | Cruise ship and expedition ships |

| Main ship type | Example sub ship types |
|---|---|
| **Offshore supply ships** | Platform Supply Ship, Crew/Supply Vessel, Anchor Handling Tug Supply, Offshore Tug/Supply Ship |
| **Other offshore ships/units** | Well Stimulation Vessel, Crane Platform, jack up, FPSO, Oil, Diving Support Vessel, FSO, Semi-Submersible, Drilling Rig, Supply Platform, jack up, Support Platform, Standby Safety Vessel, Cable Layer, etc. |
| **Tugs** | Articulated Pusher Tug, Tug, Pusher Tug |
| **Fishing vessels** | Stern Trawler, Whale Catcher, Trawler, Seal Catcher, Fishing Vessel, Factory Stern Trawler |
| **Pleasure Crafts** | Yacht, Motorboats, Houseboat, Sailing Vessel |
| **Other** | Stone Carrier, Suction Hopper Dredger, Utility Vessel, Pilot Vessel, Mooring Vessel, Fire Fighting Vessel, Work/Repair Vessel, Fish Factory Ship, Hopper/Dredger, Pollution Control Vessel, Salvage Ship, Crew Boat, Fishery Research Vessel, Mining Vessel, Fish Farm Support Vessel, Supply Tender, Lighthouse Tender, Fishery Patrol Vessel, Training Ship, Buoy & Lighthouse Tender, Patrol Vessel, Icebreaker, Hospital Vessel, etc. |

**Table 2-3 Classification of ship size.**

| Length category |
|---|
| 0-30 |
| 30-70 |
| 70-100 |
| 100-150 |
| 150-200 |
| 200-250 |
| 250-300 |
| 300-350 |
| >350 |

## 2.2.5 Bathymetry data

Bathymetry data (depth data) is important for the calculations of grounding accidents. These data are produced based on available nautical charts. All grounds and shallow waters below 10 m in vicinity of the proposed offshore wind farms are included in the dataset. These data are imported into the IWRAP model as polygons representing the depth contours.

## 2.2.6 Risk scenarios

Installation of an offshore wind farm will introduce obstacles that the ship traffic has to avoid. If not successful in doing this a collision to a wind turbine will be the result. However, the deviations required of the ship traffic to avoid the wind turbines may also increase the potential for ship-ship collisions and/or grounding. The navigational risk analysis therefore covers the following risk contributions:

- Ship-turbine collision risk for powered vessels (i.e., typically human error).
- Ship-turbine collision risk for drifting vessels (e.g., vessel with technical error).
- Changes in ship-ship collision risk due to increased traffic density around the offshore wind farm.
- Changes in ship grounding risk due to changes in ship routes due to the offshore wind farm.
- Impact on export cable from anchoring and fishing.

## 2.3 Risk evaluation

The ship traffic before and after the construction of the wind farm is modelled in order to compare the impact of the offshore wind farm on the navigational risk. Ship-ship collision and grounding of ships will thus be modelled in cases predicting before (i.e. existing conditions) and after construction of the wind farm.

**Table 2-4 Calculated scenarios**

| Scenario | Existing routes | Relocated routes | Turbines included |
|---|---|---|---|
| 1 (Before) | x | | |
| 2 (After) | x | x | x |

All risk results are presented in terms of annual accident frequency, which is the expected number of accidents per year. For some of the key figures, the return period is also given. The higher the return period, the less frequently an event is estimated to occur. A higher average return period indicates an expectation that a longer period of time will pass between events.

Further, the main findings from the risk assessment is classified into degree of impact. There is no established terminology and modulation for the relative size of the environmental impact, but both the European EIA Directive and the Danish Environmental Assessment Act (LBK nr 973 af 25/06/2020) describe a number of parameters that must be included in the assessment of environmental impacts.

The terminology for degree of impact used in the EIA is shown in Table 2-5. The right-hand column of the table describes the typical effects on the environment at the different degrees of impact shown in the left-hand column.

**Table 2-5 Terminology for environmental impact in EIA.**

| Degree of impact | Typical effects on the environment |
|---|---|
| Major impact | Impacts occur on a large scale, high intensity, which are transboundary, complex and/or of long-term occurrence, are frequent or likely to happen and/or can cause irreversible damages to a significant extent. Cumulative effects of the above nature. |
| Moderate impact | Impacts occur which are not major impacts, but which are either of a relatively large extent or long-term in nature (e.g. throughout the lifetime of a project), occur with recurring frequency or are relatively likely and may cause certain irreversible, but completely local damage. |
| Minor impact/negligible and no impact/positive impact | Impacts occur which may have a certain extent or complexity, a certain duration, in addition to very short-term effects, and which have a certain probability of occurring, but which do not cause irreversible damage.<br>There are small impacts that are locally defined, uncomplicated, short-lived or without long-term effect and completely without irreversible effects. Or there is no impact in relation to the status quo.<br>Positive impacts occur. |

There are no governing quantitative risk acceptance requirements for the establishment of offshore wind farms. In Denmark the approval of the navigational risk level is done on a case-by-case process by the Danish Maritime Authority (DMA).

Therefore, the risk evaluation cannot make a definite conclusion on whether the risk is within any defined acceptable limits. It will instead present the accident frequencies, and return periods, and discuss the results and explain any potential changes in risk. Based on this it can be judged by DMA if the navigational risk associated with wind farm is acceptable.

# 3 ANALYSIS BASIS

This chapter describes the basis for the navigational risk assessment.

## 3.1 Aflandshage offshore wind farm

### 3.1.1 Location

The Aflandshage OWF is planned to be established in Øresund, in an area between Stevns and Amager's southern tip, see Figure 3-1. The total project area is approx. 56.5 km$^2$, of which the potential area for offshore wind turbines amounts to approx. 42 km$^2$. The distance between the coast and the nearest potential offshore wind turbines is 8 km.

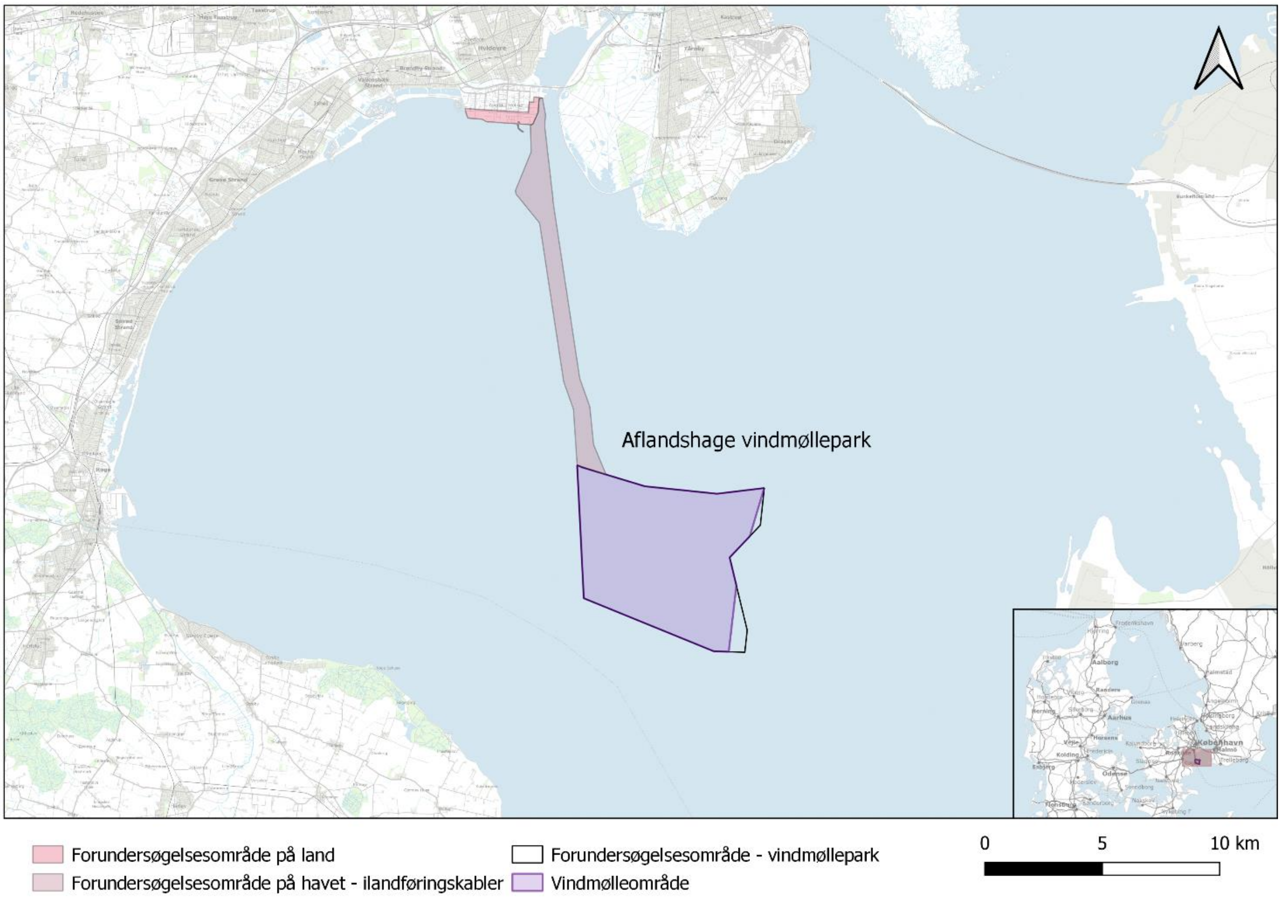


**Figure 3-1 Proposed location of Aflandshage OWF, showing location of cable route and windfarm area (purple).**

The cables for grid connection of the wind farm will be installed in a project corridor connecting to the facilities of Energinet placed close to Avedøreværket and defined by Energinet as the connection point for Aflandshage Offshore Wind Farm. The offshore project corridor for grid connection covers an area of approximately 12.5 km$^2$.

## 3.1.2 Technical specification and layout

Aflandshage OWF will comprise 26-45 offshore wind turbines, depending on the turbine capacity, with an installed capacity of up to 300 MW. Figure 3-2 shows the proposed layout of the wind turbines and their capacities, either as 5.5-6.5 MW ("small") turbine arrangement (in green), 7.5-8.5 MW ("intermediate") turbine arrangement (in yellow) and 9.5-11.0 MW ("large") turbine arrangement (in red). The maximum number of turbines can therefore be 45 turbines with a smaller turbine size (5.5 MW).

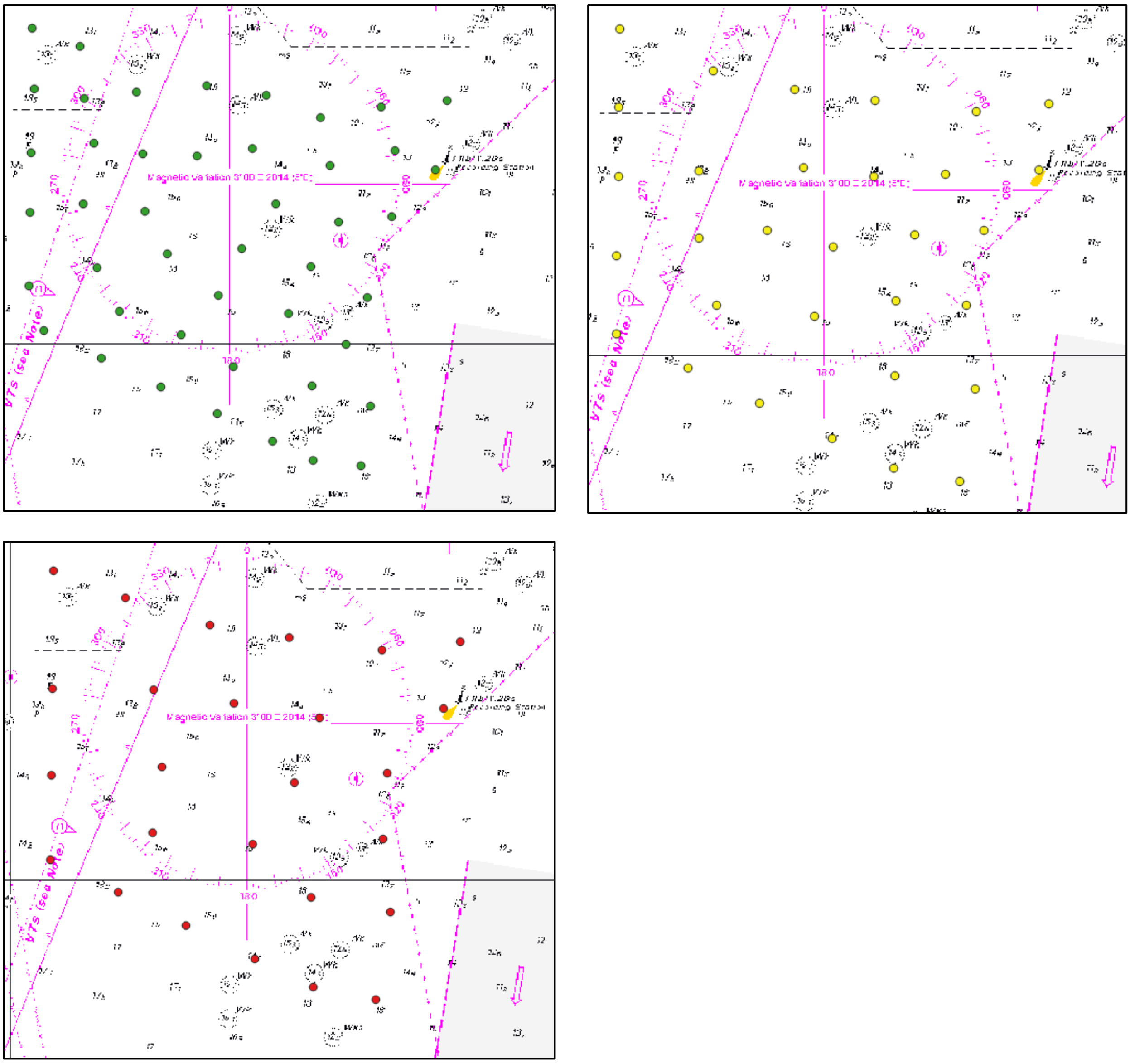

**Figure 3-2 Proposed layout of Aflandshage OWF. Small turbine layout in green, intermediate turbine layout in yellow and large turbine layout in red.**

The offshore substation (OSS) is included in the point locations in Figure 3-2 and will be modelled for potential ship collisions (allisions) similar as the wind turbines. The OSS is the system that collects and exports the power generated by turbines through specialized submarine cables. The platform consists of a topside and a foundation. The offshore substation platform is expected to have a length of 35 – 40 m, a width of 25-30 m and a height of 15-20 m. The highest point of the OSS is expected to be 30 – 35 m above sea level.

### 3.1.3 Metocean characteristics

Table 3-1 shows the metocean characteristics for Aflandshage OWF. The table also briefly explains how this is incorporated in the risk model using IWRAP.

**Table 3-1 Metocean characteristics for waters around Aflandshage OWF.**

| Data | Characteristics | Modelling in IWRAP |
|---|---|---|
| **Prevailing wind direction** | Prevalent wind direction from south-west /11/. See detailed wind rose in appendix A. | The prevalent wind direction has been applied in IWRAP, and will affect the drift direction (drift grounding and ship-turbine drift collisions) |
| **Ice** | Ships have sailed in drifting ice and in ice with low ice-concentration. This is judged to have negligible effect on navigational performance in this area. | Ice is not modelled in IWRAP. |
| **Visibility (fog, precipitation)** | Poor and very poor visibility count for only 3.7% of measurements in 2019, based on DMI data. | Errors due to human factors (and/or combined with external factors) are part of the default IALA causation factors in IWRAP, see appendix A. |
| **Current** | Mean current speed measured at Nordre Røse is 0.5m/s /11/. The speed of the current should not pose any additional risks compared to other similar areas. | Current is not modelled in IWRAP. |
| **Waves** | Waves in this area is judged to not cause any disturbance to the commercial traffic. Smaller vessel will be more affected by waves, as in any other locations. | Waves is not modelled in IWRAP. |

Visibility data were obtained from the Danish Meteorological Institute (DMI) for Drogden lighthouse for the calendar year 2019. This station is the closest station with visibility data to the site and is assumed therefore to be most representative of visibility conditions at the site. The distribution of visibility measurements is shown in Table 3-2.

**Table 3-2 Visibility data for Drogden lighthouse, 2019.**

| Visibility class | Description | % (of hourly measurements) |
|---|---|---|
| **Good** | Visibility more than 5 nautical miles | 86.0% |
| **Moderate** | Visibility between 2 and 5 nautical miles | 10.3% |
| **Poor** | Visibility between 1,000 meter and 2 nautical miles | 2.7% |
| **Very poor or fog** | Visibility less than 1,000 meter | 1.0% |

## 3.1.4 Waterway characteristics

The Aflandshage offshore windfarm is located close to the Traffic separation scheme "Off Falsterbo", as seen in the lower right corner in Figure 3-3. The water depth in the area is 13-16 m.

From the offshore wind farm, it is about 11 km to land to the north (Amager), 9 km to land to the west (Stevns) and 13 km to land to the east (Falsterbo).

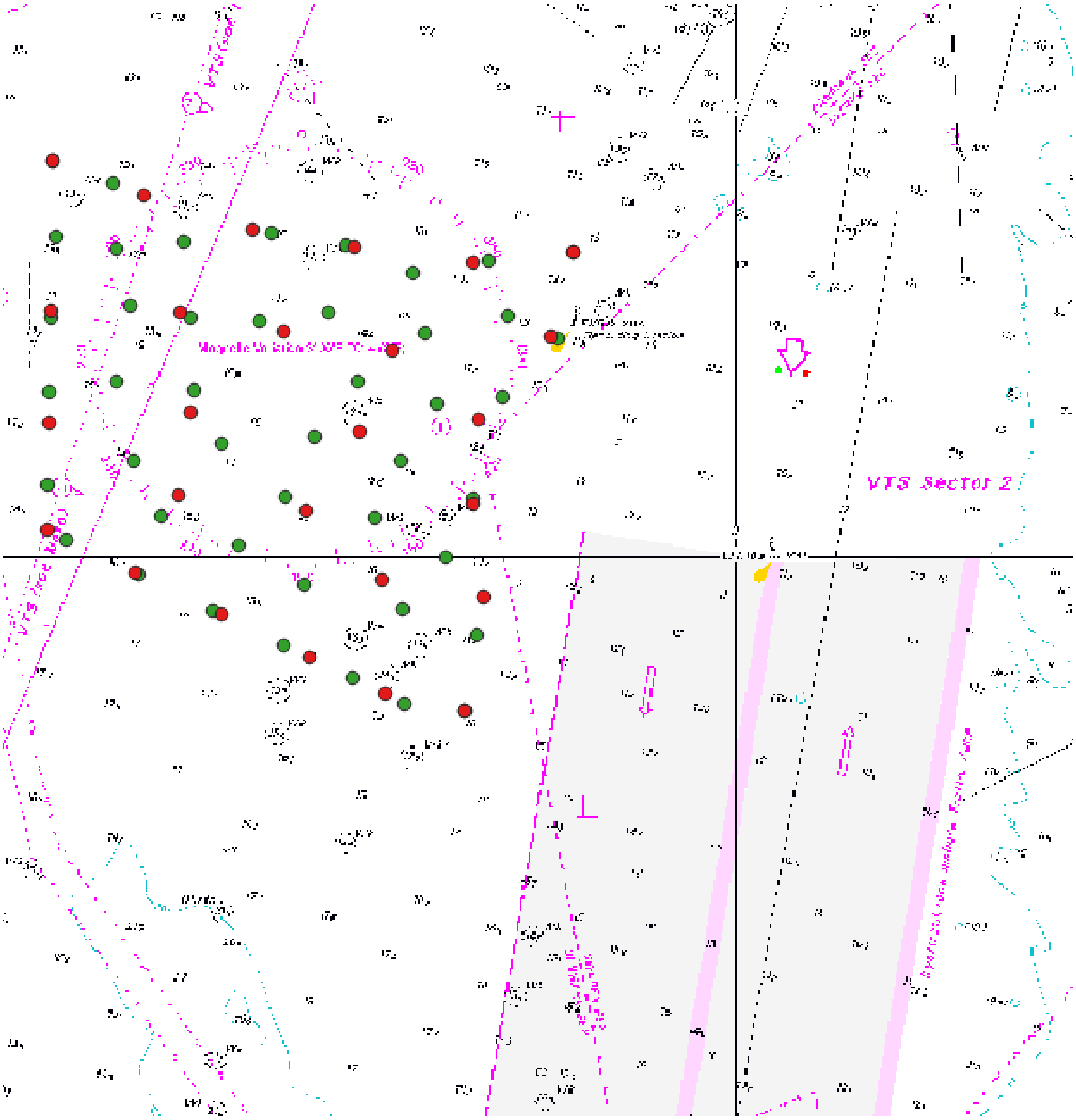


**Figure 3-3 Nautical chart for area around Aflandshage. Layout of the wind farm for small turbine layout (in green) and large turbine layout (in red). The intermediate turbine layout is not shown since many of the turbines will then be "hidden" under the small and large layout. Thus, for intermediate turbine layout, see Figure 3-2.**

Ships of 300 gross tonnage (GT) and upwards proceeding to or from ports or anchorages in the Sound or passing through the reporting area is required to follow the Ship Reporting System. Ships of this size will therefore be monitored by the Sound VTS (Vessel Traffic Service). The Sound VTS provide surveillance of the SOUNDREP area using a combination of radar and AIS. The operational area of SOUNDREP covers the northern, central and southern part of the Sound as shown on the chart given in Appendix G.

The system includes;

- Requirements for ships to report to VTS (ship name, ID, position, destination, ETA, etc.).
- VTS monitoring of area.
- The Traffic separation scheme (TSS) "In the Sound", situated to the north in the narrows of the Sound.
- Traffic separation scheme "Off Falsterbo".
- IMO Recommendation on Navigation through the entrances to the Baltic Sea – The Sound
- Air draught limitations.

Harbours within the SOUNDREP area are covered by provisions about mandatory pilotage for certain ships bound for or coming from Danish and Swedish ports.

There are no speed restrictions in the area. Tugs for emergency/assistance are located in the ports of Malmö and Copenhagen. A summary of the waterway characteristics and what is modelled in IWRAP is shown in Table 3-3. As seen in Figure 3-3, it is one light buoy that will need to be re-located.

**Table 3-3 Waterway characteristics for Aflandshage OWF.**

| Site characteristic | Summary | Modelling in IWRAP |
|---|---|---|
| **Water depth** | The water depth in the area of the planned establishment is 13-16 m. | Bathymetry data based on updated nautical charts has been applied in IWRAP, this will affect powered and drift groundings. |
| **Nautical charts** | Nautical chart for area around Aflandshage.<br><br>It was informed in the HAZID workshop that the pilots meeting point, currently laying inside the present wind farm area, will need to be shifted to another position. The recording station in the north-east of the wind farms also needs to be moved. | Nautical charts, in combination with ship traffic data, has been used to define the routes in the study area. |
| **VTS** | Ships of 300 gross tonnage and upwards proceeding to or from ports or | VTS plays an important role to ensure the safety of navigation. DNV GL recognise that there are |

| Site characteristic | Summary | Modelling in IWRAP |
|---|---|---|
| | anchorages in the Sound or passing through the reporting area is required to follow the Ship Reporting System. | estimates from 5 % effect on reduction in accidents and up to 50 % (in combination with TSS) /10/. Effect of VTS is indirectly included in the way that the ships navigate in the area, as the AIS could potentially look different if there were no VTS. |
| **Tug availability for emergency** | Located in Malmö and Copenhagen | Applied in the model, with default IALA "tug parameters", see Appendix A. |
| **TSS** | The southbound TSS "Off Falsterbo" is close to the wind farm. | TSS part of the waterway routes in IWRAP. |
| **Pilotage and Pilot exemption Certificate (PEC)** | Harbours within the SOUNDREP area are covered by provisions about mandatory pilotage for certain ships bound for or coming from Danish and Swedish ports. | Pilotage plays an important role to ensure the safety of navigation. DNV GL recognise that there are estimates up to 50% effect on reduction in accidents /10/. Similar to VTS, this effect is also "indirectly" part of the risk model. |

### 3.1.5 Accidents

According to the HELCOM[1] database there has not been any accidents within the wind farm area during the period 1989 to 2017. However, there have been groundings closer to the coast off Amager, in Drogden and closer to the Swedish boarder, as shown in the Figure 3-4. Ship collisions are also shown in the area. In addition, one collison (not shown on the map) occurred September this year in thick fog involving a Russian warship and a freighter just south of Drogden channel.

The dataset is constructed by the HELCOM Secretariat and has been compiled by the HELCOM Contracting Parties[2]. The actual location of the accidents, as presented in the map, may therefore deviate from the "real" location. However, it is reasonable to assume that the real locations are not far off from the locations reported by HELCOM. Accident statistics has been used to compare the calculated frequencies in IWRAP towards the historical accidents in the area.

[1] The Baltic Marine Environment Protection Commission – also known as the Helsinki Commission (HELCOM).

[2] According to the decision of the HELCOM SEA 2/2001 shipping accident data compilation will include only so called conventional ships according to the Regulation 5, Annex I of MARPOL 73/78 - any oil tanker of 150 GT and above and any other ships of 400 GT and above which are engaged in voyages to ports or offshore terminals under the jurisdiction of other Parties to the Convention.

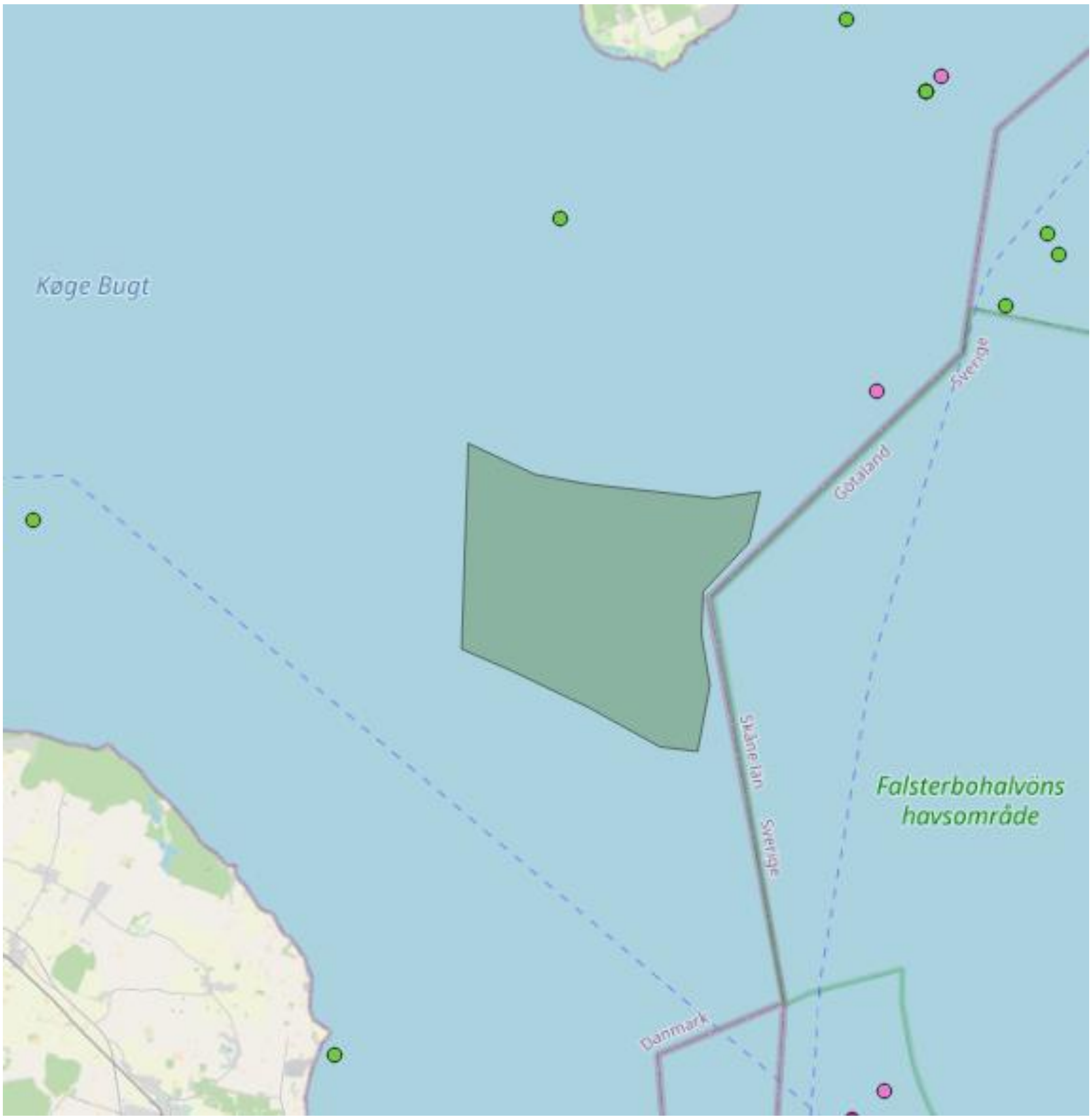


**Figure 3-4 Location of accidents registered in the HELCOM database from the period 1989-2017. Green points: Groundings, pink/purple: Ship collisions.**

## 3.2 Nordre Flint offshore wind farm

### 3.2.1 Location

Nordre Flint OWF is planned to be established east of Saltholm in Øresund within a 33 km$^2$ project area. The project area includes a 17 km$^2$ offshore windfarm area reserved for turbines, inter-array cables and a possible transformer platform with transformer installations.

The cables for grid connection of the farm will be installed in another part of the project area forming a cable corridor connecting to facilities on shore. This part of the project area is 15.6 km$^2$.

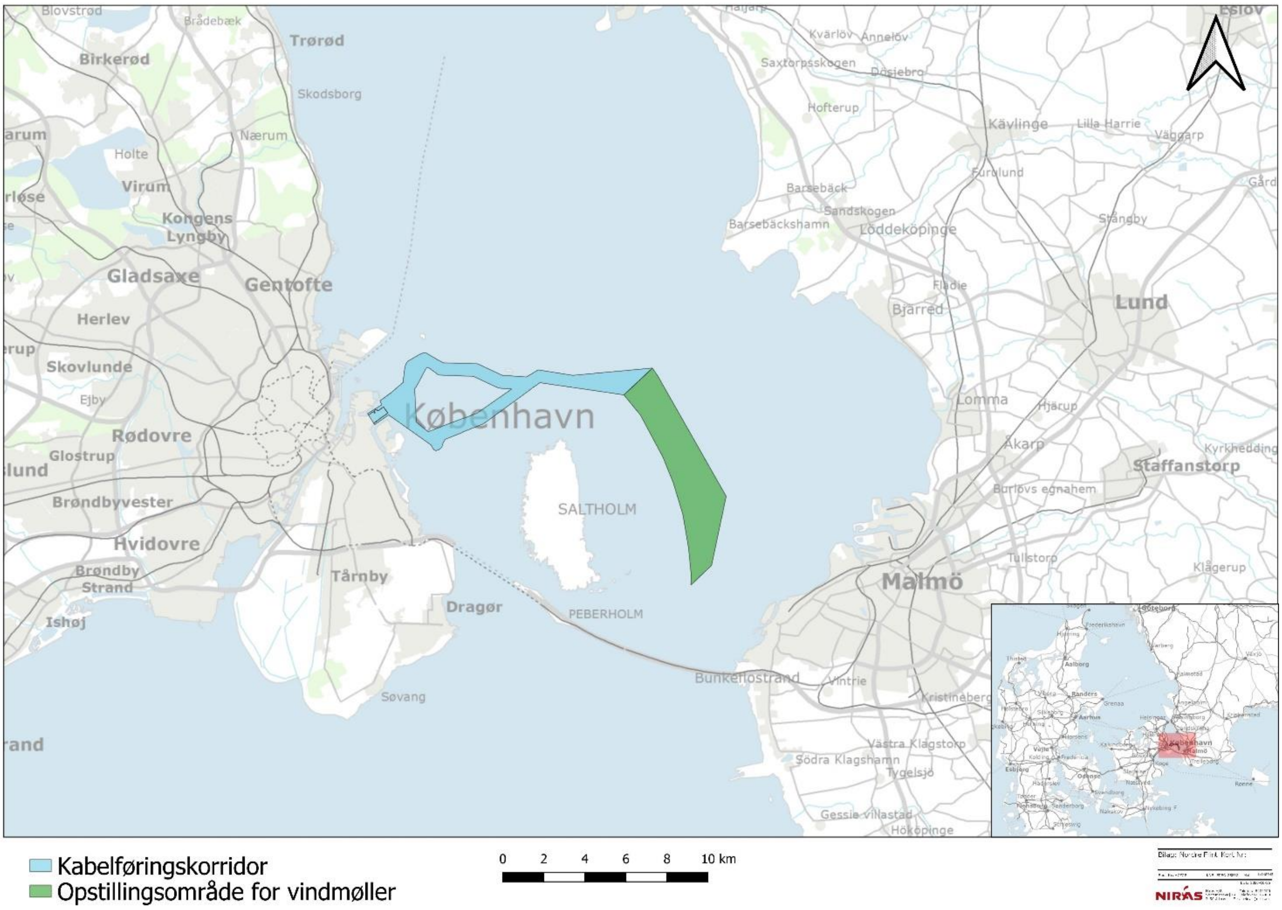


**Figure 3-5 Proposed location of Nordre Flint OWF, showing location of cable route (light blue) and windfarm area (green).**

## 3.2.2 Technical specification and layout

Nordre Flint OWF will comprise 16-29 offshore wind turbines, depending on the turbine capacity, with an installed capacity of up to 160MW. Figure 3-6 shows the proposed layout of the wind turbines and their capacities, either as 5.5-6.5 MW turbine arrangement (in green, also referred to as 'small turbine arrangement') or 9.5-10.0 MW arrangement (in red, also referred to as large turbine arrangement'). The maximum number of turbines can therefore be 29 turbines with a smaller turbine size (5.5-6.5 MW) or 16 turbines (9.5-10.0 MW) with a large size turbine.

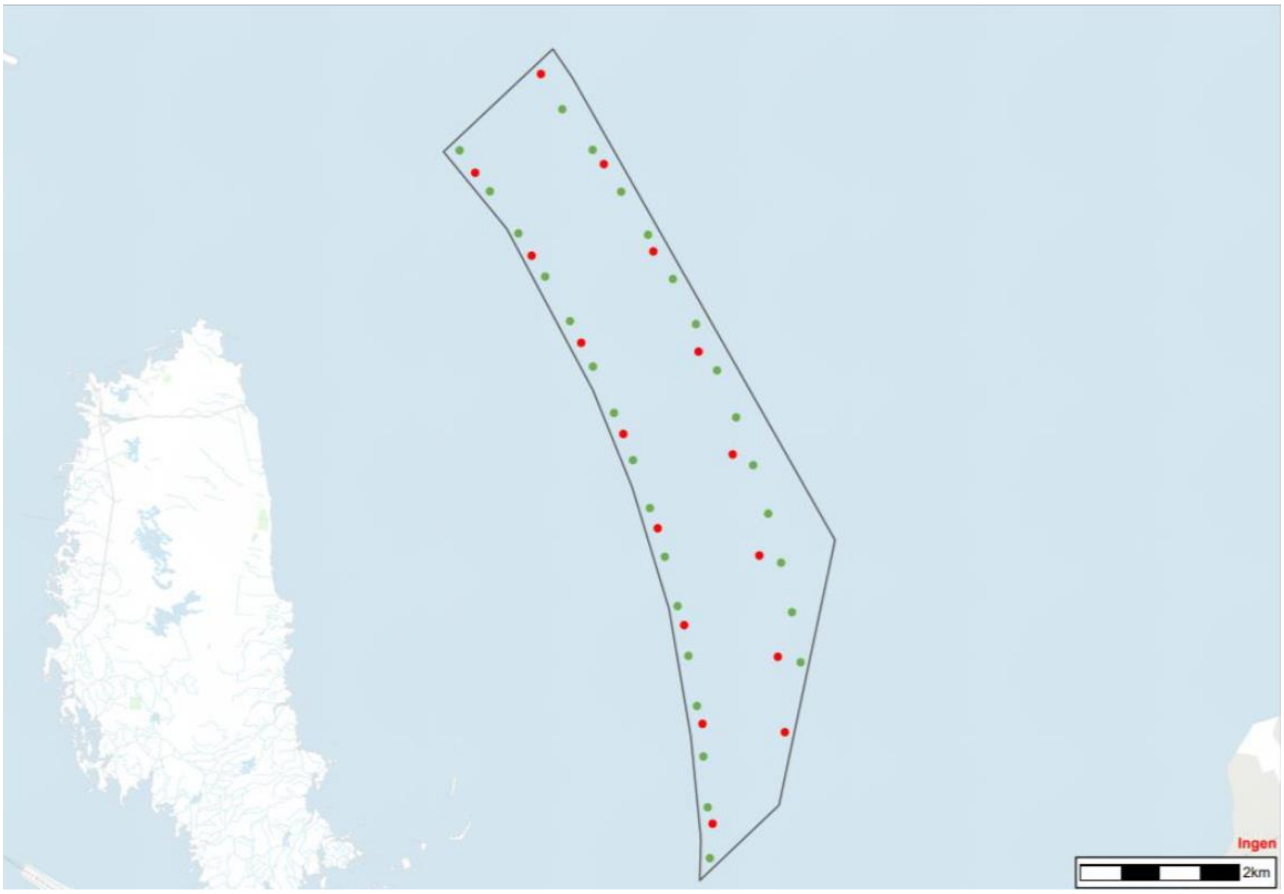


**Figure 3-6 Proposed layout of Nordre Flint wind turbines and their capacities (5.5-6.5 MW turbines shown in green, 9.5-11 MW turbines shown in red).**

Nordre Flint will not have an offshore substation platform. Connection cables will transport the electrical power to Energinet's 132 kV substation at Amagerværket.

### 3.2.3 Metocean characteristics

Table 3-4 shows the metocean characteristics for Nordre Flint. The table also briefly explains how this is incorporated in the risk model using IWRAP.

**Table 3-4 Metocean characteristics for waters around Nordre Flint OWF.**

| Data | Characteristics | Modelling in IWRAP |
|---|---|---|
| **Prevailing wind direction** | Prevalent wind direction from south-west /11/. See detailed wind rose in appendix A. | The prevalent wind direction has been applied in IWRAP, and will affect the drift direction (drift grounding and ship-turbine drift collisions) |
| **Ice** | Ships have sailed in drifting ice and in ice with low ice-concentration. This is judged to have negligible effect on navigational performance in this area. | Ice is not modelled in IWRAP. |

| Data | Characteristics | Modelling in IWRAP |
|---|---|---|
| **Visibility (fog, precipitation)** | Poor and very poor visibility count for only 3.7% of measurements in 2019, based on DMI data. | Errors due to human factors (and/or combined with external factors) are part of the default IALA causation factors in IWRAP, see appendix A. |
| **Current** | Mean current speed measured at Nordre Røse is 0.5m/s /11/. The speed of the current should not pose any additional risks compared to other similar areas. | Current is not modelled in IWRAP. |
| **Waves** | Waves in this area is judged to not cause any disturbance to the commercial traffic. Smaller vessel will be more affected by waves, as in any other locations. | Waves is not modelled in IWRAP. |

Visibility data were obtained from the Danish Meteorological Institute (DMI) for Drogden lighthouse for the calendar year 2019. This station is the closest station with visibility data to the site and is assumed therefore to be most representative of visibility conditions at the site. The distribution of visibility measurements is shown in Table 3-5.

**Table 3-5 Visibility data for Drogden lighthouse, 2019.**

| Visibility class | Description | % (of hourly measurements) |
|---|---|---|
| **Good** | Visibility more than 5 nautical miles | 86.0% |
| **Moderate** | Visibility between 2 and 5 nautical miles | 10.3% |
| **Poor** | Visibility between 1,000 meter and 2 nautical miles | 2.7% |
| **Very poor or fog** | Visibility less than 1,000 meter | 1.0% |

### 3.2.4 Waterway characteristics

This area of Øresund is shallow, and ships may only pass this area through one of the two waterways, Flintrännan (hereinafter referred to as the Flintchannel) going under the Øresund bridge and Drogden channel (between Saltholm and Amager). The Øresund bridge makes it also almost impossible to pass for larger ships, expect using these the two mentioned waterways.

The depth in the Drogden channel (location see Figure 5-1) is 8.0 m at mean sea level and the passage width is 300 m. The depth of Flintchannel is also 8.0 m at mean sea level, see Figure 3-7. The vertical clearance of the Øresund bridge is 55 m and the passage width 370 m. Piloted vessels through Flintchannel has a maximum allowed draft of 7.2 meters at mean sea level [5].

Ships that exceed draft limit of 8.0 m need to use the Great Belt route that allows the largest ships. The limit is here a draft of 15.4 m and an air draft of 65 m (limited by the clearance of the east bridge of the Great Belt Fixed Link).

The Flintchannel is the waterway that will be closest to the Nordre Flint offshore wind farm, passing the south area of the farm. Ships sailing in Flintchannel need to be within the lateral marks on each side of the channel (green and red marks), to avoid shallow waters on each side, and to ensure safe clearance with the bridge structure (horizontal/width clearance) when sailing under the bridge.

Due to shallow waters east of the wind farm, ships sailing through the Sound need to keep east of the two green buoys, the Black-Yellow-Black (BYB) mark in north and the Yellow-Black (YB) mark in south.

The area west of the planned wind farm also has shallow waters, in particular the two grounds; Bjørnen (1.7 m) and Nordre Flint (1.5 m). Ships are therefore not likely to sail very close to the west side of the wind farm.

There are two dedicated anchorage areas in northeast.

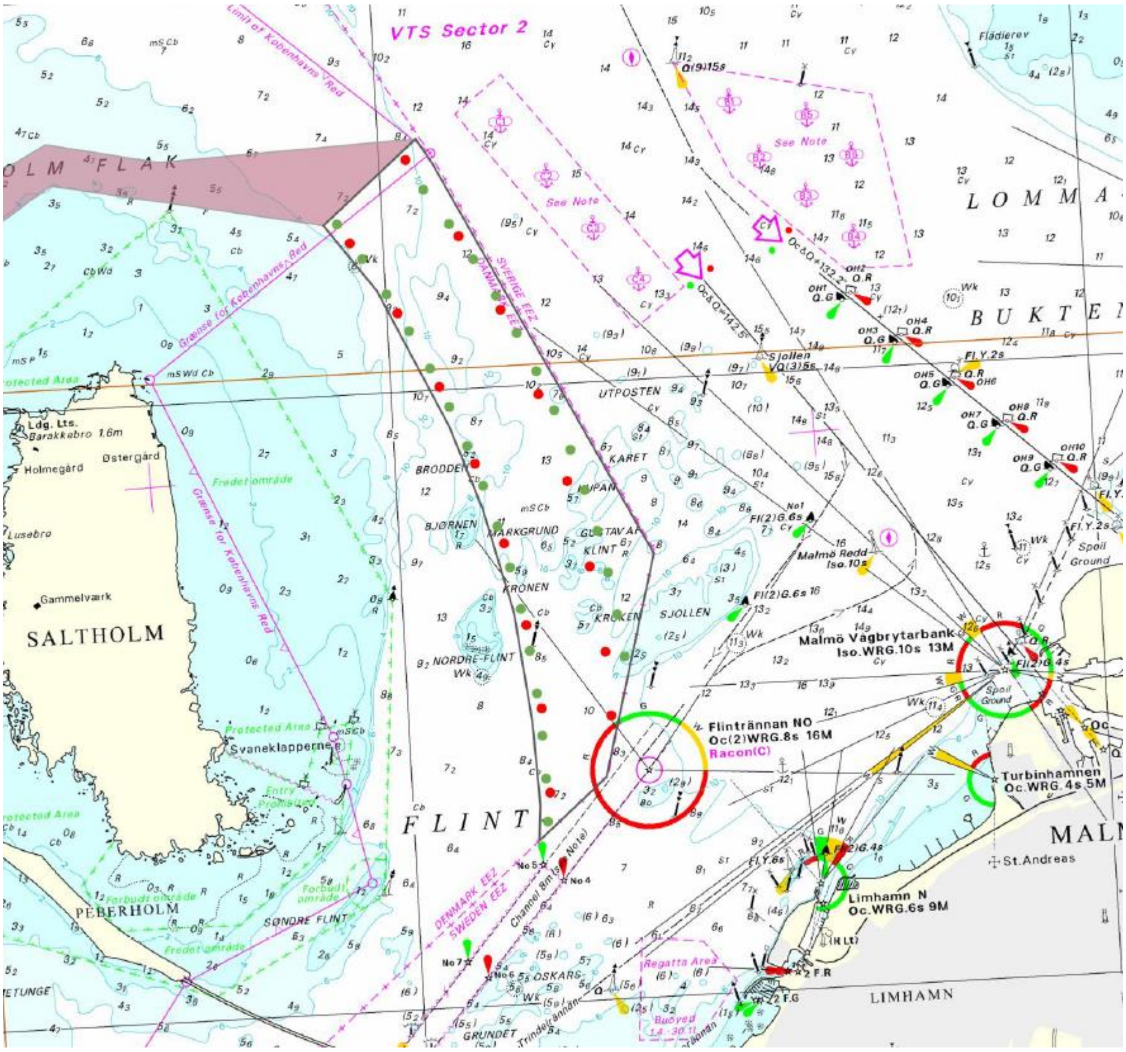


**Figure 3-7 Nautical chart for area around Nordre Flint and proposed layout of wind turbines ("Small turbine" layout shown in green, "Large turbine" layout shown in red).**

Ships of 300 gross tonnage (GT) and upwards proceeding to or from ports or anchorages in the Sound or passing through the reporting area is required to follow the Ship Reporting System. The SOUNDREP area requirements are described in 3.1.4.

There are no speed restrictions in the area. However, ships normally sail with reduced speed when passing the Øresund Bridge.

Tugs for emergency/assistance are located in the ports of Malmö and Copenhagen. A summary of the waterway characteristics and what is modelled in IWRAP is shown in Table 3-6

**Table 3-6 Waterway characteristics for Nordre Flint OWF.**

| Site characteristic | Summary | Modelling in IWRAP |
|---|---|---|
| **Water depth** | The water depth in the area of the planned establishment is 5-13 m. Flintchannel allows only 8 m draft, so it is no alternative for the largest ships, which will mostly take the Great Belt route (draft limit of 15.4m). | Bathymetry data based on updated nautical charts has been applied in IWRAP, this will affect powered and drift groundings. |
| **Nautical charts** | Nautical chart for area around Nordre Flint.<br><br>As seen in Figure 3-7, it is one cardinal mark (east mark) in the wind farm area that will need to be moved. | Nautical charts, in combination with ship traffic data, has been used to define the routes in the study area. |
| **VTS** | Ships of 300 gross tonnage and upwards proceeding to or from ports or anchorages in the Sound or passing through the reporting area is required to follow the Ship Reporting System. | VTS plays an important role to ensure the safety of navigation. DNV GL recognise that there are estimates from 5 % effect on reduction in accidents and up to 50 % (in combination with TSS) /10/. Effect of VTS is indirectly included in the way that the ships navigate in the area, as the AIS could potentially look different if there were no VTS. |
| **Emergency tugs** | Located in Malmö and Copenhagen | Applied in the model, with default IALA "tug parameters", see Appendix A. |
| **TSS** | There are no TSS in the study area, i.e. in vicinity of the planned wind farm (only to the north in the narrows of the Sound and "Off Falsterbo". | TSS is not included in IWRAP. |
| **Pilotage and Pilot exemption Certificate (PEC)** | Harbours within the SOUNDREP area are covered by provisions about mandatory pilotage for certain ships bound for or coming from Danish and Swedish ports. | Pilotage plays an important role to ensure the safety of navigation. DNV GL recognise that there are estimates up to 50% effect on reduction in accidents /10/. Similar to VTS, this effect is also "indirectly" part of the risk model. |

### 3.2.5 Accidents

According to the HELCOM[3] database there has been 6 groundings and 1 collision in the area, including waters south of the wind farm, in the period 1989 to 2017. The majority of these accidents are located in close vicinity to the Flintchannel and outside the port of Malmö[4]. Figure 3-8 shows the locations of the accidents, groundings with blue mark and the one collision with green mark.

The dataset is constructed by the HELCOM Secretariat and has been compiled by the HELCOM Contracting Parties[5]. The actual location of the accidents, as presented in the map in Figure 3-8, may therefore deviate from the "real" location. However, it is reasonable to assume that the real locations are not far off from the locations reported by HELCOM. Accident statistics has been used to compare the calculated frequencies in IWRAP towards the historical accidents in the area.

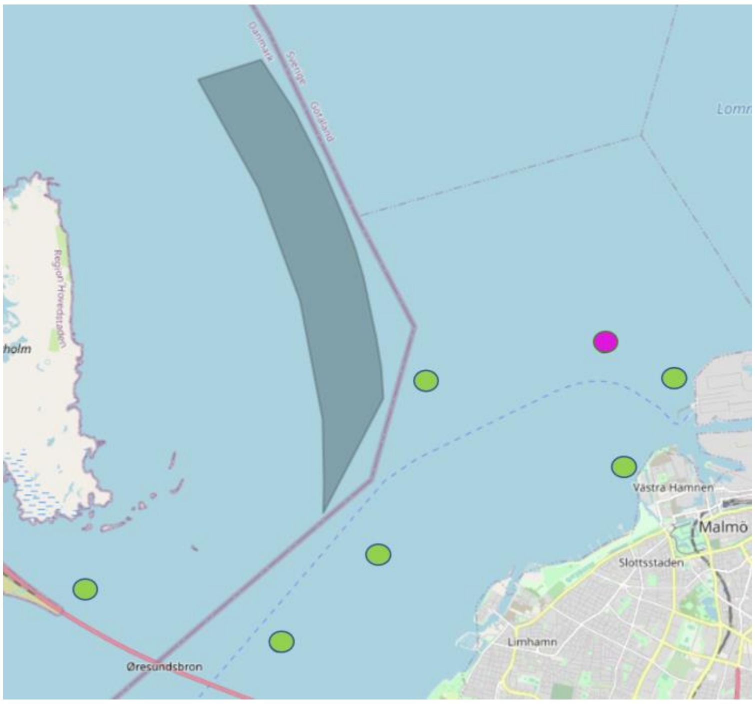


**Figure 3-8 Location of accidents registered in the HELCOM database, from the period 1989-2017. Green points: Groundings, pink points: Ship collision.**

[3] The Baltic Marine Environment Protection Commission – also known as the Helsinki Commission (HELCOM).

[4] The grounding northwest of the Øresund Bridge is outside the IWRAP mode area. Thus, five groundings are counted.

[5] According to the decision of the HELCOM SEA 2/2001 shipping accident data compilation will include only so called conventional ships according to the Regulation 5, Annex I of MARPOL 73/78 - any oil tanker of 150 GT and above and any other ships of 400 GT and above which are engaged in voyages to ports or offshore terminals under the jurisdiction of other Parties to the Convention.

## 3.3 Analysis assumptions

### 3.3.1 Design and layout

The turbines on Aflandshage and Nordre Flint will have individual capacity of 5.5-10MW, depending on type. The foundation of the turbines will be gravity- or monopile foundation, see Figure 3-9 and Figure 3-10. Note that monopiles will have lower interface (closer to sea level) compared to illustrations presented.

Since the final layout of the turbines in the offshore wind farms is not known at present, the navigational risk assessment is performed such that it will represent a conservative assumption for all possible turbine layouts i.e. both with regards to turbine size and location of the turbines within the offshore wind farm area. The conservative approach is intentionally chosen to overestimate uncertain risks in order to be confident that we are not underestimating them.

The risk assessment is therefore based on a layout of turbines that, in the context of navigational risk, is considered as the most conservative. The chosen conservative layout is:

- Aflandshage: 45 turbines with a smaller turbine size (5.5-6.5 MW), including one OSS centrally located in the wind farm. Gravity-based structure assumed.
- Nordre Flint: 29 turbines with a smaller turbine size (5.5-6.5 MW), also gravity-based structure.

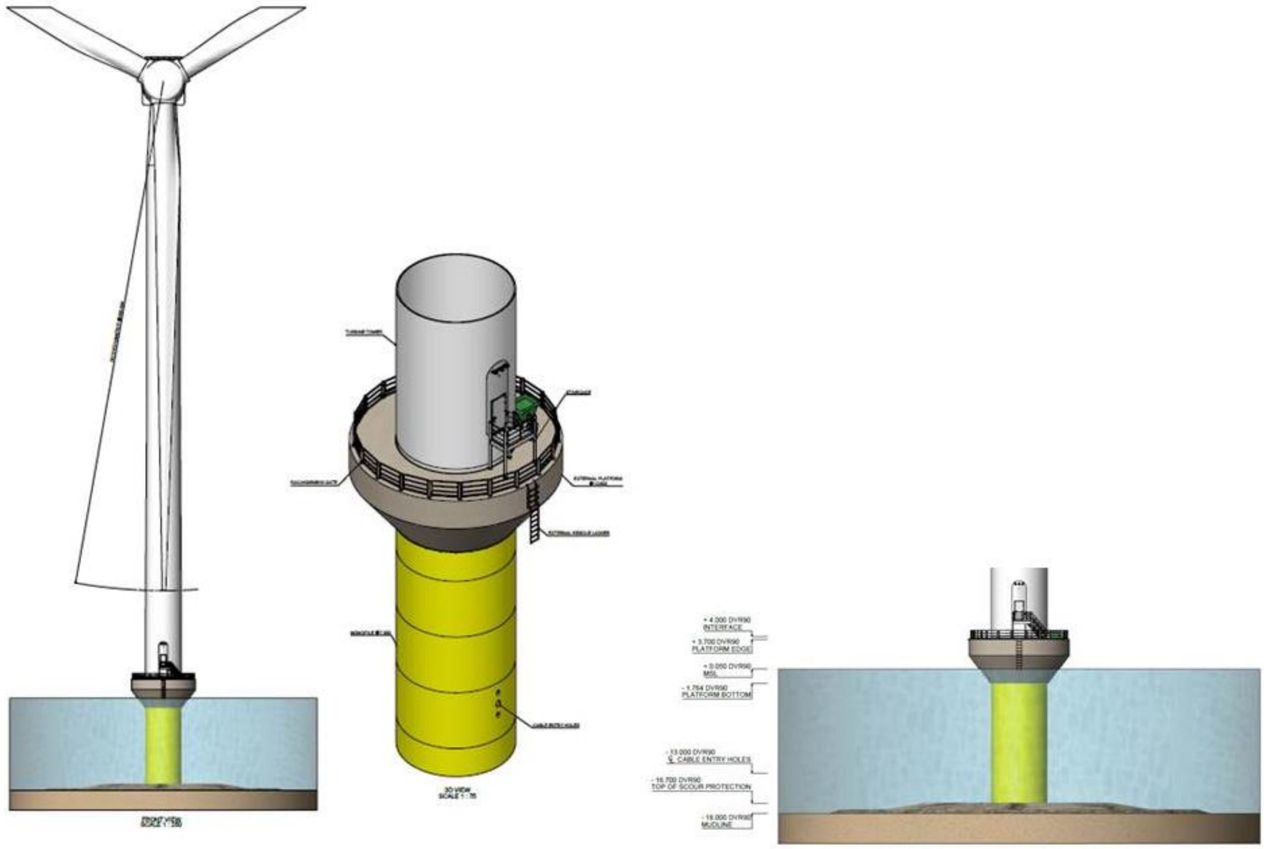

**Figure 3-9 Illustration of wind turbine with monopile foundation.**

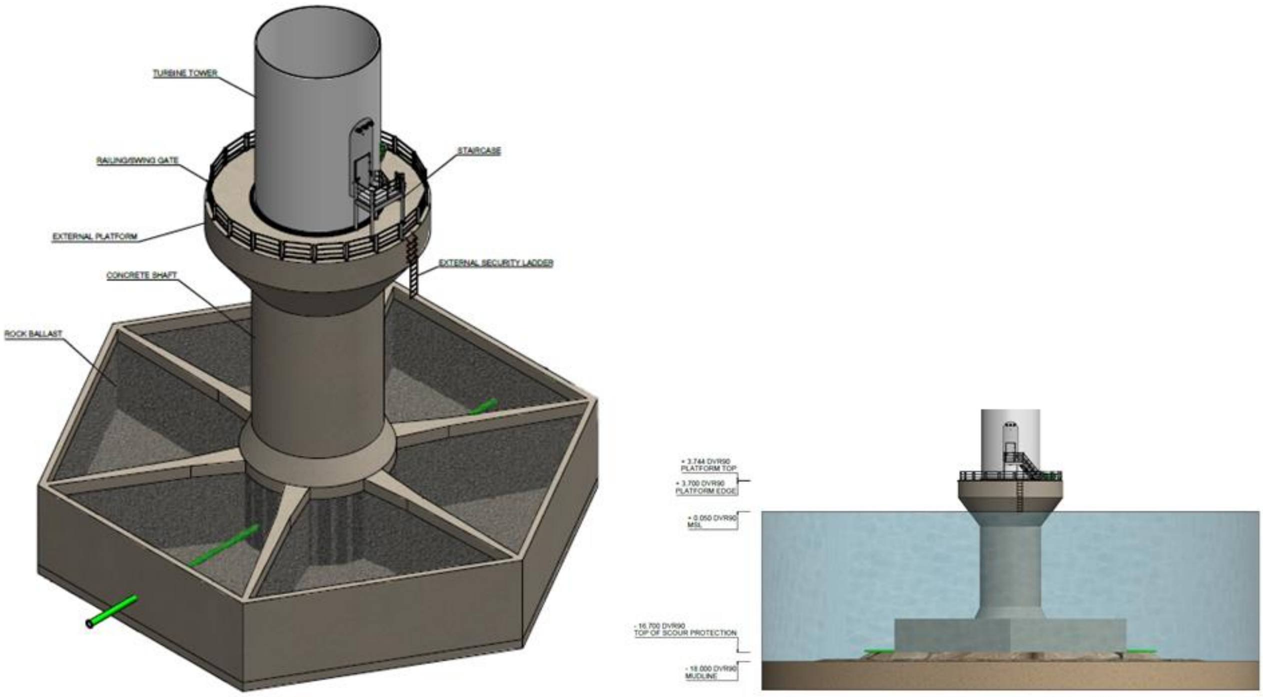


**Figure 3-10 Illustration of wind turbine with gravity foundation.**

The chosen layout is 45 and 29 turbines since this is assumed to result in the highest likelihood of collision. It is noted that a layout with 10MW turbines would take up approximately the same area, but the lower number of turbines would present fewer obstacles to the ship traffic, which would lead to a reduced potential of ship collisions. The placement of the turbines for both wind farms is according to the design layout for small turbine size.

The diameter of the gravity base at the water surface, which is relevant for the ship-turbine collision is assumed to be 11 m[6]. Gravity base is chosen as the conservative value, since this will give the largest diameter above the sea level.

Each wind farm will have a Crew Transfer Vessel (CTV) for maintenance of the turbines. There will be a 200m safety zone around the power cables on the seabed[7]. There will be no safety zone around the wind turbines, expect during construction. The wind turbines will be marked in accordance with industry best practice and/or statutory standards, likely to be yellow up to 15 m above sea level. There will be at least 20m clearance from the tip of turbine blades to sea level.

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[6] Using a slightly larger diameter (13m) is assessed to not change the results significantly.

[7] On the Danish side.

## 3.3.2 Marking and lighting

The following assumptions are used in this risk assessment, see Figure 3-11 for example.

- For offshore wind turbines, it is assumed that these will be marked in nautical charts with an appropriate legend, such as 'turbine' and/or danger circle. This may include ID number.
- Power cables are marked (e.g. prohibited to carry out fishing activity with bottom contacting gear).
- Requirements from the DMA for Racon[8] may be expected, depending on the exact location of the wind turbines. It is not assumed in the risk assessment that radar beacons are installed on WTGs.
- The marking with light on the turbines in relation to shipping and navigation is expected to comply with the requirements by the DMA.
- Typically, all turbines placed in the corners and at sharp bends along the periphery (significant peripheral structures = SPS) of the wind farm, will be marked with a yellow light. Additional turbines along the periphery will be marked, so that there will be a maximum distance between SPS defined turbines of 2 nautical miles.
- The yellow light will be visible for 180 degrees along the peripheral and for 210-270 degrees for the corner turbines (typically located around 5-10 m up on the WTG tower). The light will be flashing synchronously with 3 flashes per 10 second and with an effective reach of at least 5 nautical miles.
- Bottom turbine towers can be painted according to requirements. Indirect light will illuminate the part of the painted section with the turbine identification number.
- During construction the complete construction area will be marked with yellow lighted buoys with a reach of at least 2 nautical miles. Details on the requirements for the positions and number of buoys will be agreed with the DMA.
- In relation to shipping and navigation the marking and lighting requirements are independent of wind turbine size.

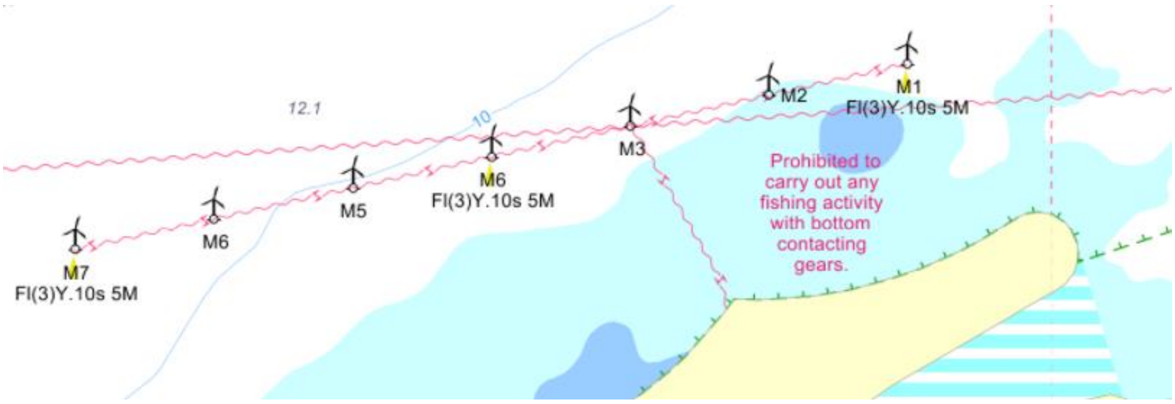



**Figure 3-11 Example charting of OWF where three turbines have light flashing synchronously. All turbines are marked with ID, and the power cable grid is also shown in the chart.**

[8] Radar beacon (short: racon) is defined as "A transmitter-receiver associated with a fixed navigational mark which, when triggered by a radar, automatically returns a distinctive signal which can appear on the display of the triggering radar, providing range, bearing and identification information."

### 3.3.3 Crew transfer vessels trips

The wind farms will be serviced and maintained throughout the life of the wind farm from a local port in the vicinity of the wind farm. Thus, traffic with crew transfer vessels (CTV) between a dedicated port and the offshore wind farms will be added in the model. The port to be used have not yet been identified, but four ports have been proposed: The rescue port near Copenhagen Airport, Dragør port, Prøvesten port and Klagshamn port. The following estimates are assumed:

- CTV capacity will be adapted to the final choice of layout, but with two farms that are geographically located with a relatively large distance, it will be necessary with two CTVs.
- If we assume the maximum number of turbines, i.e. small turbines layout, then it is expected that there will be a CTV that will sail for fault corrections and normal service duties 300 days a year. The other CTV must be expected to sail approx. 180 days a year. This will mean that there will be approx. 480 trips in total (+/- 40)
- It is further assumed that not both wind farms will be visited on each trip, so a conservative one trip every day (365 trips) for each wind farm is used.
- Klagshamn port was used as a "conservative" port assumption. This is because the vessel will need to cross the southern part of Drogden on the way to Aflandshage and the Flintchannel on the way to Nordre Flint. It could also be argued that Copenhagen or Dragør are conservative assumptions, but based on a qualitative assessment, the difference is assumed to be minimal.
- The number of trips is a very conservative estimate, perhaps most relevant to the first year of operation. After the first year of operation, it is very likely that the number of tours will decrease. Figure 3-12 shows an example CTV.

**Figure 3-12 Example CTV from the Lillgrund OWF.**

# 4 RISK ASSESSMENT FOR AFLANDSHAGE OFFSHORE WIND FARM

## 4.1 Modelling of ship traffic through/around wind farm

A traffic density plot for the waters around the planned Aflandshage OWF is shown in Figure 4-1. In the further assessment, note that:

- Risk assessment for construction and decommissioning, incl. cable installation operations is handled in chapter 4.5.4.
- The risk evaluation of the power cable impact is handled in chapter 4.5.6.

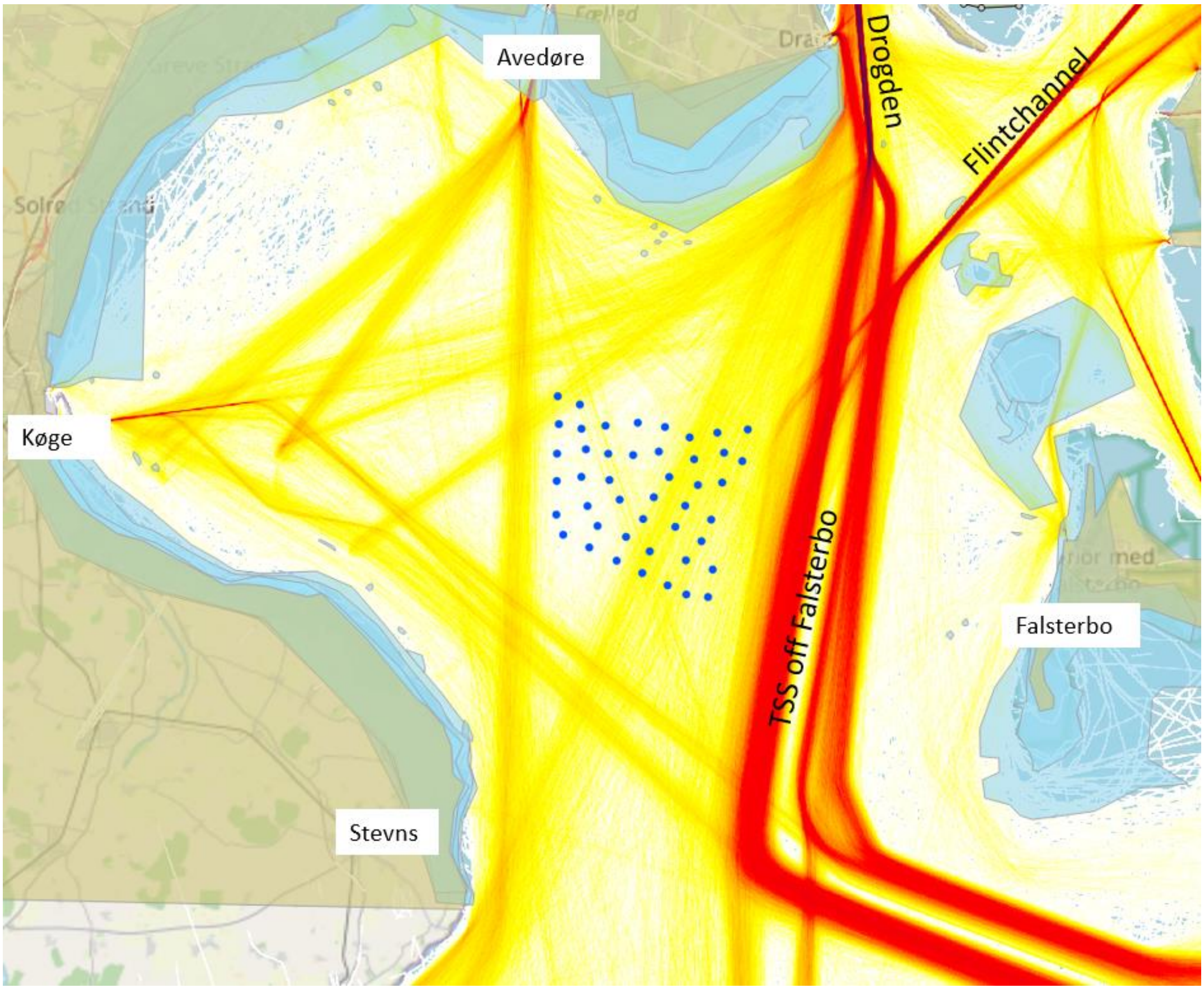



**Figure 4-1 Density of traffic around Aflandshage, based on AIS-data from 2019. "Small turbine" layout is indicated with blue points for each turbine position.**

The wind farm is situated west of the TSS route off Falsterbo. The ship traffic within the study area comprises a route model, as presented in Figure 4-2. The main routes (including those for fishing and pleasure crafts) have been identified and given a route ID, as listed in Table 4-1. Note that only routes with substantial traffic are given a unique identifier, but that does not exclude routes with less traffic in the model.

The route with the most traffic in the vicinity of the planned wind farm is southbound TSS route off Falsterbo. The traffic composition here is mostly passenger/roro (32%), oil product/chemical tankers (23%) and general cargo ships (21%).

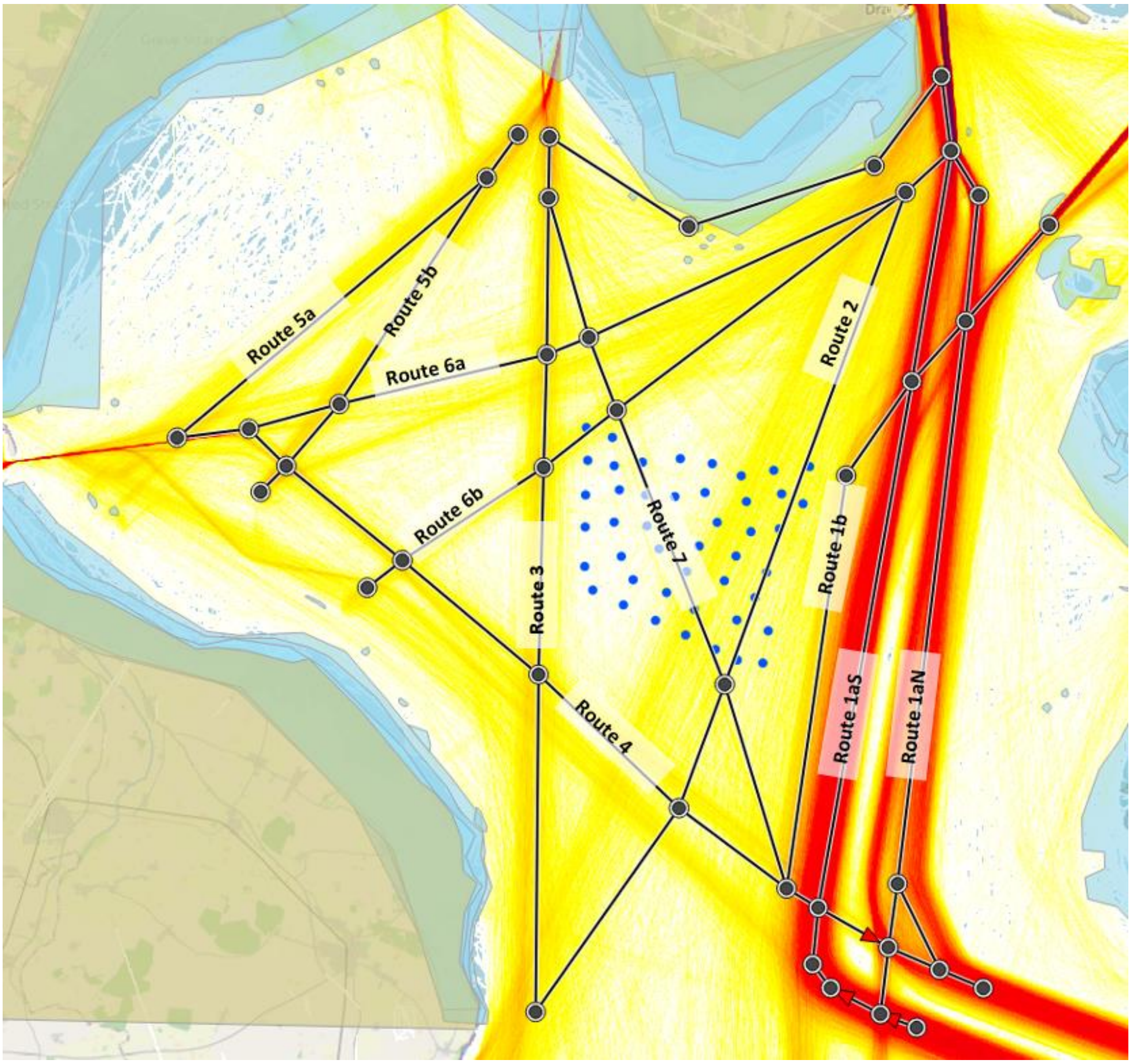



**Figure 4-2 Modelling of routes for existing situation, based on AIS-data from 2019. Layout of the planned wind farm is indicated on the map ("small turbine layout").**

**Table 4-1 Routes in vicinity of Aflandshage and traffic composition**

| ID | Route name | Route description | Traffic composition (most dominating ships listed) |
|---|---|---|---|
| 1aN | TSS off Falsterbo Northbound | Northbound traffic in 'TSS off Falsterbro' | General cargo ships (63%), product/chemical tankers (9%) and passenger/roro (9%) |
| 1aS | TSS off Falsterbo Souhtbound | Southbound traffic in 'TSS off Falsterbro' | General cargo ships (60%), product/chemical tankers (15%) and bulk carriers (8%) |
| 1b | TSS off Falsterbo 'west' | Southbound traffic also in TSS, but closer to west, near planned wind farm | General cargo ships (37%), passenger/roro (27%) and product/chemical tankers (12%) |

| | | | |
|---|---|---|---|
| 2 | Drogden-Stevns | Traffic between Drogden and Stevns area | Pleasure crafts (58%), general cargo ships (17%) and other (8%) |
| 3 | Avedøre-Stevns | Traffic between Avedøre and Stevns area | Other (98%) |
| 4 | Køge-Falsterbro | Traffic between Køge and off Falsterbo area | Passenger/roro on the Køge-Rønne line operated by Bornholmslinjen (64%), general cargo ships (27%) and other (6%) |
| 5a | Køge-Avedøre | Traffic between Køge and Avedøre | Other (99%) |
| 5b | Strøby-Avedøre | Traffic between Avedøre and waters outside Strøby | Other (97%) |
| 6a | Køge-Drogden inner | Traffic between Køge and Drogden (inner) | General cargo ships (62%), other (29%) and tugs (4%) |
| 6b | Køge-Drogden outer | Traffic between Køge and Drogden (outer) | Other (99%) |
| 7 | Avedøre-Falsterbro | Traffic between Avedøre and off Falsterbo area | General cargo ships (95%) |

Figure 4-3 shows the number of passing ships per route, grouped by ship type. Full details in the traffic composition can be found in Appendix C.

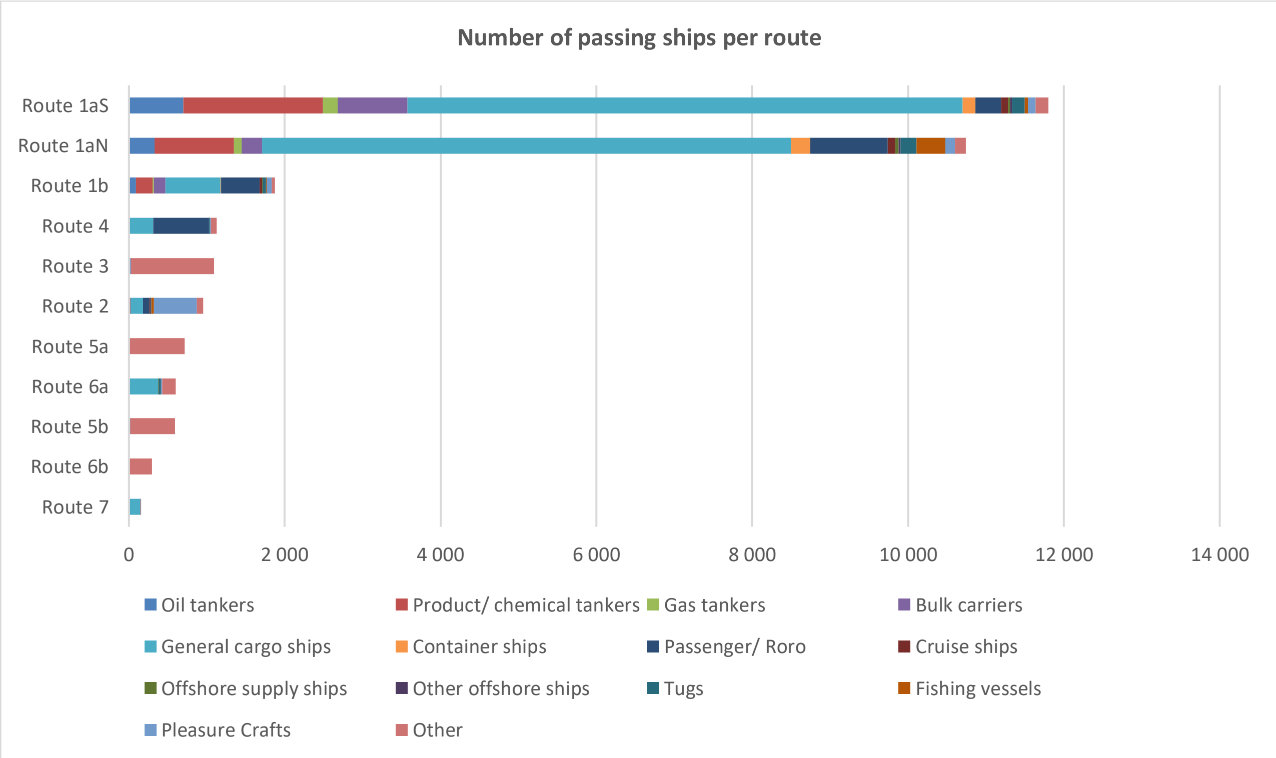



**Figure 4-3 Number of passing ships per route in 2019, categorised by ship type. The order of colour is shown in the label.**

'TSS off Falsterbo' (Routes 1aN and 1aS) are the routes with most traffic. Most of the ships in the 1aS route, which is closest to the wind farm, are in the length category 70-100 m (3,883 passing ships/33% share), but there have also been larger ships in the category 250-300 m (200 passing ships/2% share).

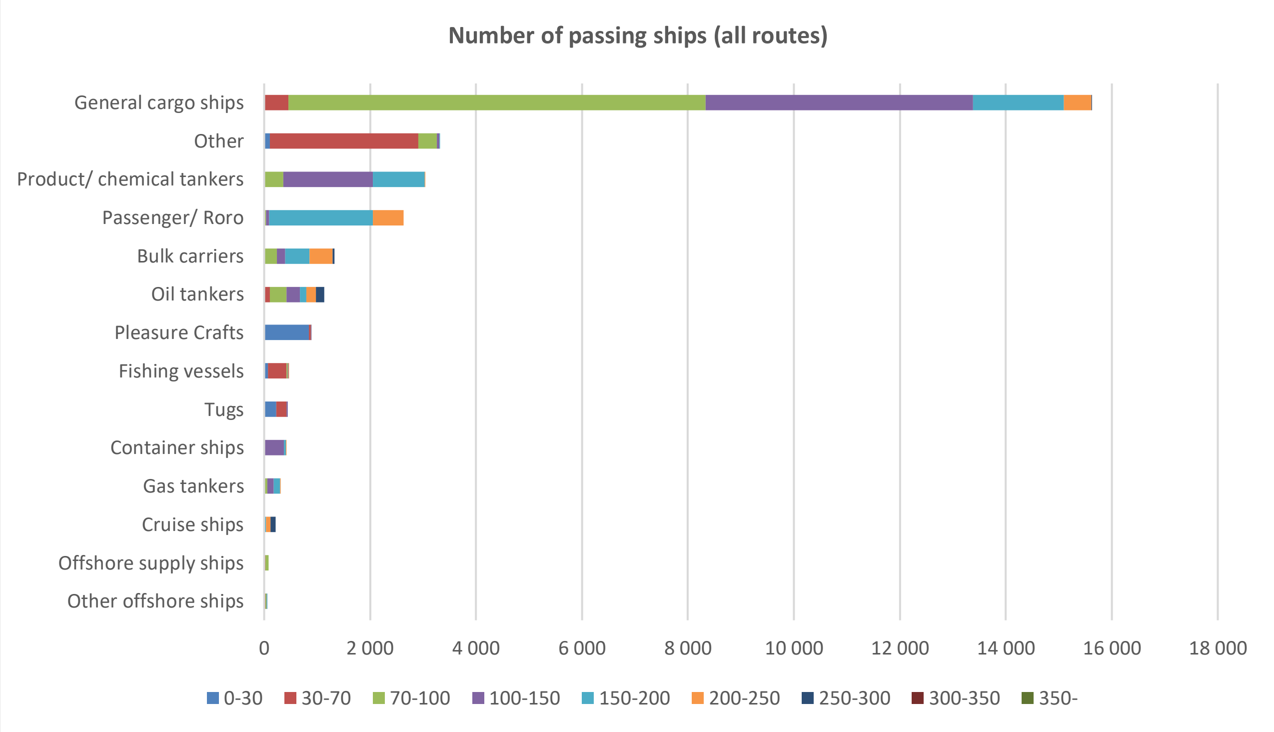



**Figure 4-4 Number of passing ships for all routes in 2019, grouped by ship length (m).**

## 4.2 Hazard identification

The key findings from the hazard identification study are listed in the bullet points below. For full details of the HAZID results we refer to HAZID report for Aflandshage and Nordre Flint offshore wind parks (DNV GL Report No.: 2020-0940) [2].

The key findings are:

- No high risks (unacceptable risks) where identified specifically for Aflandshage, except from one general high risks hazard (common for both wind farms); powered collision with the turbine from passenger or tanker ships. This impact may in worst case lead to parts of the turbine falling down on the deck and/or results in damages to hull with possibility of water ingress.
- Ship traffic in Køge Bay can change in the future, for example as a result of the construction of artificial islands south of Avedøre Holme.
- It was commended in the workshop that the wind farm comes close to the southbound TSS. Danpilot commented that this may pose a risk due to ships out of course or drifting ships.
- There is a pilot mark located in the middle of the wind farm that needs to be moved. Danpilot has indicated a new tentative position in Figure 4-5.

General recommendations, for both wind farms, proposed in the HAZID workshop are part of the safety recommendations in chapter 6.

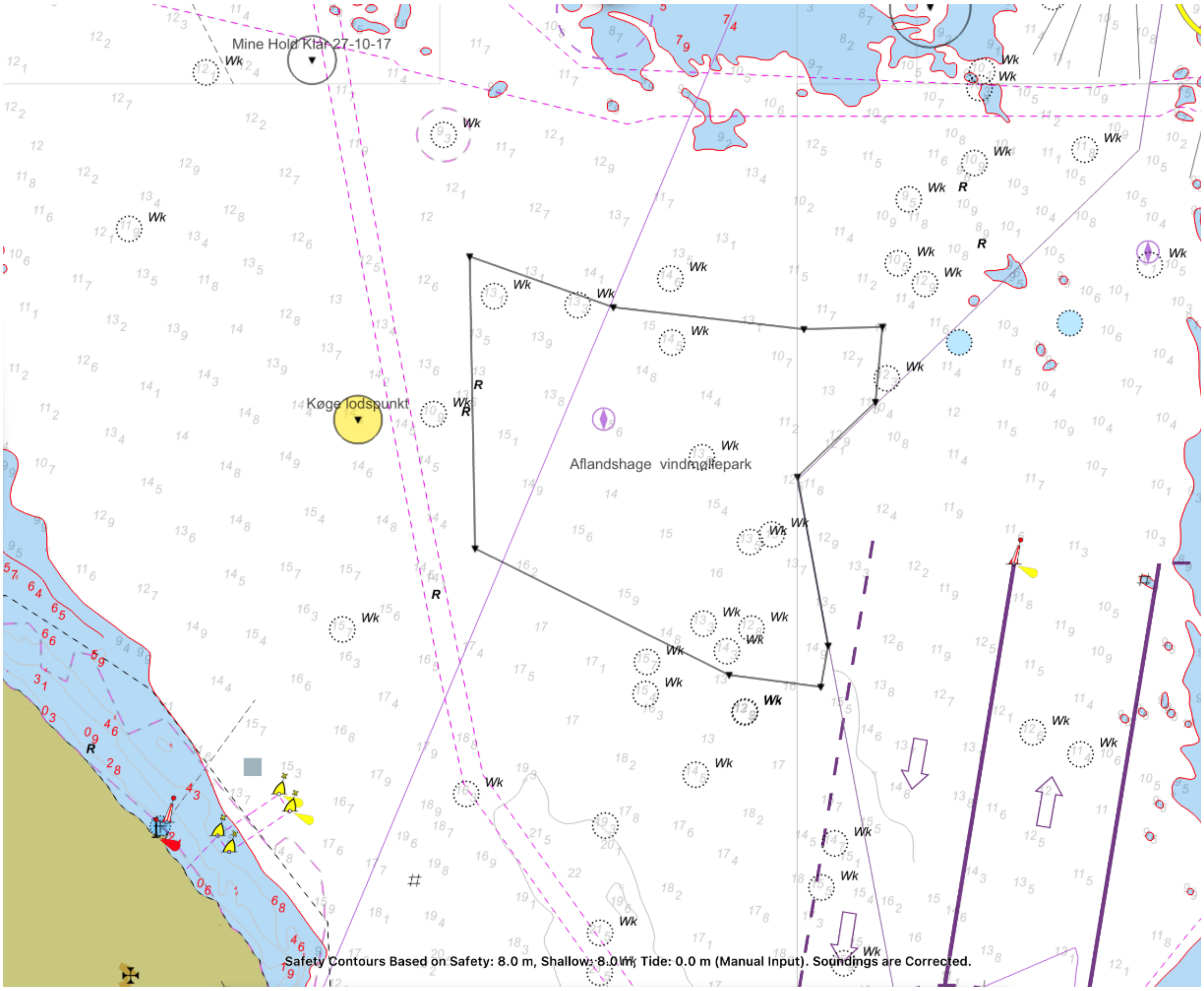



**Figure 4-5 Danpilot has indicated a new tentative position for the pilot mark west of the Aflandshage OWF.**

## 4.3 Frequency analysis

### 4.3.1 Existing conditions (before establishment)

The existing condition represents the case where the offshore wind farm is not established and is meant as a base for comparison in order to assess the impact the wind farm will have on the navigational risk. Figure 4-2 showed the IWRAP model for existing routes (current situation).

As seen from Table 4-2, grounding is the dominating risk contributor with a calculated frequency of 0.15 groundings per year. This equals to about one grounding every 6.6 years.

From the HELCOM database we found several registered groundings in the period 1989 to 2017. Eight groundings were found to be relevant for the IWRAP model area, which equals to one grounding every 3.5 years (frequency of 0.29). Comparing IWRAP with real accidents we see that IWRAP is calculating a lower grounding frequency than has been observed the last decades, but still in the same order of magnitude.

Although there is a difference between the IWRAP results and accident statistics registered in HELCOM, this have no practical implications for this study. It is the risk evaluations, comparing the 'before' and ‘after’ situation (the “delta risk”) of the wind farm establishment that is key, i.e. the percentage potential increase in accident frequency.

Detailed risk results are provided in Appendix E.

**Table 4-2 Calculated accident frequencies for current situation (before establishment) within the study area. Frequencies are modelled in IWRAP.**

| Accident type | Before establishment |
|---|---|
| Powered grounding | 9.1E-02 |
| Drift grounding | 6.0E-02 |
| **Total grounding** | **1.5E-01** |
| HeadOn ship-ship collisions | 1.4E-02 |
| Overtaking ship-ship collisions | 1.7E-02 |
| Crossing ship-ship collisions | 6.6E-03 |
| Merging ship-ship collisions | 3.3E-03 |
| Bend ship-ship collisions | 2.3E-03 |
| **Total ship-ship collisions** | **4.4E-02** |
| Ship-turbine powered collision | -- |
| Ship-turbine drift collision | -- |
| **Total ship-turbine collision** | **--** |

The frequency of ship-ship collisions is calculated to be 0.044, which is about one collision every 23 years. The accidents statistics reveals that there are relatively few collisions within our study area. Four ship collisions were found relevant for the study area during 1989 to 2017, which would equal to one collision every seven years. However, this is not considered as enough data to make any sufficient comparison with IWRAP values. The TSS routing system, separating northbound and southbound traffic off Falsterbo, is the key reason for the relatively low ship-ship collision frequency of this area. There is also not much crossing traffic, which is also indicated on the low crossing ship-ship collisions frequency.

### 4.3.2 Revised condition (after establishment)

It is assumed that some of the ship traffic will reroute to avoid passing through the farm. The routes used to model these components of the ship traffic in the risk analysis must be adjusted accordingly based on the assumed future behaviour of this traffic – i.e., how far the traffic will tend to relocate.

The revised routeing pattern following construction of the wind farm has been estimated based on the review of impact on navigation. It is assumed that ships will revise their voyage plans in advance of encountering the wind farm due to effective mitigation in the form of information distribution about the development to mariners through Notices to Mariners, updated charts, liaison with ports, etc.

The revised IWRAP traffic model is shown in Figure 4-6.

Given the project location, no significant disruption of the major commercial shipping lanes is expected. However, the traffic that today goes through the wind farm area will need to be re-located. The traffic composition in these routes consist mainly of general cargo ships, pleasure crafts and fishing vessels. Traffic on route 2 and 7 are passing straight through the wind farm area.

The following bullet points summarizes the revised routing system, as modelled in IWRAP:

- Route 6b (Traffic between Køge and Drogden, outer route): In the revised model the traffic will keep safe distance to the farm and is assumed to re-route north of the wind farm. In total 296 passing vessels (mainly vessels in category 'other') is re-routed.
- Route 7 (Traffic between Avedøre and waters off Falsterbo): In the revised model the traffic will keep safe distance to the farm and is assumed to re-route to the west side of the wind farm, merging with existing route 3 and 4. In total 154 passing vessels (mainly general cargo ships) is moved from route 7.
- Route 2 (Traffic between Drogden and waters off Stevns): Traffic (dominantly pleasure crafts) is assumed to keep safe distance by relocating further west, but they will likely not sail into TSS lanes with large commercial traffic (assumed relocated to route 1b). In total 910 passing vessels is moved.
- 365 CTV trips to Aflandshage OWF are added. See detailed CTV route assumption in Appendix A.

Note that original route 2 and 7 is not shown in the figure 4-6 as these routes are "deleted" in the model, and the traffic moved to route 1b, and 3 and 4 respectively.

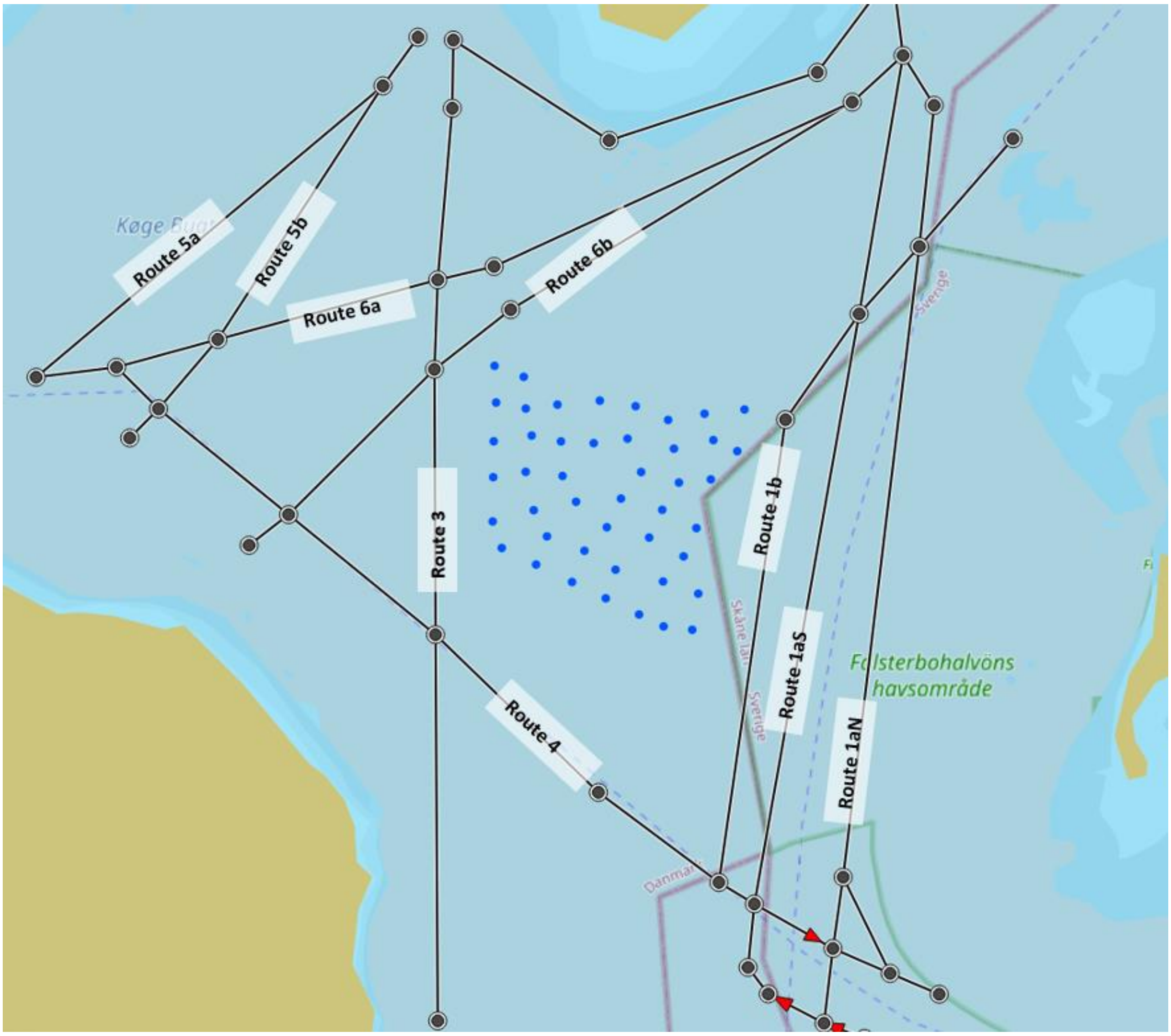



**Figure 4-6 Revised routes assumption due to Aflandshage OWF.**

**Table 4-3 Accident frequencies, after establishment of Aflandshage OWF.**

| Accident type | After establishment |
|---|---|
| Powered grounding | 8.6E-02 |
| Drift grounding | 6.0E-02 |
| **Total grounding** | **1.5E-01** |
| HeadOn ship-ship collisions | 1.4E-02 |
| Overtaking ship-ship collisions | 1.8E-02 |
| Crossing ship-ship collisions | 7.5E-03 |
| Merging ship-ship collisions | 3.4E-03 |
| Bend ship-ship collisions | 2.3E-03 |
| **Total ship-ship collisions** | **4.5E-02** |
| Ship-turbine powered collision | 3.7E-04 |

| Accident type | After establishment |
|---|---|
| Ship-turbine drift collision | 6.4E-04 |
| **Total ship-turbine collision** | **1.0E-03** |

The risk evaluation of the accident frequencies, before vs after establishment of Aflandshage offshore wind farm, are presented in chapter4.5.

## 4.4 Consequence analysis

There are several potential consequences should a ship-turbine collision occur. The least severe consequence is that a drifting vessel grazes a wind turbine. In this event, there may be minor damage to both the vessel and the turbine. It is likely that all personnel and passengers, and the structures, would not experience any injury or damage. Personnel and crew should in this event have sufficient time to prepare for impact and thereby ensure all persons are in safe locations.

The severity of a striking event generally increases with the speed of impact and size of the vessel. However, smaller vessels like pleasure crafts or fishing vessels may also experience severe damage if striking a wind turbine at speed. A powered striking (i.e., occurring at speed) would likely result in the most severe consequences for both the vessel and the turbine. Worst-case scenario of a powered striking could result in the following:

- Personnel/passenger injury or fatality
- Major damages to the vessel. Damages could potentially be so severe that vessel foundering is possible. Damages could also result in a release of cargo.
- Major damages to the wind turbine and/or foundation.

Although potential consequences have the possibility of being severe, it is important to also consider the frequency of powered striking when considering the risk. Resulting frequency of any wind turbine striking, as presented in Table 4-3, is 1.02E-03. This event has a return period of 1 in every 984 years.

## 4.5 Risk evaluation

Table 4-4 summarises the calculated accident frequencies, before and after establishment of Aflandshage OWF. The following chapters discusses the results of each of the accident types; grounding, ship-ship collision and ship-turbine collision. The evaluations focus on the numerical outputs from the model, i.e. the accident frequencies.

**Table 4-4 Accident frequencies, before and after establishment of Aflandshage OWF.**

| Accident type | Before establishment | After establishment | Difference (after vs before) | |
|---|---|---|---|---|
| Powered grounding | 9.1E-02 | 8.6E-02 | -4.9E-03 | -5.4% |
| Drift grounding | 6.0E-02 | 6.0E-02 | -5.4E-04 | -0.9% |
| **Total grounding** | **1.51E-01** | **1.5E-01** | **-5.0E-03** | **-3.3%** |
| HeadOn ship-ship collisions | 1.4E-02 | 1.4E-02 | 2.6E-04 | 1.9% |
| Overtaking ship-ship collisions | 1.7E-02 | 1.8E-02 | 7.9E-05 | 0.5% |
| Crossing ship-ship collisions | 6.6E-03 | 7.5E-03 | 8.5E-04 | 12.9% |
| Merging ship-ship collisions | 3.3E-03 | 3.4E-03 | 6.5E-05 | 1.9% |
| Bend ship-ship collisions | 2.3E-03 | 2.3E-03 | 4.0E-06 | 0.2% |
| **Total ship-ship collisions** | **4.4E-02** | **4.5E-02** | **1.3E-03** | **2.9%** |
| Ship-turbine powered collision | -- | 3.7E-04 | -- | -- |
| Ship-turbine drift collision | -- | 6.4E-04 | -- | -- |
| **Total ship-turbine collision** | **--** | **1.0E-03** | **--** | **--** |

The consequences of a ship-ship collision or grounding event are the same regardless of the wind farm establishment. The consequence of a collision with the wind turbine is dependent on collision angle, the vessel type, size of vessel and the vessel speed. The qualitative consequence descriptions were given in the previous chapter (chapter 4.4).

### 4.5.1 Ship-turbine collision risk during operation

The presence of the offshore wind farm is assumed to result in that some of the ship traffic will relocate to avoid passing through the offshore wind farm. The routes used to model these components of the ship traffic in the frequency analysis is adjusted accordingly based on the assumed future behaviour of this traffic i.e. how the traffic will tend to relocate. In the analysis it is assumed that ship traffic will not travel through the farm.

The accumulated results for the entire offshore wind farm are presented in Table 4-4. It shows the frequency and return period for the two scenarios (powered/drifting collision), as well as the combined sum for the two.

The ship-turbine accident frequencies are the lowest of all the accidents, with an annual frequency of 1.02E-3. This is equivalent to a collision happening 1 in every 984 years. It is noted that the calculated collision frequencies cover all cases of collision, i.e., both minor collisions as well as severe collisions where repair of ship is needed before the ship can continue its planned journey.

The routes that have the highest contribution to the ship-turbine collision frequency are:

- Traffic in route 1b
- Traffic in southbound TSS lane (route 1aS)
- Traffic in northbound TSS lane (route 1aN)

The ship types that have the highest contribution to the ship-turbine collision frequency are: General cargo ships (39%), passenger/roro (24%) and other 13%.

In the HAZID and the risk assessment there has been special attention on wind turbines close to the southbound TSS lane (both considering small turbine and large turbine layout), see Figure 4-7. The key findings from the assessment of this structure are:

- The turbines in the eastern edge of the wind farm area are located close to busy traffic lanes; 1,874 passing vessels in route 1b and 11,804 passing vessels in route 1aS in 2019.
- The turbines will have large ships passing, historically up to a length of 300 m in 2019. The draft limitation of 8.0 m in the Flintchannel is limiting larger ships to use this channel.
- The distance from the turbines on the edge of the wind farm area to the outer edge of the southbound TSS is about 1,240 m.
- Although the distance from the turbines to the southbound TSS (edge to edge) is 1,240m, the vast majority (90%) of the ships sails closer to the separation zone (separating southbound and northbound lanes) with a distance of at least 2,050 m, see Figure 4-7.
- Traffic in southbound TSS (including the traffic in route 1b) has a 66% contribution to the ship-turbine accident frequency.
- The calculation of risk for the southbound TSS (legs 9, 10 and 11 combined), based on the "small turbine layout", shows a ship-turbine collision frequency of 6.7E-04, which equals to one accident every 1,485 years.

A risk contributor to the ship-turbine collision frequency is also the crew transfer vessels when they sail to and from the wind farm turbines. IWRAP is not able to model the patterns of the CTV in-between the wind turbines, but the voyages to/from port to the wind farm is included in the model. The latest ship-turbine collision accident in Danish waters was in April 2020 when a CTV hit a turbine in the North Sea, seriously injuring one crew member and harming another two. The risks should be mitigated with good operating procedures and crew training.

For the remaining routes and legs, not mentioned above, it is evident that the commercial vessel traffic is largely undisturbed by the presence of the wind farm with regards to risk of ship-turbine collision.

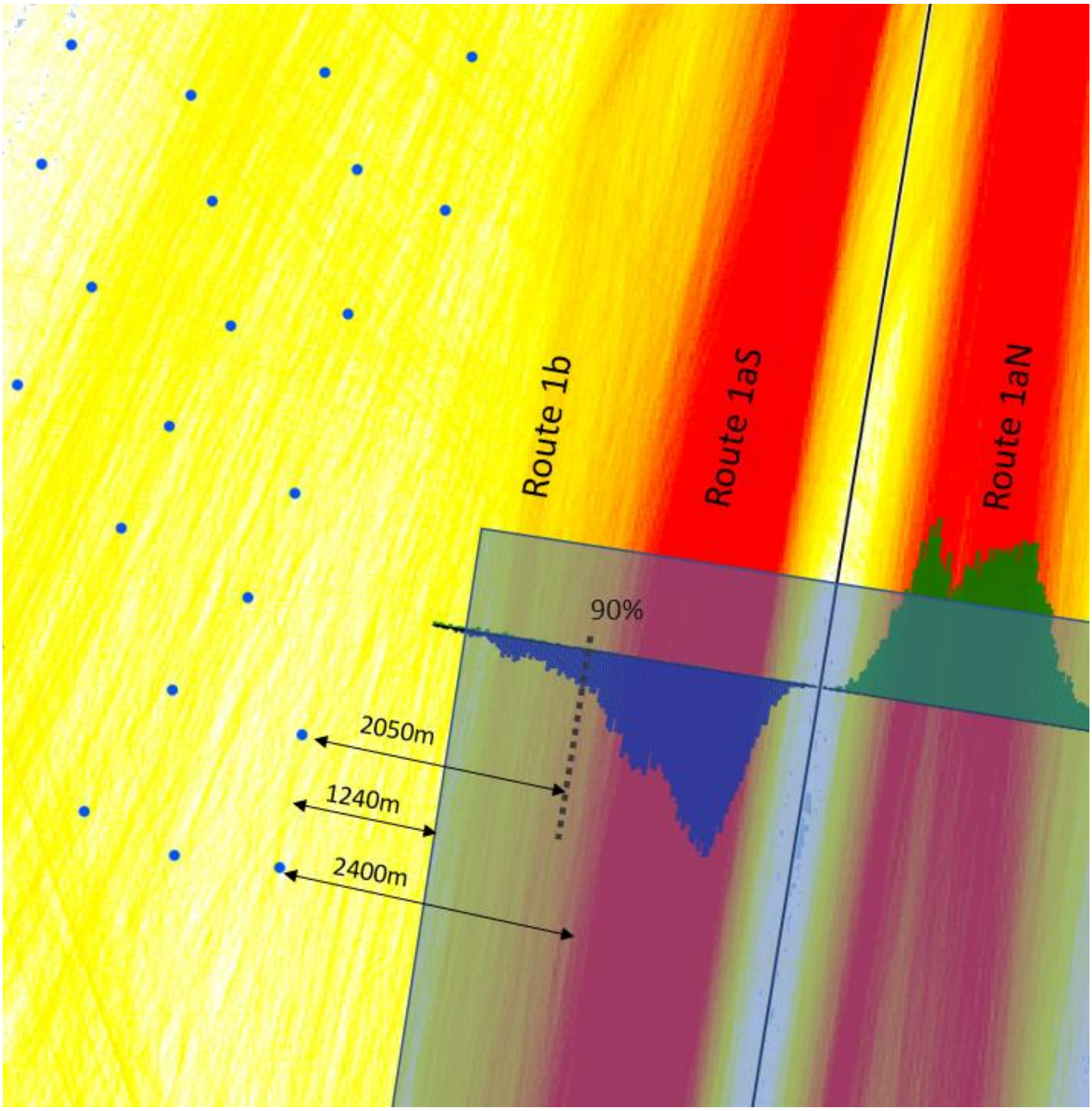



**Figure 4-7 Traffic density plot showing the lateral traffic distribution for the northbound and southbound lanes in the TSS. The lanes in the TSS are marked with dotted blue line.**

## 4.5.2 Ship grounding risk

It is calculated that the total grounding frequency after establishment is 1.46E-02 (seven years between accidents), actually decreasing 3.3% from today's situation. This is mainly due to that some of the traffic that sailed through the wind farm area, passing the coast of Stevns is now routed closer to the middle of the sound between Denmark and Sweden (because they need to re-route east of the wind farm). Further distance from the coast means reduced grounding risk. Vessels on existing route 2, that in the revised model is moved to TSS, will also get a more direct sailing line towards Drogden channel, this is also a contributor to the decrease in grounding frequency.

## 4.5.3 Ship-ship collision risk

It is calculated that the ship-ship collision frequency will increase by 2.9% due to the establishment of the wind farm. After the establishment, the ship-ship collision frequency is 4.5E-02 which yield a return period on 22 years between accidents.

The reason why the accident frequency has increased is because of the merged traffic. This is due to vessels that need to re-route and merge into other existing lanes. The additional CTV voyages to/from the wind farm is also contributing to the increased frequency.

## 4.5.4 Risk during construction and decommissioning

The number of vessels that operate in construction and decommissioning phases is generally expected to only have a small risk addition to current traffic.

The vessels that are anticipated to be present during construction include construction barges, support tugs, jack-up rigs, supply/crew vessels and cable laying vessels. These vessels will also be present in the region during decommissioning. It is likely that approximately 10-15 vessels (including support vessels) may be on site at any time during the construction phase. Construction vessels are anticipated to be sailing at very low speeds through the construction zone.

The highest navigation risk during construction will be:

- Cable laying barges crossing routes 6a, 6b and potentially route 3 during installation of grid connection cables. In addition, close to Avedøre Holme, cable barge must pass the navigational channel with shallow water on both sides. Procedure for safe voyages, especially close to Avedøre Holme, should be made for the construction work in dialogue with VTS and pilots.
- Smaller vessels operating in close proximity to construction and work vessels during construction. However, this risk is mitigated by safety zones that is anticipated to be implemented during construction operations. The safety zones are expected to prohibit "third party vessels" from entering into, transiting through, mooring, or anchoring within safety zones.

It is assumed that 500m safety zones will be established during construction around each location where the towers, nacelles, blades and subsea cables will be installed in navigable waters. However, the exact safety zone radius will be agreed with the DMA prior to construction. The intention of establishing safety zones is to safeguard mariners from the hazards associated with construction of the wind farm.

## 4.5.5 Qualitative assessment of potential cumulative impacts and effect on SAR

The previous evaluations have considered the proposed project in isolation. Under this section the potential cumulative and in-combination impacts on shipping (of any nearby developments in the area) will be reviewed. This will include any proposed developments not yet constructed, but scoped, within the area. An increased navigational risk due to cumulative effects in the area has been assessed.

The Aflandshage OWF is relatively far away from the two other existing wind farms in the Øresund-region; Lillgrund offshore wind farm and Middelgrunden offshore wind farm. Lillgrund Wind Farm is located about 6 km off the coast of southern Sweden, just south of the Öresund Bridge. Middelgrunden offshore wind farm is located 3.5 km outside Copenhagen.

The planned Aflandshage OWF is located approximately 22 km from Nordre Flint OWF.

Based on the distances between the wind farms and the traffic patterns/routes we see no cumulative effects that would affect the navigational risk near the Aflandshage OWF, or the other offshore wind farms, in any negative way.

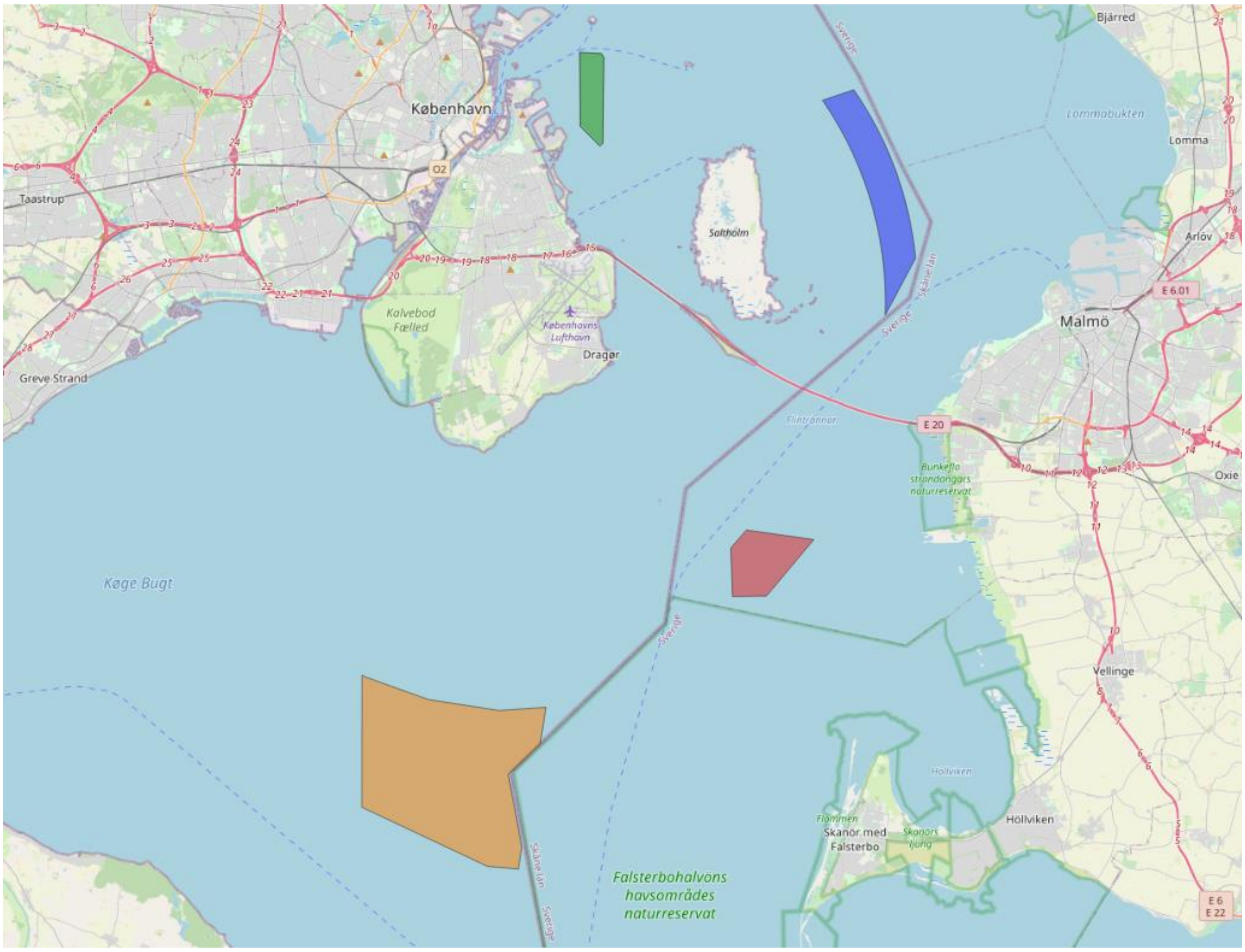



**Figure 4-8 Locations of wind farms: Blue: Nordre Flint (planned), red: Lillgrund (existing), green: Middelgrunden (existing) and orange: Aflandshage (planned). Nordre Flint and Aflandshage are illustrated with the layout that gives the most wind turbines (5.5-6.5MW turbines).**

No significant disruption of Search and Rescue (SAR) operations at sea is expected, as the spacing between the turbines (approx. 500 m) and the minimum distance between the Highest Astronomical Tide (HAT) and the lower wing tip (approx. 20 m) will allow for rescue boats to sail in between turbines and through the wind farm.

### 4.5.6 Assessment of cable interaction with ship traffic

Anchoring, emergency anchorage or trawling activity with bottom gear near proposed cable route(s) could potentially interact with the power cable. Therefore, a high-level review of potential cable impacts from ship activities was carried out using the available AIS and VMS data covering the proposed cable route.

**Dropped or dragged anchor**

Figure 4-9 shows the density of traffic above the power cable. Typical cable interaction hazards related to the ship traffic are:

- Sinking vessels
- Dragged anchors
- Dropped anchors
- Dropped objects (e.g. containers).
- Grounding vessels

Sinking vessels, dropped anchor or object directly above the power cable is a very unlikely event, thus considered negligible risk contribution. The probability that a ship will sink is equal to 5.1E-9 per sailed nautical mile [9]. Due to the shore power cable is suggested to be dredged into the seabed and the water depths in the area, grounding/contact to cables are also assumed negligible.

The dragged anchor scenario could result as a consequence of two events:

- Anchoring in an emergency situation (emergency dragged anchor).
- Uncontrolled drop of the anchor (accidental dragged anchor).

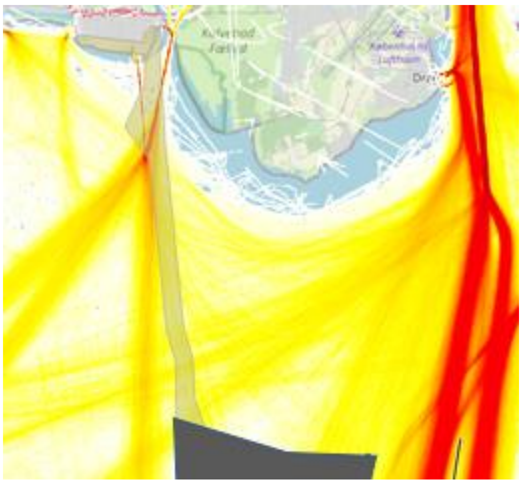


**Figure 4-9 Density of traffic above the power cable area (light grey area).**

Power cables will be clearly marked in charts. However, in emergency situations a vessel drifting towards shore or a turbine may attempt to anchor to reduce the risk of collision or grounding. Cables should therefore be buried to a sufficient depth to avoid being uncovered. Where power cables cannot be sufficiently buried, it is important that alternative types of cable protection are considered

Di Padovaa et.al. found, based on [6] and [7], that the frequency of anchors lost (events/ship/year) vary between 0.01 to 0.005 events/ship/year [8]. A frequency of 0.005 corresponds to 1 anchor lost every 150 ship per year). This must therefore be considered as a very 'low frequency event'.

### Fishing activity

AIS data from 2019 and VMS data from Fiskeristyrelsen for the years 2010 to 2019 are used to assess the fishing activities in both the offshore wind farm area and the corresponding cable route.

The AIS and VMS data[9] was filtered to only include data points where the vessels have been sailing with a speed equal to or below 5 knots, as this is assumed the threshold for trawling and net activities. A visual representation of the VMS data points in the period 2010-2019 is shown in Figure 4-10.

Trawling has been illegal in some parts of Øresund since 1932 to prevent fish stocks being depleted. This means that the green points in Figure 4-10 must be either wrong registration of fishing activity in the WMS data, illegal fishing, or simply fishing vessels sailing at low speed (not performing fishing).

A relatively low fishing activity can be observed in both the wind farm area and along the planned cable route. There is higher activity south of the windfarm area. Also, along the east coast of Amager, bottom fishing is conducted along the coast, especially for cod, eel and turbot.

Further, a simple analysis of the 2019 AIS data were performed to compare AIS data to the VMS data. AIS tracks for the year 2019 from fishing vessels sailing with speed equal to or below 5 knots was used. The result showed that there were almost no tracks from fishing vessels sailing below 5 knots in the wind farm area, see density plots for Aflandshage in Appendix B.

After closer investigation of the VMS data, it was found that most of the fishing activities registered are from the years prior to 2015. An inspector from the Ministry of Environment and Food of Denmark also commented in the first public hearing for Aflandshage that commercial fishing in Køge Bay has declined for some years. VMS data points segregated by years are illustrated in Figure 4-11. As the AIS data used in this analysis is from 2019, the lack of fishing vessels tracks with speed equal to or below 5 knots from AIS is reasonable.

[9] Note that for VMS data: For the years 2010 and 2011 vessels of length 15 meters or longer are included, while for the data points from 2012 to 2019 vessels from 12 meters are included.

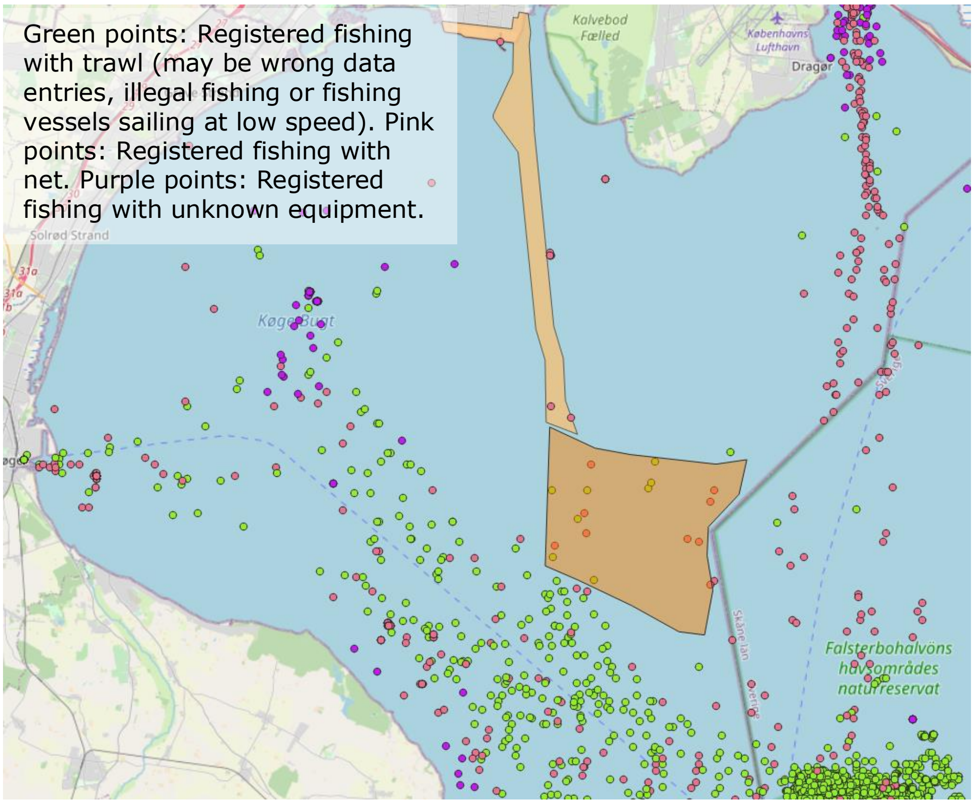



**Figure 4-10 Visual representation of registered fishing activities from VMS data for the area around Aflandshage offshore wind farm from 2010 to 2019.**

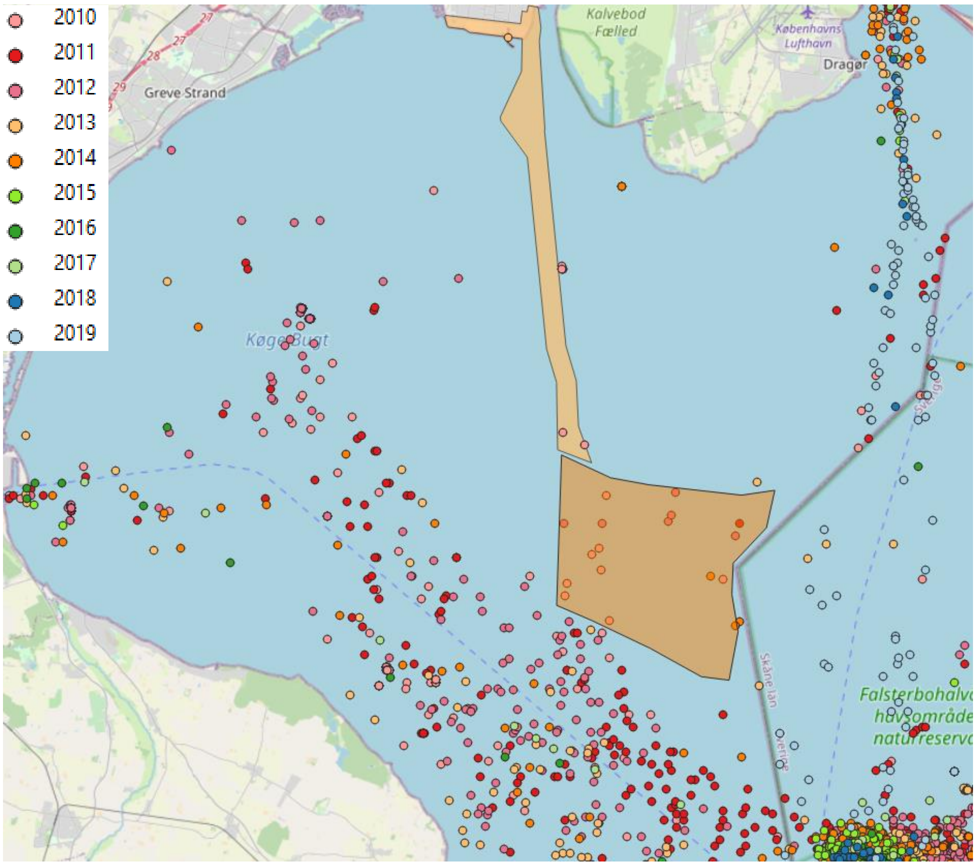



**Figure 4-11 VMS data (2010-2019), with colour legend representing each respective year.**

# 5 RISK ASSESSMENT FOR NORDRE FLINT OFFSHORE WIND FARM

## 5.1 Modelling of ship traffic through/around wind farm

A traffic density plot for the whole region around the planned Nordre Flint OWF is shown in Figure 5-1. The study area for the navigational risk assessment concerned with the wind turbines *operations* are shown inside the map. Note:

- Risk assessment for construction and decommissioning, incl. cable installation operations are handled in chapter 5.5.4.
- The risk evaluation of the power cable impact is handled in chapter 5.5.6.

Most of the traffic that sails through Øresund, between Kattegat and Baltic Sea, use the Drogden channel west of Saltholm. Based on traffic modelling, the Drogden channel had 25,616 passing vessels in 2019, while the Flintchannel had 6,040. This means that it is about 4 times more traffic through Drogden compared with Flintchannel.

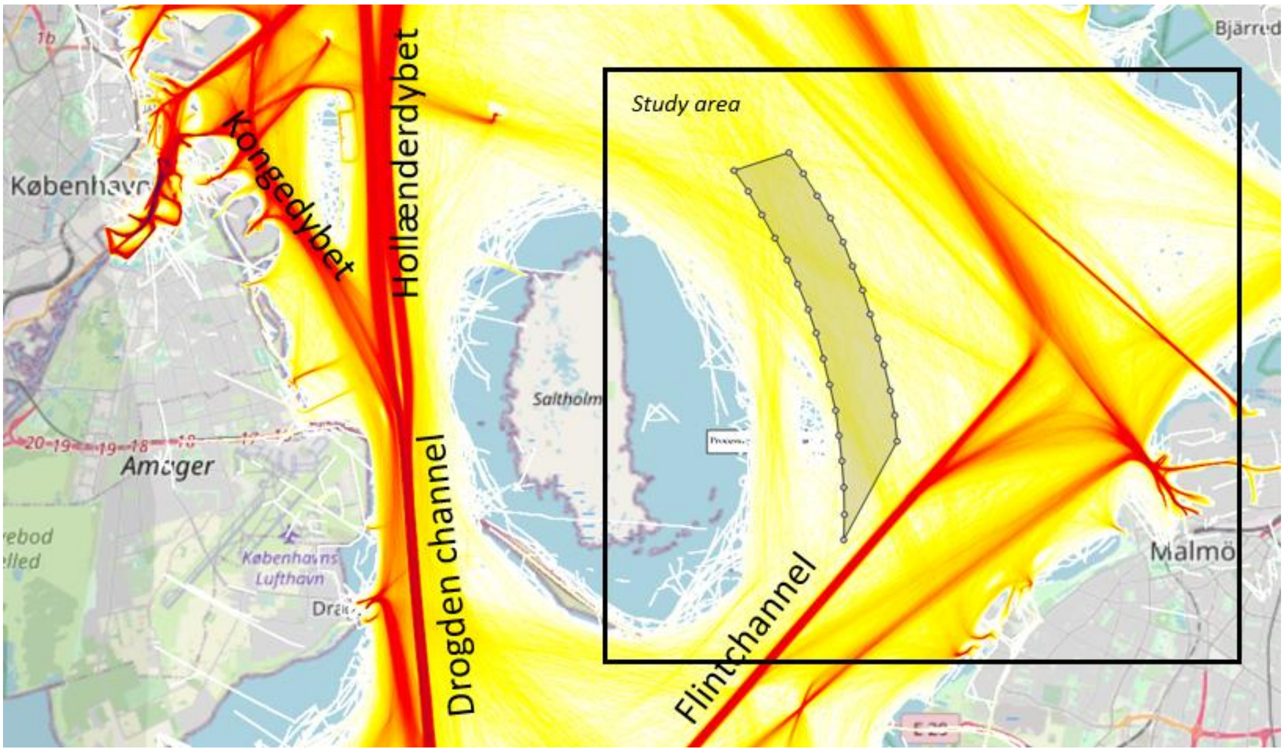



**Figure 5-1 Density of traffic around Nordre Flint, based on AIS-data from 2019.**

The ship traffic within the study area comprises a route model, as presented in Figure 5-2. The main routes (including those for fishing and pleasure crafts) have been identified and given a route ID, as listed in Table 5-1. Note that only routes with substantial traffic are given a unique identifier, but that does not exclude routes with less traffic in the model.

The route with the most traffic in the vicinity of the planned wind farm is Flintchannel (Route 3). The traffic composition here is mostly passenger/roro (32%), oil product/chemical tankers (23%) and general cargo ships (21%).

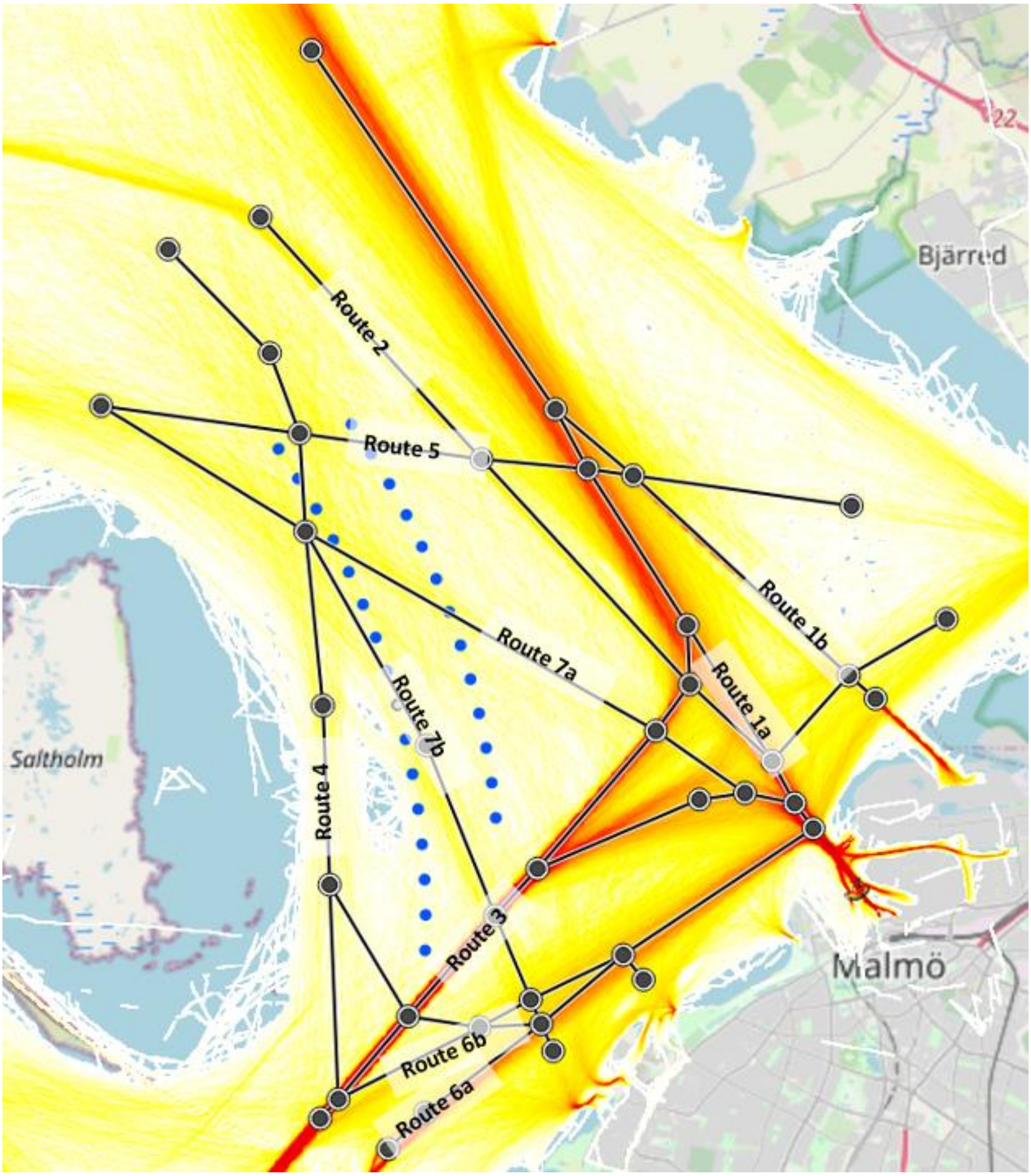



**Figure 5-2 Modelling of routes for existing situation, based on AIS-data from 2019. Layout of the planned wind farm is indicated on the map ("small turbine layout").**

**Table 5-1 Routes in vicinity of Nordre Flint and traffic composition**

| ID | Route name | Route description | Traffic composition (most dominating ships listed) |
|---|---|---|---|
| 1a | Malmö port | Traffic between Kattegat and Malmö port. | Other (30%), general cargo ships (24%) and tug (20%). |
| 1b | Oil terminal Malmö | Traffic between Kattegat and the oil terminal in Malmö port. | Product/chemical tankers (46%), oil tankers (25%) and tugs (16%). |
| 2 | Saltholm Flak North | Traffic between Copenhagen area and ports around Malmö, sailing north of Saltholm Flak. | Tugs (75%), other (11%) and pleasure crafts (8%) |
| 3 | Flintchannel | Traffic in the Flintchannel. | Passenger/roro (32%), Product/chemical tankers (23%) and general cargo ships (21%). |
| 4 | East of Saltholm | Traffic that transits north/south between the planned wind farm and the Saltholm island. | Pleasure crafts (77%) and other (22%). |
| 5 | Lomma | Traffic between Copenhagen area and Lomma Bay, connecting to route 1, 2 and 3. | Pleasure crafts (94%) and other (3%) |
| 6a | Trindelchannel | Traffic between Malmö port and the Øresund Bridge via Trindelchannel. | Other (76%) and pleasure crafts (21%). |
| 6b | Oskarsgrundet | Traffic between Malmö port and the Øresund Bridge, passing Oskarsgrundet. | Other (79%) and pleasure crafts (21%). |
| 7a | Nordre Flint (outer) | Traffic that transits through the wind farm between Copenhagen area and ports in Sweden, mainly Malmö. | Pleasure crafts (98%) |
| 7b | Nordre Flint (inner) | Traffic that transits through the wind farm between Copenhagen area and ports in Sweden, mainly Limhamn. | Pleasure crafts (65%) and fishing vessels (34%) |

Figure 5-3 shows the number of passing ships per route, grouped by ship type. Full details in the traffic composition can be found in Appendix B.

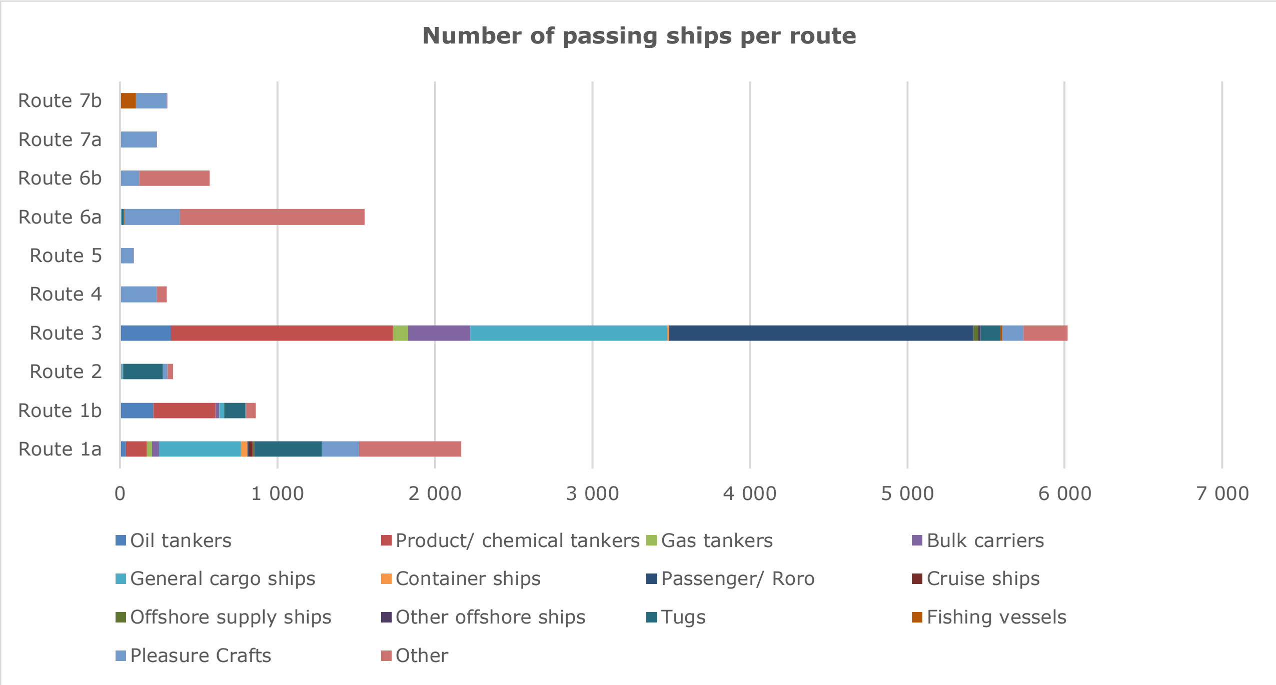



**Figure 5-3 Number of passing ships per route in 2019, categorised by ship type. The order of colour is shown in the label.**

Flintchannel (route 3) is the route with most traffic, which is also the commercial route which is closest to the offshore wind farm. Most of the ships in this route are in the length category 150-200 m (2,383 passing ships/40% share), but there have also been larger ships in the category 200-250 m (904 passing ships/15% share) and 250-300 (49 passing ships/1% share).

VMS data has been used to assess if commercial and recreational fishing vessels are underrepresented in the AIS-data.

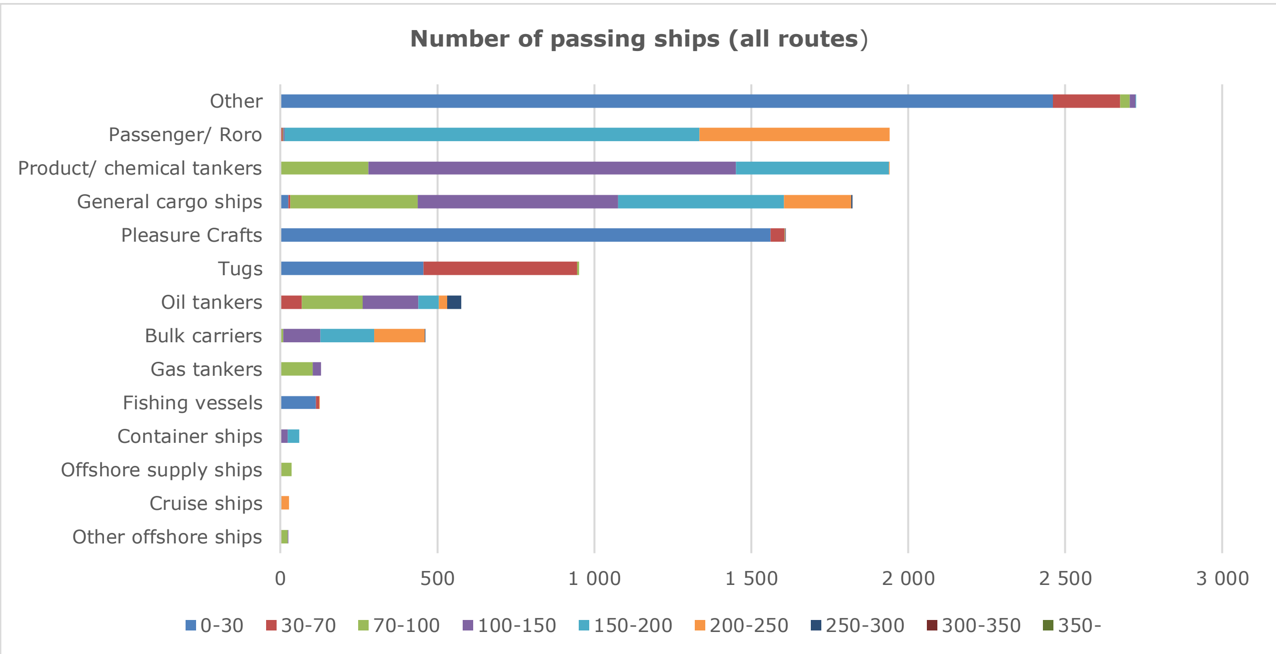



**Figure 5-4 Number of passing ships for all routes in 2019, grouped by ship length (m).**

## 5.2 Hazard identification

The key findings from the hazard identification study are listed in the bullet points below. For full details of the HAZID results we refer to HAZID report for Aflandshage and Nordre Flint offshore wind parks (DNV GL Report No.: 2020-0940) [2].

The key findings are:

- No high risks (unacceptable risks) where identified specifically for Nordre Flint, except from one general high risks hazard (common for both wind farms); powered collision with the turbine from passenger or tanker ships. This impact may in worst case lead to parts of the turbine falling down on the deck and/or results in damages to hull with possibility of water ingress.
- It was requested to move the southern boundary of the feasibility study area (away from the Flintchannel) in the north direction to:
    a) Avoid conflict with commercial traffic in the main route in Flintchannel and to have better space for evasive manoeuvres.
    b) Avoid that pleasure crafts sailing south of the park being re-routed into the main shipping route in Flintchannel.
- The establishment of the turbines will likely make some traffic with smaller vessels to sail west of the wind farm towards Saltholm. This is a shallow area and the water depth measuring around Saltholm is old. It was recommended that new measurements are made and that deep buoys are laid out.
- The Lynetteholm project may lead to changes in ship traffic in the area. The cumulative effect resulting from the final design of the Lynetteholm project is discussed in chapter 5.5.5.
- The establishment of power cables must be notified to seafarers well in advance and a guidance vessel should be present.
- There will be added crossing traffic in the area due to construction work, also in Drogden and Hollænderdybet.

General recommendations, for both wind farms, proposed in the HAZID workshop are part of the safety recommendations in chapter 6.

## 5.3 Frequency analysis

### 5.3.1 Existing conditions (before establishment)

The existing condition represents the case where the offshore wind farm is not established and is meant as a base for comparison in order to assess the impact the wind farm will have on the navigational risk. Figure 5-2 showed the IWRAP model for existing routes (current situation).

The results from the modelling of the current situation (before establishment) are shown in Table 5-2. As seen from the table, grounding is the dominating risk contributor with a calculated frequency of 0.084 groundings per year. This equals to about one grounding every 12 years.

From the HELCOM database we found 5 registered groundings in the period 1989 to 2017, which equals to one grounding every 5.6 years (frequency of 0.18). Comparing IWRAP with real accidents we see that IWRAP is calculating a lower grounding frequency than has been observed the last decades, but still in the same order of magnitude.

Although there is a difference between the IWRAP results and accident statistics registered in HELCOM, this have no practical implications for this study. It is the risk evaluations, comparing the 'before' and 'after' situation (the "delta risk") of the wind farm establishment that is important, i.e. the percentage potential increase in accident frequency.

The areas with the highest grounding risk today are found in the Flintchannel (from the Øresund Bridge and up to the southern part of the planned wind farm), and the waters between Flintchannel and Limhamn, closer to the Swedish mainland. Detailed risk results are provided in Appendix F.

**Table 5-2 Calculated accident frequencies for current situation (before establishment) within the study area. Frequencies are modelled in IWRAP.**

| Accident type | Frequency before establishment |
|---|---|
| Powered grounding | 3.3E-02 |
| Drift grounding | 5.0E-02 |
| **Total grounding** | **8.4E-02** |
| Head-On ship-ship collisions | 6.3E-03 |
| Overtaking ship-ship collisions | 2.2E-03 |
| Crossing ship-ship collisions | 2.4E-03 |
| Merging ship-ship collisions | 7.9E-04 |
| Bend ship-ship collisions | 1.2E-03 |
| **Total ship-ship collisions** | **1.3E-02** |
| Ship-turbine powered collision | -- |
| Ship-turbine drift collision | -- |
| **Total ship-turbine collision** | **--** |

The frequency of ship-ship collisions is calculated to be 0.013, which is about one collision every 78 years. The accidents statistics reveals that there are, in fact, few collisions within our study area. One collision was registered in the period 1989 to 2017, making it one collision every 28 years. However, one event is not sufficient to make a statistical comparison.

There may be several reasons for the low frequency of ship-ship collisions:

- Less traffic compared to Drogden channel, which is the main route through Øresund. There are statistically more collisions in the Drogden channel (outside our study area) compared to Flintchannel and the waters outside Malmö. There are also 4 times more traffic in Drogden.
- Only one main shipping route through the study area, very little crossing commercial traffic and waterways that cross other waterways, i.e. less ship crossing collision candidates.

### 5.3.2 Revised condition (after establishment)

Due to the presence of the offshore wind farm it is assumed that some of the ship traffic must reroute to avoid passing through the farm. The routes used to model these components of the ship traffic in the risk analysis must be adjusted accordingly based on the assumed future behaviour of this traffic – i.e., how far the traffic will tend to relocate.

The revised routeing pattern following construction of the wind farm has been estimated based on the review of impact on navigation. It is assumed that ships will revise their voyage plans in advance of encountering the wind farm due to effective mitigation in the form of information distribution about the development to mariners through Notices to Mariners, updated charts, liaison with ports, etc.

Given the project location, no significant disruption of the major commercial shipping lanes (not including commercial fishing), is expected. However, the traffic that today goes through the wind farm area will need to be re-located. The traffic composition in these routes consist mainly of pleasure crafts, fishing vessels and the ship type category 'other'. As mentioned in section 5.1 the traffic on route 7a and 7b are passing straight through the wind farm area. Some smaller parts of route 4 and 5 is also inside the wind farm area and will hence need to be relocated.

The following bullet points summarizes the revised routing system, as modelled in IWRAP:

- Route 7a (Traffic to/from Copenhagen area connecting to route 3 and traffic that sails between Denmark and Sweden): In the revised model the traffic will keep safe distance to the farm and is assumed to re-route north of the wind farm (revised route 5) and then continue south/east. In total 234 passing vessels is re-routed from route 7a.
- Route 7b (Traffic to/from Copenhagen area connecting to route 3 and traffic that sails between Denmark and Sweden): In the revised model the traffic will keep safe distance to the farm and is assumed to re-route the west side of the wind farm, merging with the revised route 4. In total 300 passing vessels is moved from route 7b.
- Route 4 (Traffic north/south between the planned wind farm and Saltholm): Sails through the north-western part of the wind farm area and is assumed to keep safe distance by relocating further west towards Saltholm. In total 296 passing vessels is moved closer to Saltholm.
- Route 5 (Traffic from/to Copenhagen area connecting to route 1, 2 and 3.): Vessels that sails through the north-eastern part of the wind farm area and is assumed to keep safe distance by relocating further north. In total 90 passing vessels is moved to north side of the wind farm.
- 365 CTV trips to Nordre Flint OWF are added. See detailed CTV route assumption in Appendix A.

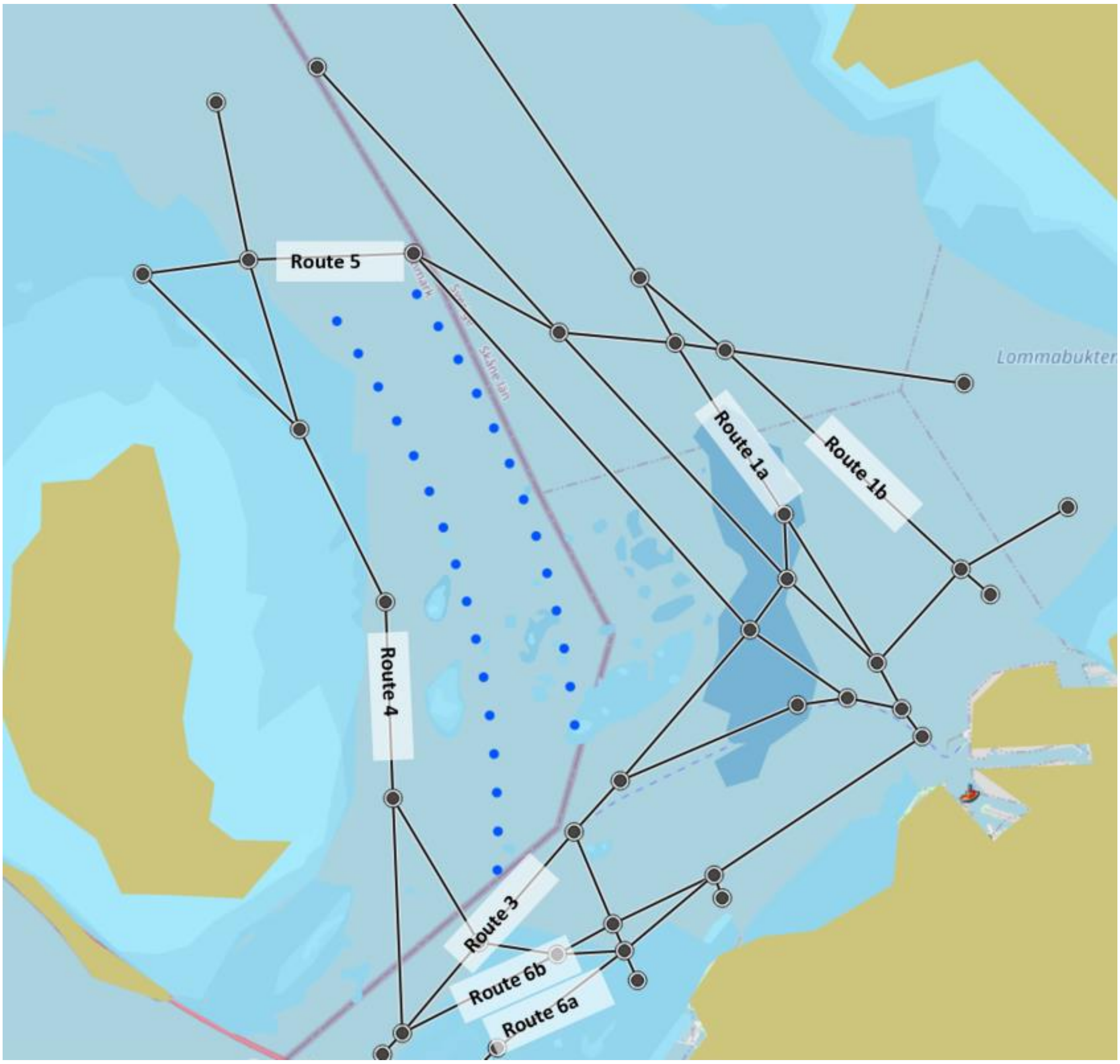



**Figure 5-5 Revised routes due to Nordre Flint OWF.**

**Table 5-3 Accident frequencies, after establishment of Nordre Flint offshore wind farm.**

| Accident type | After establishment |
|---|---|
| Powered grounding | 3.4E-02 |
| Drift grounding | 5.0E-02 |
| **Total grounding** | **8.4E-02** |
| HeadOn ship-ship collisions | 6.6E-03 |
| Overtaking ship-ship collisions | 2.4E-03 |
| Crossing ship-ship collisions | 2.2E-03 |
| Merging ship-ship collisions | 8.2E-04 |
| Bend ship-ship collisions | 1.2E-03 |

| Accident type | After establishment |
|---|---|
| **Total ship-ship collisions** | **1.3E-02** |
| Ship-turbine powered collision | 2.5E-04 |
| Ship-turbine drift collision | 1.9E-04 |
| **Total ship-turbine collision** | **4.4E-04** |

The risk evaluation of the accident frequencies, before vs after establishment of Nordre Flint OWF, are presented in chapter 5.5.

## 5.4 Consequence analysis

There are several potential consequences should a ship-turbine collision occur. The least severe consequence is that a drifting vessel grazes a wind turbine. In this event, there may be minor damage to both the vessel and the turbine. It is likely that all personnel and passengers, and the structures, would not experience any injury or damage. Personnel and crew should in this event have sufficient time to prepare for impact and thereby ensure all persons are in safe locations.

The severity of a striking event generally increases with the speed of impact and size of the vessel. However, smaller vessels like pleasure crafts or fishing vessels may also experience severe damage if striking a wind turbine at speed. A powered striking (i.e., occurring at speed) would likely result in the most severe consequences for both the vessel and the turbine. Worst-case scenario of a powered striking could result in the following:

- Personnel/passenger injury or fatality
- Major damages to the vessel. Damages could potentially be so severe that vessel foundering is possible. Damages could also result in a release of cargo.
- Major damages to the wind turbine and/or foundation.

Although potential consequences have the possibility of being severe, it is important to also consider the frequency of powered striking when considering the risk. Resulting frequency of any wind turbine striking, as presented in Table 5-3, is 4.4E-04. This event has a return period of 1 in every 2,290 years.

## 5.5 Risk evaluation

Table 5-4 summarises the calculated accident frequencies, before and after establishment of Nordre Flint offshore wind farm. The following chapters discusses the results of each of the accident types; grounding, ship-ship collision and ship-turbine collision. The evaluations focus on the numerical outputs from the model, i.e. the accident frequencies.

**Table 5-4 Accident frequencies, before and after establishment of Nordre Flint OWF.**

| Accident type | Before establishment | After establishment | Difference (after vs before) | |
|---|---|---|---|---|
| Powered grounding | 3.3E-02 | 3.4E-02 | 7.0E-04 | 2.1% |
| Drift grounding | 5.0E-02 | 5.0E-02 | 2.0E-04 | 0.4% |
| **Total grounding** | **8.4E-02** | **8.4E-02** | **9.0E-04** | **1.1%** |
| HeadOn ship-ship collisions | 6.3E-03 | 6.6E-03 | 2.3E-04 | 3.6% |
| Overtaking ship-ship collisions | 2.2E-03 | 2.4E-03 | 2.2E-04 | 10.0% |
| Crossing ship-ship collisions | 2.4E-03 | 2.2E-03 | -1.3E-04 | -5.6% |
| Merging ship-ship collisions | 7.9E-04 | 8.2E-04 | 2.6E-05 | 3.2% |
| Bend ship-ship collisions | 1.2E-03 | 1.2E-03 | 1.6E-05 | 1.4% |
| **Total ship-ship collisions** | **1.3E-02** | **1.3E-02** | **3.6E-04** | **2.8%** |
| Ship-turbine powered collision | -- | 2.5E-04 | -- | -- |
| Ship-turbine drift collision | -- | 1.9E-04 | -- | -- |
| **Total ship-turbine collision** | **--** | **4.4E-04** | **--** | **--** |

The consequences of a ship-ship collision or grounding event are the same regardless of the wind farm establishment. The consequence of a collision with the wind turbine is dependent on collision angle, the vessel type, size of vessel and the vessel speed. The qualitative consequence descriptions were given in the previous chapter (chapter 5.4).

### 5.5.1 Ship-turbine collision risk during operation

The presence of the offshore wind farm is assumed to result in that some of the ship traffic will relocate to avoid passing through the offshore wind farm. The routes used to model these components of the ship traffic in the frequency analysis is adjusted accordingly based on the assumed future behaviour of this traffic i.e. how the traffic will tend to relocate. In the analysis it is assumed that ship traffic will not travel through the farm.

The accumulated results for the entire offshore wind farm are presented in Table 5-4. It shows the frequency and return period for the two scenarios (powered/drifting collision), as well as the combined sum for the two.

The ship-turbine accident frequencies are the lowest of all the accidents, with an annual frequency of 4.4E-4. This is equivalent to a collision happening 1 in every 2,286 years. It is noted that the calculated collision frequencies cover all cases of collision, i.e., both minor collisions as well as severe collisions where repair of ship is needed before the ship can continue its planned journey.

The routes that have the highest contribution to the ship-turbine collision frequency are:

- Traffic in route 7a that was re-routed north and east of the wind farm. Here, leg 95 which is the main leg east off the wind farm, contributed with 32% of the accident frequency. Also, the traffic north of the wind farm will contribute to this, even do this is does not show up in the results as any particular contribution.

- Traffic in the Flintchannel (mainly leg 70) has a 21% contribution to the accident frequency, mainly due to drifting collisions. The commercial traffic in this route will have increased attention and focus from all bridge resources due to shallow waters and the Øresund Bridge.
- Traffic in route 4, that after the establishment merged with traffic in route 7b. Here, leg 96 which is the main leg west off the wind farm, contributed with 11% of the accident frequency. There are several grounds nearby, e.g. Nordre Flint, Bjørnen, and shallow waters outside Saltholm. Therefore, vessels may ground rather than hit the turbines.

The ship types that have the highest contribution to the ship-turbine collision frequency are: Pleasure crafts (48%), other (16%), product/chemical tankers (9%), passenger/roro (8%) and general cargo (8%). The risk for smaller vessel (e.g. pleasure crafts) is very much related to poor visibility and the fact that these vessels may have less navigational equipment and instruments onboard. The larger the ships, the more resources (officers) are likely to be present on the bridge, and more requirements are put on competence, training, navigational equipment and Bridge Resource Management (CRM).

In the HAZID and the risk assessment there has been special attention on wind turbine WTG 16, which is the turbine that is closest to a commercial shipping lane, see Figure 5-6. The key findings from the assessment of this structure are:

- WTG 16 is the turbine which will have most passing vessels (compared to other routes within the study area); 6,019 vessels used this route in 2019 (that is traffic both ways).
- WTG 16 will have large ships passing, historically up to 300 m in 2019. The draft limitation of 8.0 m in the Flintchannel is limiting larger ships to use this channel.
- The distance from WTG 16 to the outer line of the Flintchannel is about 350 m, which equals to 1.2 ships length (using the ship with max length of 300 m).
- Officers on watch sailing this channel will have great attention and focus due to the very shallow waters on both sides. There are also fixed structures (lateral marks with light) at two locations in the Flintchannel. As seen in Figure 5-6, is also a photo of one of the ropax vessels passing one of the starboard hand lateral marks.
- The bathymetry (water depths) and navigational structures around WTG 16 will most likely not “stop” a ship from hitting WTG 16, or nearby turbines ,except the northmost lateral structure No 5 in Figure 5-6 (the most northern green lateral mark) since the depth in the area is around 7.0 m (based on nautical charts).
- Traffic in the Flintchannel (leg 70) has a 21% contribution to the ship-turbine accident frequency. The traffic is dominated by passenger/roro, product/chemical tankers and general cargo ships. Traffic density plot is shown in Figure 5-7.
- It will be less space for evasive manoeuvres. However, this channel does not have much space for evasive manoeuvres, as it is already shallow waters on each side.
- There several other “objects” (lateral marks) and grounds that have “zero” distance to the outer boundary of the Flintchannel (see blue arrows in Figure 5-6.
- The calculation of risk for the Flintchannel (legs 12, 13, 38 and 70 combined), based on the “small turbine layout”, shows a ship-turbine collision frequency of 1.2E-04, which equals to one accident every 8 000 years.

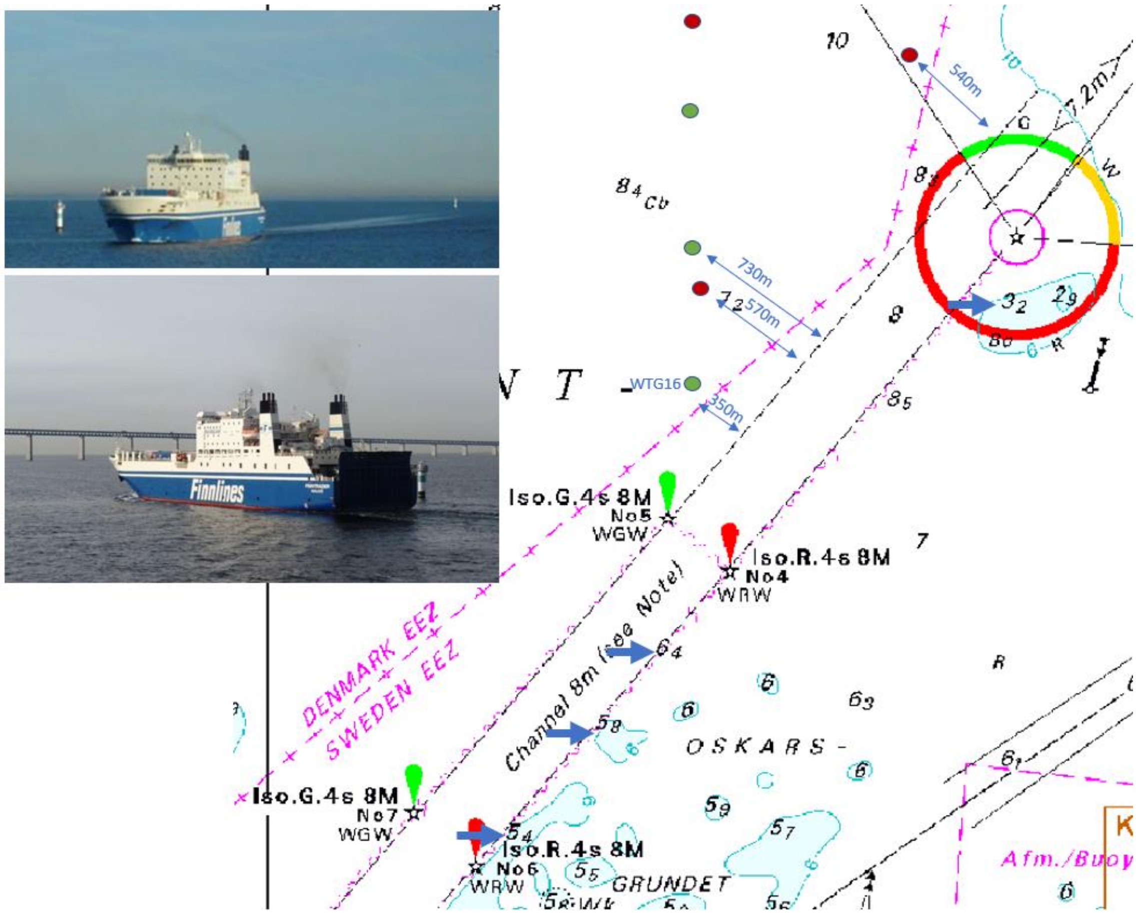



**Figure 5-6 Nautical map for area around WTG 16 and the Flintchannel. Inside the figure is also a photo of a ropax vessels passing the starboard lateral marks, sailing towards the bridge.**

It is also noted that the distance between other offshore wind farms in the region and main commercial shipping lanes are; Distance from Flintchannel to Lillgrund offshore wind farm is about 930 m (and in between it is shallow waters of only 3 m depth), distance from Middelgrund offshore wind farm to the channel in Hollænderdybet is about 480 m (also “protected” by shallow waters of only 3m depth).

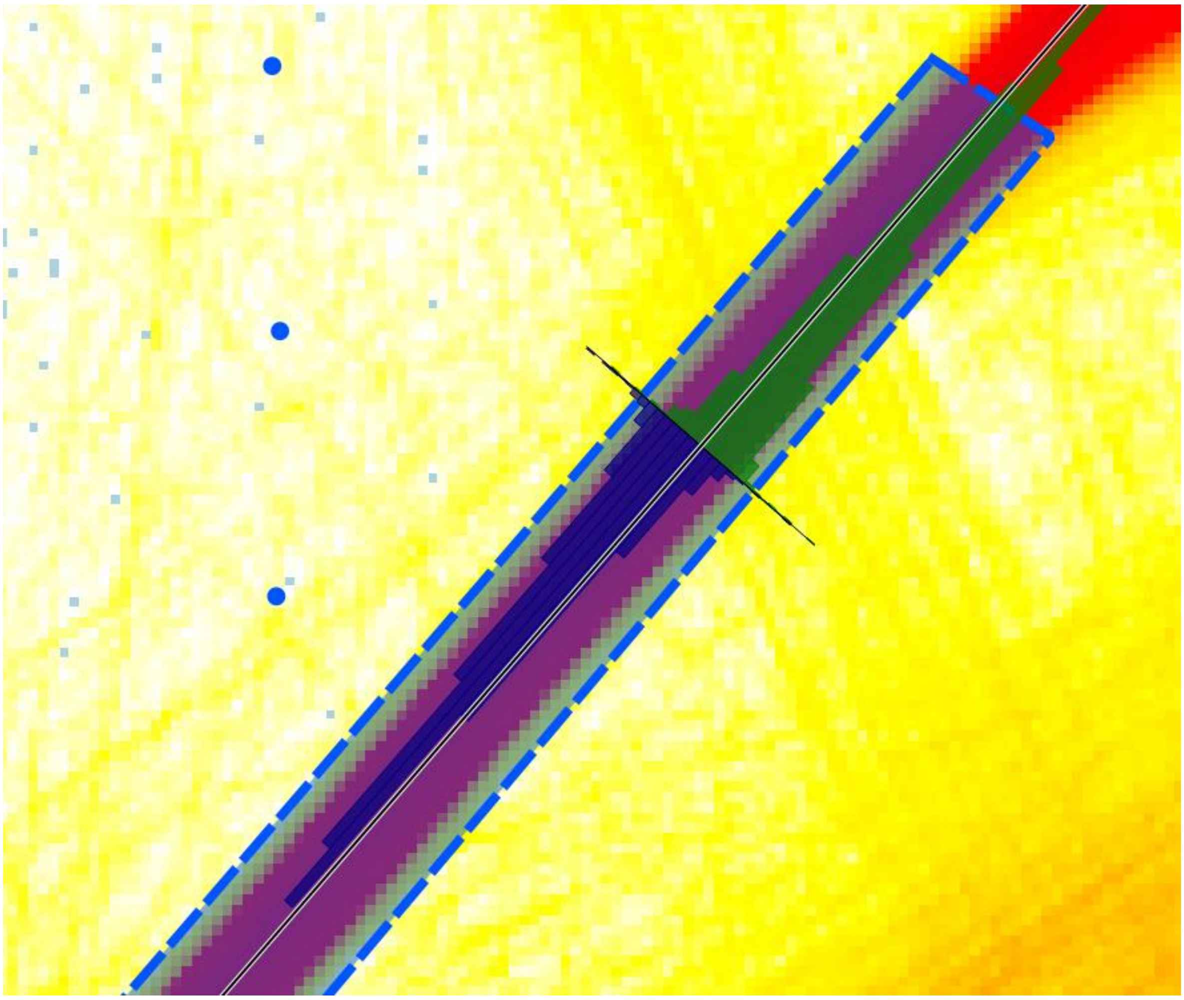


**Figure 5-7 Traffic density plot showing the lateral traffic distribution in the Flintchannel. The outer boundaries of the 8m Flintchannel is marked with dotted blue line.**

A risk contributor to the ship-turbine collision frequency is also the crew transfer vessels when they sail to and from the wind farm turbines. IWRAP is not able to model the patterns of the CTV in-between the wind turbines, but the voyages to/from port to the wind farm is included in the model. The latest ship-turbine collision accident was in April 2020 when a CTV hit a turbine in the North Sea, seriously injuring one crew member and harming another two. The risks should be mitigated with good operating procedures and crew training.

For the remaining routes and legs, it is evident that the commercial vessel traffic is largely undisturbed by the presence of the wind farm with regards to risk of ship-turbine collision.

### 5.5.2 Ship grounding risk

It is calculated that the total grounding frequency after establishment is 8.4E-02 (12 years between accidents), increasing 1.1% from today's situation, mainly due to that some of the pleasure craft traffic will be forced to sail in between Saltholm and the wind farm to take the shortest route, closer to grounds and shallow waters outside the Saltholm. The added risk can be mitigated by following measures for the waters west of the planned wind farm:

- Improved marking of the area
- Establish 'recommended route(s)' for smaller vessels
- Improved depth measurements

### 5.5.3 Ship-ship collision risk

It is calculated that the ship-ship collision frequency will increase by 2.8% due to the establishment of the wind farm. After the establishment, the ship-ship collision frequency is 1.3E-02 which yield a return period on 76 years between accidents.

The primary reason why the accident frequency increase is because of the CTV voyages to/from the wind farm. Here it must therefore be mentioned that the number of trips added, and the choice of route, was a conservative estimate.

The risk increase due to that some ship traffic will need to relocate and merge into other waterways to avoid passing through the offshore wind farm is generally negligible.

### 5.5.4 Risk during construction and decommissioning

The number of vessels that operate in construction and decommissioning phases is generally expected to only have a small risk addition to current traffic.

The vessels that are anticipated to be present during construction include construction barges, support tugs, jack-up rigs, supply/crew vessels and cable laying vessels. These vessels will also be present in the region during decommissioning. It is likely that approximately 10-15 vessels (including support vessels) may be on site at any time during the construction phase. Construction vessels are anticipated to be sailing at very low speeds through the construction zone.

The highest navigation risk during construction will be:

- Cable laying barges crossing Hollænderdybet and Kongedybet during installation of grid connection cables. There is high traffic density in Hollænderdybet and Kongedybet and a procedure for safe voyages should be made for the construction work in dialogue with VTS and pilots. Re-routing of traffic via Flintchannel may also be investigated (if possible, in limited periods during critical cable laying operations).
- Smaller vessels operating in close proximity to construction and work vessels during construction. However, this risk is mitigated by safety zones that is anticipated to be implemented during construction operations. The safety zones are expected to prohibit "third party vessels" from entering into, transiting through, mooring, or anchoring within safety zones.

It is assumed that 500m safety zones will be established during construction around each location where the towers, nacelles, blades and subsea cables will be installed in navigable waters. However, the exact safety zone radius will be agreed with the DMA prior to construction. The intention of establishing safety zones is to safeguard mariners from the hazards associated with construction of the wind farm.

## 5.5.5 Qualitative assessment of potential cumulative impacts and effect on SAR

The previous evaluations have considered the proposed project in isolation. Under this section the potential cumulative and in-combination impacts on shipping (of any nearby developments in the area) will be reviewed. This will include any proposed developments not yet constructed, but scoped, within the area. An increased navigational risk due to cumulative effects in the area has been assessed.

The Nordre Flint wind farm is relatively far away from the two other existing wind farms in the Øresund-region; Lillgrund OWF and Middelgrunden OWF. Lillgrund OWF is located about 6 km off the coast of southern Sweden, just south of the Öresund Bridge. From Nordre Flint to Lillgrund is about 10 km distance (edge to edge). Middelgrunden OWF is located 3.5 km outside Copenhagen, about 9 km from Nordre Flint (edge to edge).

The planned Aflandshage offshore wind farm is located approximately 22 km from Nordre Flint.

Based on the distances between the wind farms and the traffic patterns/routes we see no cumulative effects that would affect the navigational risk near the Nordre Flint, or the other offshore wind farms, in any negative way.

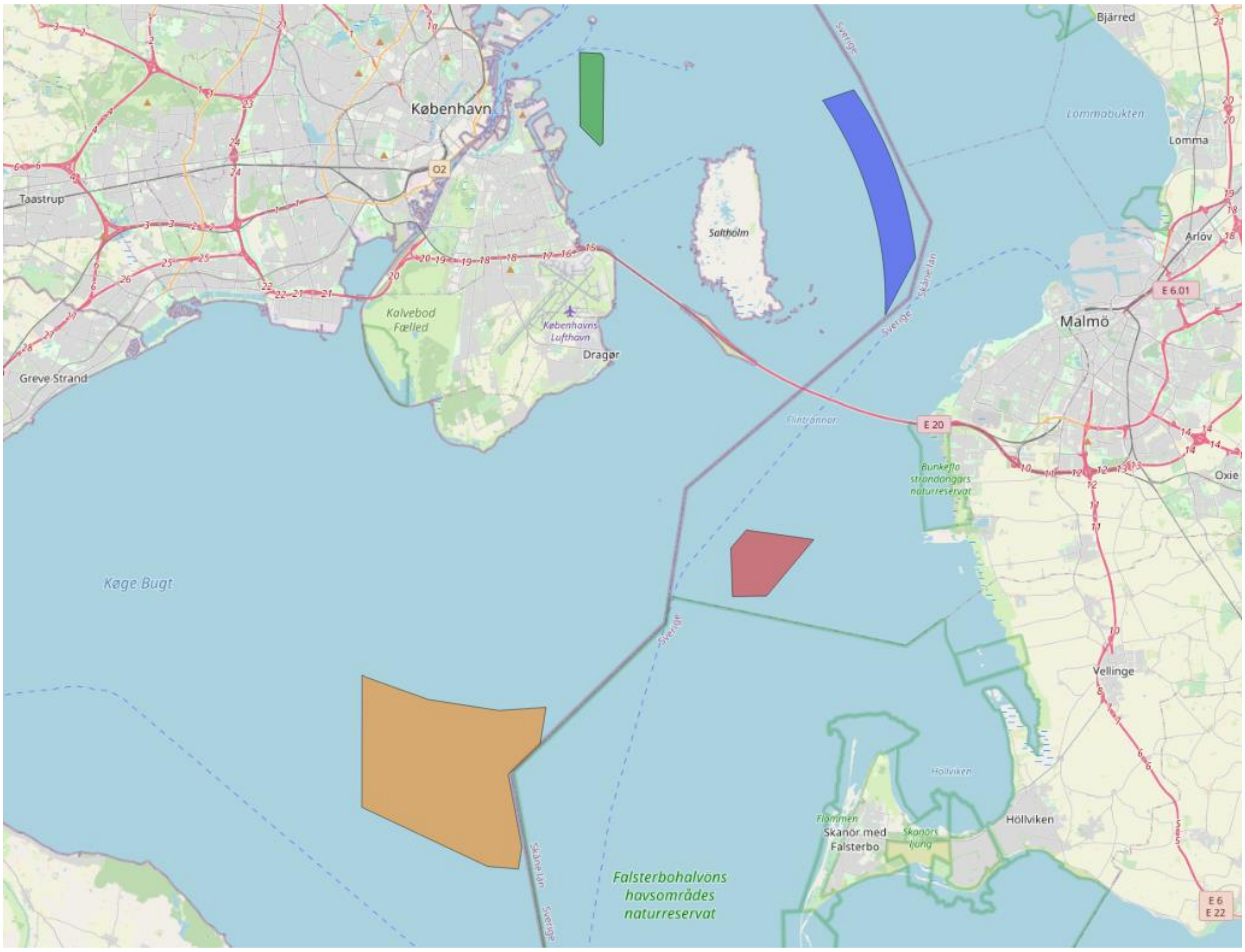



**Figure 5-8 Boundaries of wind farms: Blue: Nordre Flint (planned), red: Lillgrund (existing), green: Middelgrunden (existing) and orange: Aflandshage (planned).**

Furthermore, the Lynetteholm project is confirmed to be established. This project will increase the land area at the Port of Copenhagen, between Kronløbet, Refshaleøen and Middelgrund, by extending Refshaleøen. The land extension is shown as a pink polygon in Figure 5-9, together with the cable corridor area for Nordre Flint OWF (green polygon).

**Figure 5-9 Boundaries of Lynetteholm OWF in pink, and the cable corridor area for Nordre Flint OWF in light green.**

As shown in the figure, Lynetteholm will be located northwest of Middelgrunden OWF, and thus more than 9 km away from Nordre Flint OWF. Due to the relatively long distance between Lynetteholm and Nordre Flint OWF, no cumulative effects are expected with any negative impacts to the navigational risk around the OWF itself.

A very small portion of Lynetteholm overlaps with Nordre Flint OWF's cable corrifor, as seen from Figure 5-9. This needs to be considered when finalizing the cable corridor layout for the wind farm.

Also, the sailing pattern to, from, and through Copenhagen Port will be affected by the establishment of Lynetteholm. Rambøll carried out an EIA for the Lynetteholm project in 2020, including an assessment of the impact from Lynetteholm on the ship traffic /12/. A ship traffic density for commercial shipping based on AIS data from 2018 can be found in Rambøll's assessment and is depicted in Figure 5-10. The EIA and ship traffic assessment summarizes that there will be an impact to both the commercial shipping and pleasure craft traffic in the area. However, only local impact is expected, and the navigational risk in the Nordre Flint OWF area will thus not be affected.

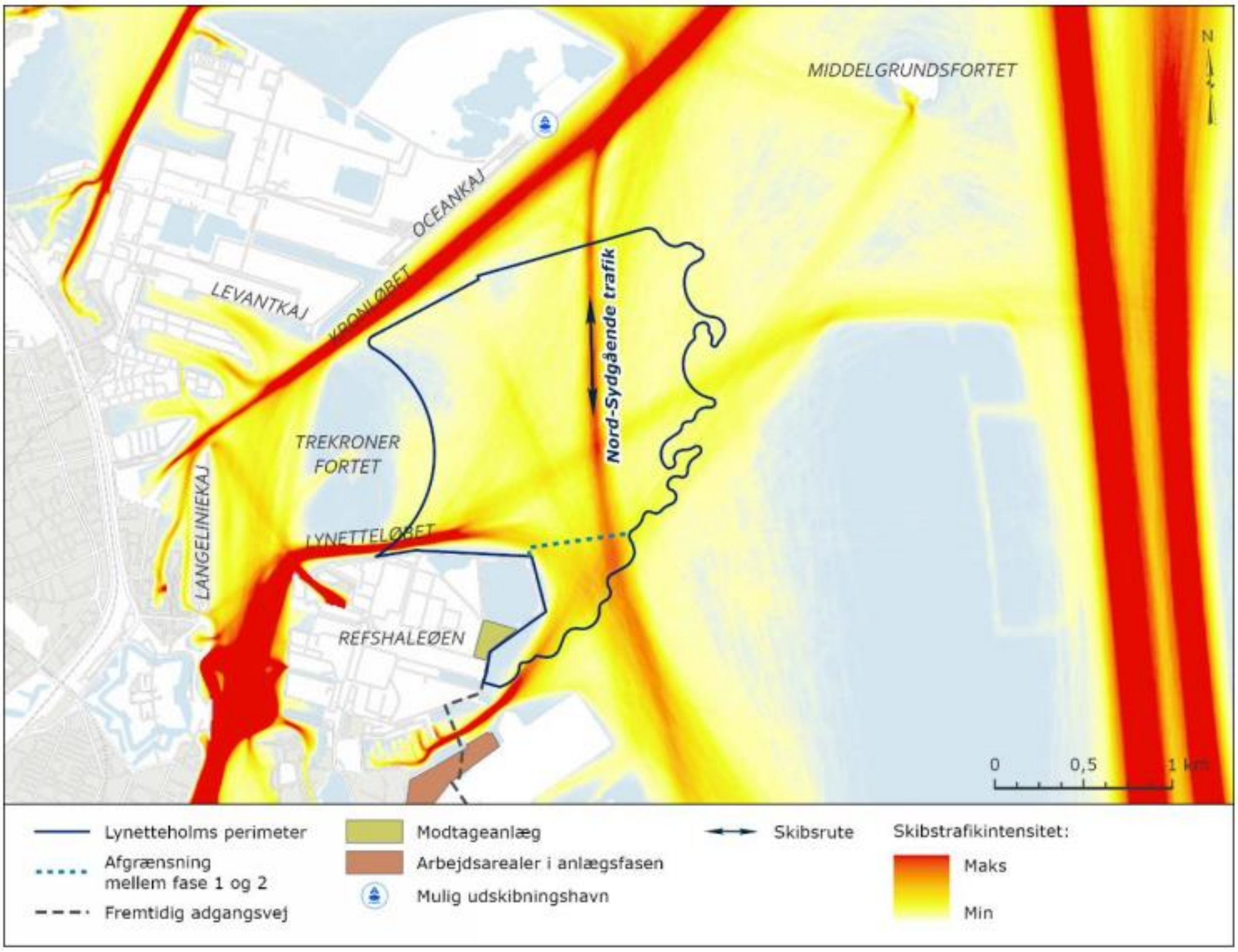



**Figure 5-10 Traffic density plot of commercial shipping traffic based on AIS-data from 2018, from Rambøll (2020) /12/.**

Lastly, no significant disruption of Search and Rescue (SAR) operations at sea is expected, as the spacing between the turbines (approx. 500 m) and the minimum distance between the Highest Astronomical Tide (HAT) and the lower wing tip (approx. 20 m) will allow for rescue boats to sail in between turbines and through the wind farm.

## 5.5.6 Assessment of cable interaction with ship traffic

Anchoring, emergency anchorage or trawling activity with bottom gear near proposed cable route(s) could potential interaction with the power cable. Therefore, a high-level review of potential cable impacts from was carried out using the available AIS and VMS data covering the proposed cable route.

### Dropped or dragged anchor

Figure 4-9 shows the density of traffic above the power cable. Typical cable interaction hazards related to the ship traffic are:

- Sinking vessels

- Dragged anchors
- Dropped anchors
- Dropped objects (e.g., containers).
- Grounding vessels

Sinking vessels, dropped anchor or object directly above the power cable is a very unlikely event, thus considered negligible risk contribution. The probability that a ship will sink is equal to 5.1E-9 per sailed nautical mile [9]. Due to the shore power cable is suggested to be dredged into the seabed and the water depths in the area, grounding/contact to cables are also assumed negligible.

The dragged anchor scenario could result as a consequence of two events:

- Anchoring in an emergency situation (emergency dragged anchor).
- Uncontrolled drop of the anchor (accidental dragged anchor).

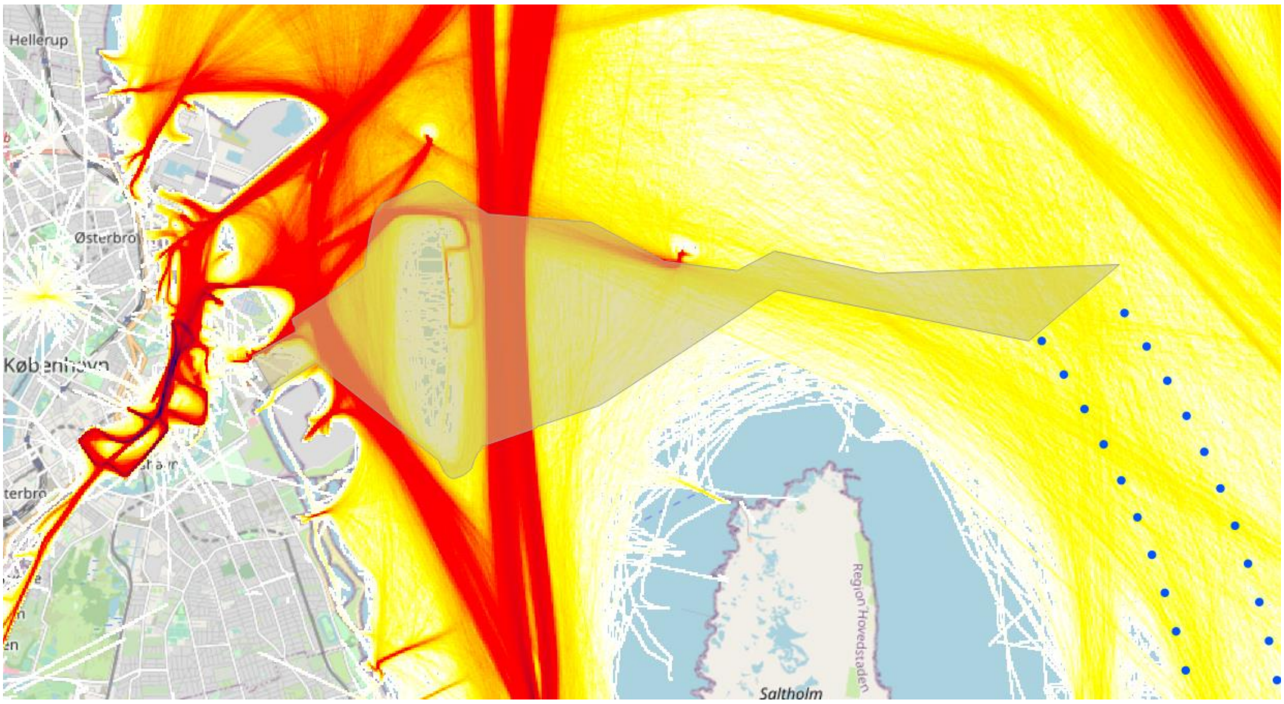



**Figure 5-11 Density of traffic above the Nordre Flint power cable corridor (light grey).**

Power cables will be clearly marked in charts. However, in emergency situations a vessel drifting towards shore or a turbine may attempt to anchor to reduce the risk of collision or grounding. Cables should therefore be buried to a sufficient depth to avoid being uncovered. Where power cables cannot be sufficiently buried, it is important that alternative types of cable protection are considered

Di Padovaa et.al. found, based on [6] and [7], that the frequency of anchors lost (events/ship/year) vary between 0.01 to 0.005 events/ship/year [8]. A frequency of 0.005 corresponds to 1 anchor lost every 150 ship per year). This must therefore be considered as a very 'low frequency event'.

## Fishing activity

AIS data from 2019 and VMS data from Fiskeristyrelsen for the years 2010 to 2019 are used to assess the fishing activities in both the offshore wind farm area and the corresponding cable route.

The AIS and VMS data[10] was filtered to only include data points where the vessels have been sailing with a speed equal to or below 5 knots, as this is assumed the threshold for trawling and net activities. A visual representation of the VMS data points is shown in Figure 4-10.

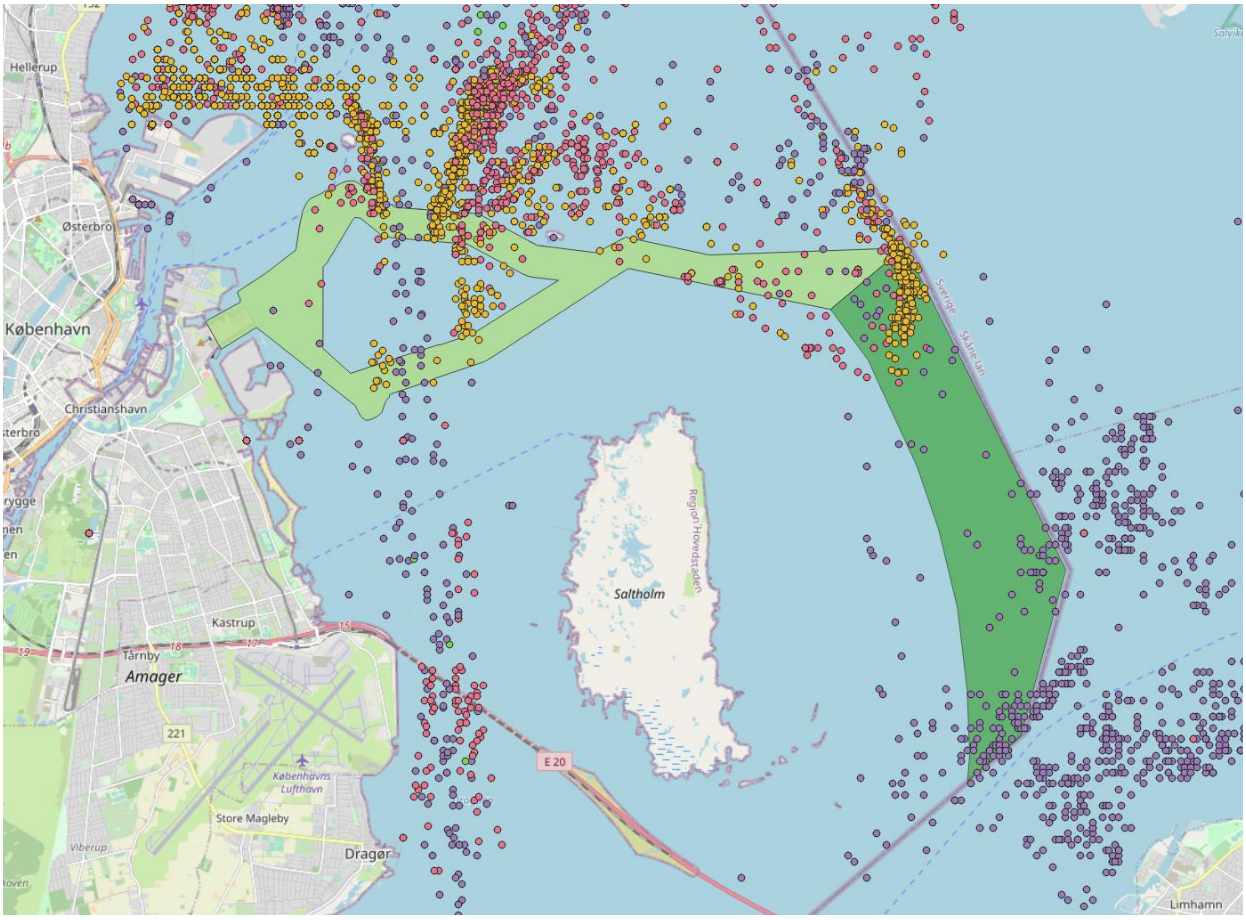



**Figure 5-12 Visual representation of fishing activities from VMS data for the area around Nordre Flint offshore wind farm from 2010-2019. Green points: Fishing with trawl. Pink points: Fishing with net. Yellow points: Fishing with traps. Purple points: Fishing with unknown equipment.**

Fishing activities are observed in both the south and north part of the windfarm area. The cable corridor is indicated in light green colour, and relatively high fishing activity can be seen in the northern part of the area, as well as some activity that crosses the entire cable corridor area in the north/south direction.

In terms of fishing equipment reported, there is relatively equal distribution of fishing with net (pink point) and fishing with traps (yellow points) in the area north of Saltholm. Most of the fishing activities south and southeast of the windfarm area have been reported without specifying type of equipment (purple points).

[10] Note that for VMS data: For the years 2010 and 2011 vessels of length 15 meters or longer are included, while for the data points from 2012 to 2019 vessels from 12 meters are included.

Trawling has been illegal in some parts of Øresund since 1932 to prevent fish stocks being depleted. This means that the green points in Figure 5-12 must be either wrong registration of fishing activity in the WMS data, illegal fishing, or simply fishing vessels sailing at low speed (not performing fishing).

Further, a simple analysis of the 2019 AIS data were performed to compare AIS data to the VMS data. In Figure 5-13 AIS tracks for the year 2019 from fishing vessels sailing with speed equal to or below 5 knots are presented. It is clear that both the VMS data and the AIS data show similar pattern when considering fishing activity. There are several tracks crossing the western part of the planned cable corridor, in Hollænderdybet and Kongedybet. Additionally, a relatively high density of fishing vessel tracks is observed in the northern part of the windfarm area.

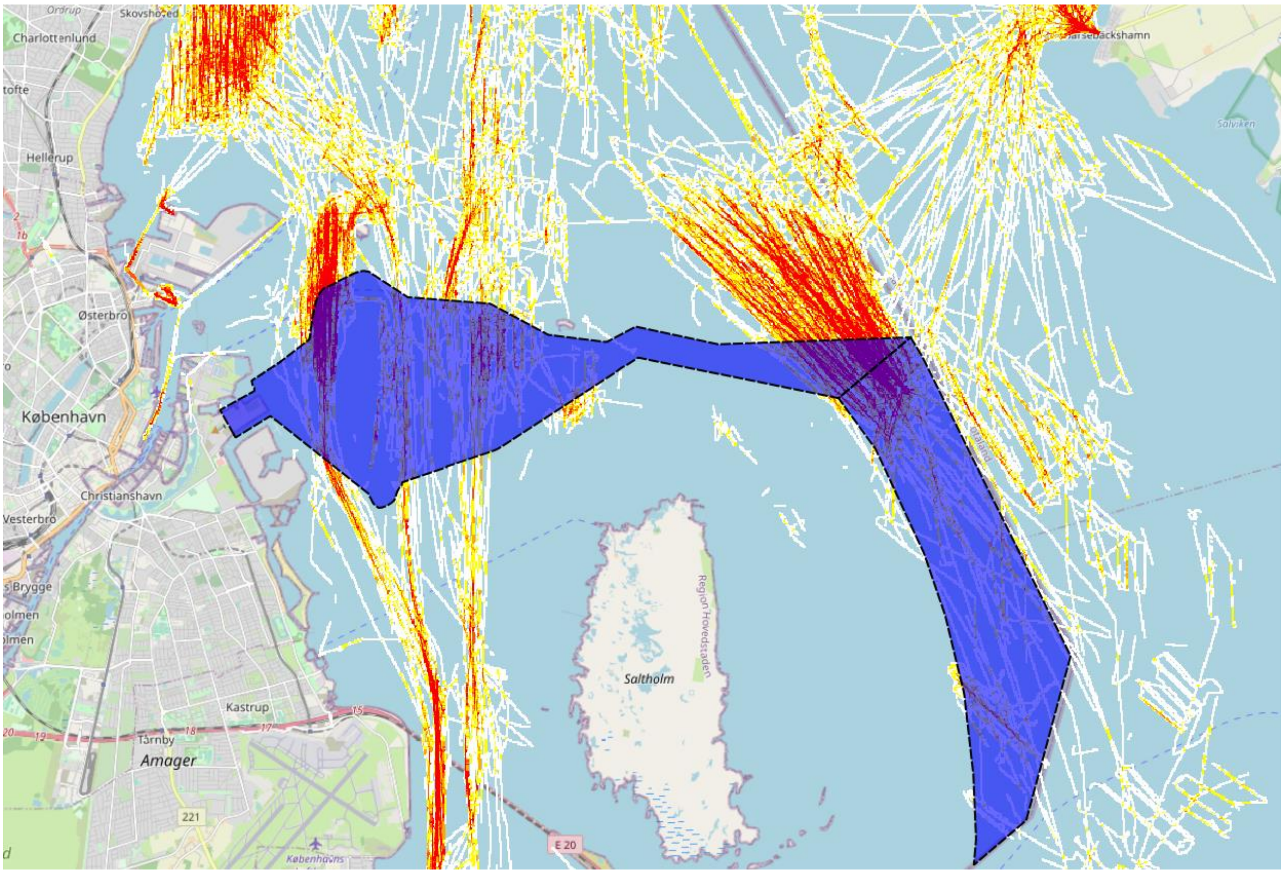



**Figure 5-13 AIS tracks from fishing vessels sailing with a speed below 5 knots (2019)**

Lastly, the VMS data was also analysed in terms of yearly activity. Figure 5-13 shows the same VMS points as presented above, however with a colour legend that represents the respective years. The lightest blue colour represents the year 2019, and these points correspond well with the filtered AIS data for the same year.

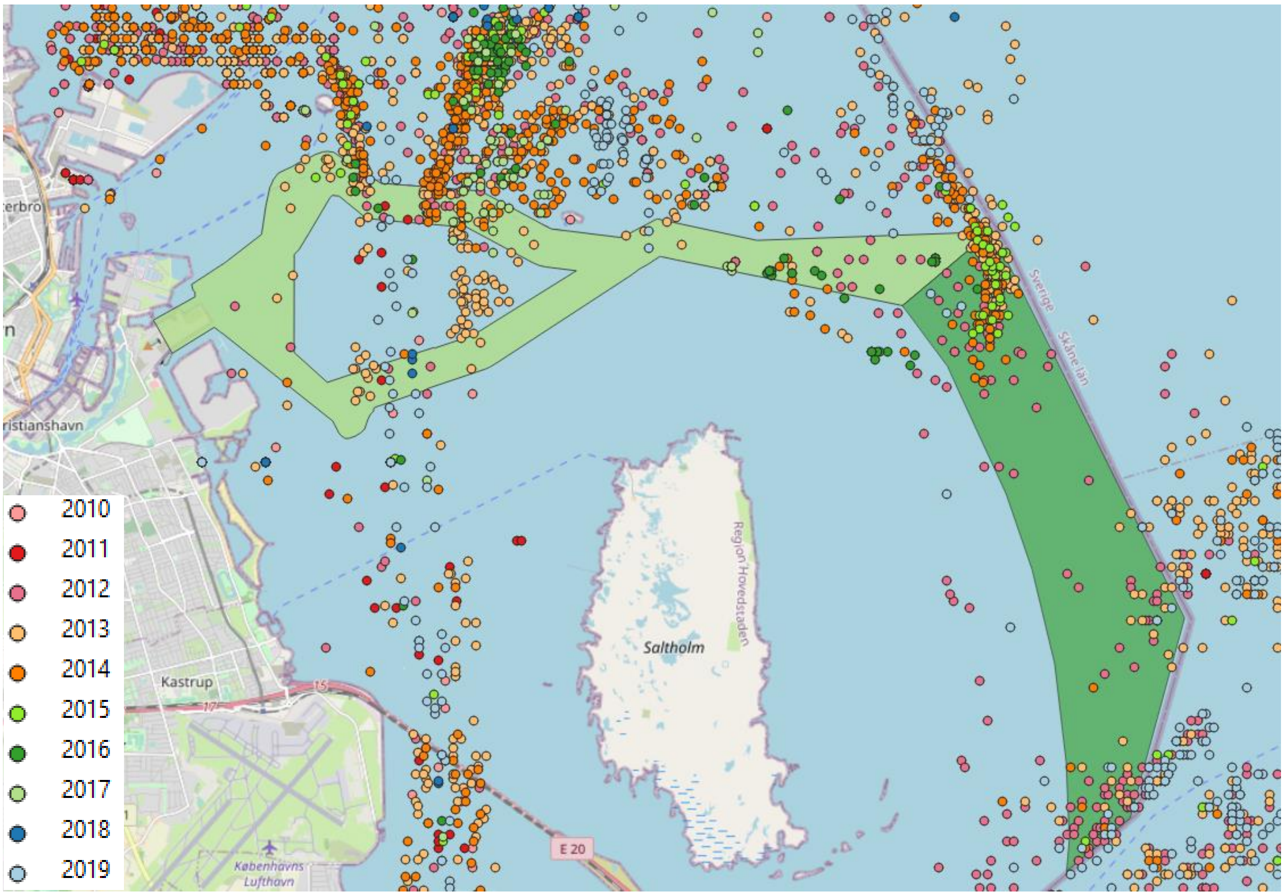



**Figure 5-14 VMS data from 2010 to 2019, with colour legend representing each respective year.**

# 6 CONCLUSION AND RECOMMENDATIONS

### Aflandshage offshore wind farm

No significant disruption of the normal commercial traffic patterns is expected during construction, operation, or decommissioning. The traffic that will be most affected by the offshore wind farm is sailings between Drogden and Stevns area, mostly dominated by pleasure crafts, and traffic between Avedøre and waters off Falsterbo area, mostly general cargo ships. These vessels will need to keep safe distance by re-routing around the wind farm.

The total change in accident frequency due to the wind farm establishment is low; 2.9 % increase for ship-ship collision and an 3.3 % decrease in frequency for grounding. The primary reason why the accident ship-ship frequency has increased is because of the merged traffic and the CTV voyages to/from the wind farm is also contributing to the increased frequency. The cause of decrease in grounding frequency is mainly that some of the traffic that sailed through the wind farm area, passing the coast of Stevns is now routed closer to the middle of the sound between Denmark and Sweden (because they need to re-route east of the wind farm). Further distance from the coast means reduced grounding risk (powered and drifting).

Based on the distances between the wind farms and the traffic patterns/routes, we see no cumulative risk effects that would affect the navigational risk near the Aflandshage OWF, or the other offshore wind farms in the region, in any negative way.

The ship-turbine accident frequencies are the lowest of all the accidents, with an annual frequency of 1.02E-3. This is equivalent to a ship-turbine collision happening 1 in every 984 years. The traffic that contributes most to this risk is traffic in southbound TSS lane, dominated by general cargo ships, passenger/roro and product/chemical tanker.

In the HAZID and the risk assessment there has been special attention on wind turbines close to the southbound TSS lane. The turbines in the eastern edge of the wind farm area are located close to busy traffic lanes; 1,874 passing vessels in route 1b and 11,804 passing vessels in route 1aS in 2019. The distance from the turbines on the edge of the wind farm area to the outer edge of the southbound TSS is about 1,240 m. However, although the distance from the turbines to the southbound TSS (edge to edge) is 1,240 m, the vast majority of the ships sails closer to the separation zone (separating southbound and northbound lanes) with a distance of about 2,050 m. Traffic in southbound TSS (including the traffic in route 1b) has a 66% contribution to the ship-turbine accident frequency. The calculation of risk for the southbound TSS (legs 9, 10 and 11 combined), based on the "small turbine layout", shows a ship-turbine collision frequency of 6.7E-04, which equals to one accident every 1,485 years.

Note that one light buoy (recording station) and one pilot mark will need to be moved. Danpilot has tentatively indicated the new position of the pilot mark to the west of the wind farm area.

## Nordre Flint offshore wind farm

No significant disruption of the normal commercial traffic patterns is expected during construction, operation, or decommissioning. The types of vessels that will be most affected by the offshore wind farm is pleasure crafts and fishing vessels. These vessels will need to keep safe distance by re-routing around the wind farm.

The total increase in accident frequency due to the wind farm establishment is low; 1.1% increase for grounding and 2.8% for ship-ship collisions. However, pleasure crafts sailing the waters between the wind farm and Saltholm will experience an increase in grounding frequency. Therefore, risk mitigation measure should be evaluated for this traffic, see recommendations proposed below. Increase of ship-ship collision is very low and is due to CTV trips to/from the wind farm.

Based on the distances between the wind farms and the traffic patterns/routes, we see no cumulative risk effects that would affect the navigational risk near the Nordre Flint or Aflandshage, or the other offshore wind farms in the region, in any negative way.

The ship-turbine accident frequencies are the lowest of all the accidents, with an annual frequency of 4.4E-4. This is equivalent to a ship-turbine collision happening 1 in every 2,286 years. The traffic that contributes most to this risk is pleasure crafts (that needed to re-route around the wind farm) and traffic in the Flintchannel, mostly dominated by passenger/roro, oil product/chemical tankers and general cargo ships.

In the HAZID and the risk assessment there has been special attention on wind turbine WTG 16, which is the turbine that is closest to a commercial shipping lane in Flintchannel. It was found that this is a route with relatively high traffic volume (6,019 passing vessels in 2019) and the distance from WTG 16 to the outer line of the Flintchannel is about 350 m, which equals to 1.2 ship lengths (using the ship with max length of 300 m). However, the officers on watch sailing this channel will have great attention and focus due to the very shallow waters on both sides. There are also fixed structures (lateral marks with light) at two locations in the Flintchannel, as well as grounds that have "zero" distance to the outer boundary of the channel. The calculation of risk for the Flintchannel only, based on the "small turbine layout", shows a ship-turbine collision frequency of 1.2E-04, which equals to one accident every 8,000 years.

Although the frequency of ship-turbine collision is low it should be noted that the presence of the wind turbines that are close to Flintchannel may lead to less space for evasive manoeuvres. IWRAP is not fully capable of taking this into consideration in the risk modelling. However, there is not a lot of space already due to shallow waters on each side and the lateral marks/structures.

It is also noted that the distance between other offshore wind farms in the region and main commercial shipping lanes are; Distance from Flintchannel to Lillgrund offshore wind farm is about 930 m (and in between it is shallow waters of only 3 m depth), distance from Middelgrund offshore wind farm to the channel in Hollænderdybet is about 480 m (also "protected" by shallow waters of only 3m depth).

One cardinal mark (east mark) in the wind farm area will need to be moved.

### For both wind farm projects (Aflandshage and Nordre Flint OWF)

No significant disruption of Search and Rescue (SAR) operations at sea is expected, as the spacing between the turbines (approx. 500 m) and the minimum distance between the Highest Astronomical Tide (HAT) and the lower wing tip (approx. 20 m) will allow for rescue boats to sail in between turbines and through the wind farm.

According to the terminology used in the Environmental Impact Assessment (EIA) for degree of impact, the establishment of the wind farms is assessed to categorize into the lowest impact category ('low'). This assessment is valid for both the small and large wind farm layouts.

The frequency assessment is calculated based on the most conservative layout ('small turbine layout') for both wind farms, meaning that the 'large turbine layout' is expected to have lower, or at least equivalent level of risk.

### Proposed risk reducing measures (for both offshore wind farms)

The following measures are proposed during the HAZID and risk assessment:

- VTS-Øresund pointed out that there may turn out to be radar interference, radar shadow, false echoes, lost echoes, etc. - contributing to lack of surveillance and insufficient situational awareness. Radar interference can only be assessed with sufficient accuracy when the final decision has been made on the design and layout of the park (number of turbines, location, height, etc.) when allocating establishment permits. An example; a radar analysis was made for the Sprogø turbines, which resulted in the installation of additional radar for the VTS Great Belt.
- The design of the wind farm, as well as the construction, should be done in such a way that the ship traffic primarily bypasses, i.e. does not sail through the wind farm area. Aids to navigation (marking in charts, buoys, light etc.) around the construction areas should be established earlier than the actual start-up of the construction, in order to provide greater awareness and knowledge of the construction work. This may also counteract the lack of updating of charts on ships.
- In addition, there should be early notifications, including posters and send-outs about the construction work targeting fishing activity and leisure boats and marinas in all surrounding ports. Sailors have Facebook groups that can be informed in addition to notice to mariners.
- Measures should be taken to compensate/mitigate for increased grounding risk for pleasure crafts and smaller vessels sailing through the sound between Saltholm and the wind farm area. Increased depth measurements (and accuracy/quality), improved navigational marking (e.g. lateral marking), dedicated lane for small ships should be considered by the relevant national authorities.
- Synchronization and harmonization of lighting with respect to other existing and planned offshore wind turbines in the region (i.e. Lillgrund and Middelgrund) should be considered. Different arrangement of lighting on the different offshore wind farms in the area may confuse mariners. It should also be ensured to minimize the disturbing effect of unsynchronized lighting. This will of course also need to consider aviation lighting.
- One light buoy (recording station) and one pilot mark within the Aflandshage wind farm will need to be re-located. Also. For Nordre Flint, one cardinal mark (east mark) in the wind farm area will need to be moved.

- In relation to construction work, a procedure should be made for safe construction vessel (incl. cable laying vessels) voyages/routes sailing in the area. This should be prepared in dialogue with VTS and pilots.
  - For crossing Hollænderdybet; re-routing of traffic via Flintchannel may also be investigated (if possible, in limited periods during critical cable laying operations).
  - For operations close to the narrow waterway south of Avedøre Holme, planning should be made in dialogue with VTS and pilots.

# 7 REFERENCES

/1/ IMO Resolution MSC 314 (88) New mandatory ship reporting system "In the Sound between Denmark and Sweden" (SOUNDREP)

http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Maritime-Safety-Committee-(MSC)/Documents/MSC.314(88).pdf

/2/ DNV GL (2020) Hazard identifikation og kvalitativ risiko evaluering af sejladssikkerhed – Aflandshage og Nordre Flint vindmølleparker, Report No.: 2020-0940, Rev. 1, Document No.: 158WPQSA-1.

/3/ IWRAP Mk2 Wiki site: https://www.iala-aism.org/wiki/iwrap/index.php/Main_Page

/4/ EC (2020) Vessel monitoring system (VMS). https://ec.europa.eu/fisheries/cfp/control/technologies/vms_en

/5/ Sound VTS, Mariners reference card for SOUNDREP: http://www.sjofartsverket.se/en/Sound-VTS/SoundRep-information/Masters-guide/

/6/ DNV GL, Gard and The Swedish Club. "Anchor loss - technical and operational challenges and recommendations", DNV GL AS, 2016.

/7/ GARD, "Loss of anchors and chain. A selection of articles previously published by Gard AS", Gard News 201, pp. 5 – 7, (2014).

/8/ A. Di Padovaa*, C. Zuliania, and F. Tallonea (2018). Dragged anchors interaction scenario: Detailed frequency analysis for pipeline design. Probabilistic Safety Assessment and Management PSAM 14, September 2018, Los Angeles, CA.

/9/ Enersea (2018). D12-B to D15-FA-1 Pipeline. D12-B to D15-FA-1 Risk Assessment and dropped object analysis.

/10/ DNV GL (2015) Vurdering av forebyggende sjøsikkerhetstiltak. Rapport Nr.: 2014-1402, Rev. F, Dokument Nr.: 1908Z31-6, Dato: 2015-05-20.

/11/ DHI (2020) Aflandshage & Nordre Flint Wind Farms. Metocean Study – Part A: Data Basis. Bathymetry, Measurements and Hindcast Models. 2020-07-17.

/12/ Rambøll (2020) Lynetteholm Miljøkonsekvensrapport. Doc ID 1100038380-1940442988-66. 2020-11-24. Versjon 7.

# APPENDIX A
## IWRAP settings and parameters

The following default IALA values have been selected in IWRAP:

### Causation factors:

| Condition | Causation factor |
|---|---|
| Head on collisions | $0.5 \cdot 10^{-4}$ |
| Overtaking collisions | $1.1 \cdot 10^{-4}$ |
| Crossing collisions | $1.3 \cdot 10^{-4}$ |
| Collisions in bend | $1.3 \cdot 10^{-4}$ |
| Collisions in merging | $1.3 \cdot 10^{-4}$ |
| Grounding – forget to turn | $1.6 \cdot 10^{-4}$ |
| Mean time between checks after missed turn | 180 seconds |

### Tug assistance:

| | |
|---|---|
| Preparation time: | 30 min |
| Success probability: | 0.85 |
| Average speed | 12.00 knot |
| Max range: | No limit |
| Max ship length: | 300 m |

### Drift parameters:

**Blackout Frequency**

| | |
|---|---|
| RoRo and Passenger | 0.10 per year |
| Other vessels | 0.75 per year |

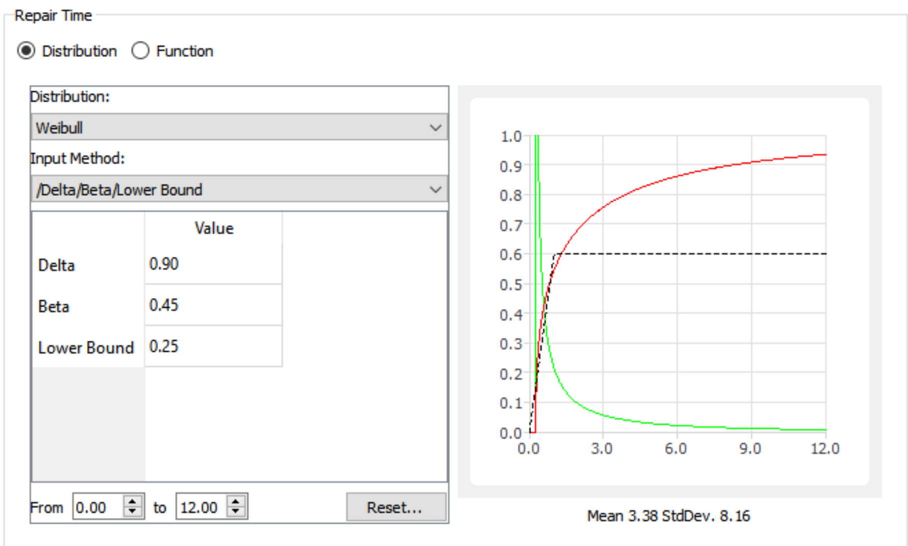
**Drift Speed**

| | |
|---|---|
| Drift Speed | 1.00 knot |

**Anchoring**

| | |
|---|---|
| Anchor probability: | 0.70 |
| Max anchor depth: | 7.0 x design draught |
| Min. anchor distance from ground: | 3.0 x ship lengths |

### Repair time:



## Wind rose

Drogden is the most relevant measurement station in terms of location being at sea right in between the two wind farms, with long-term records available /11/.

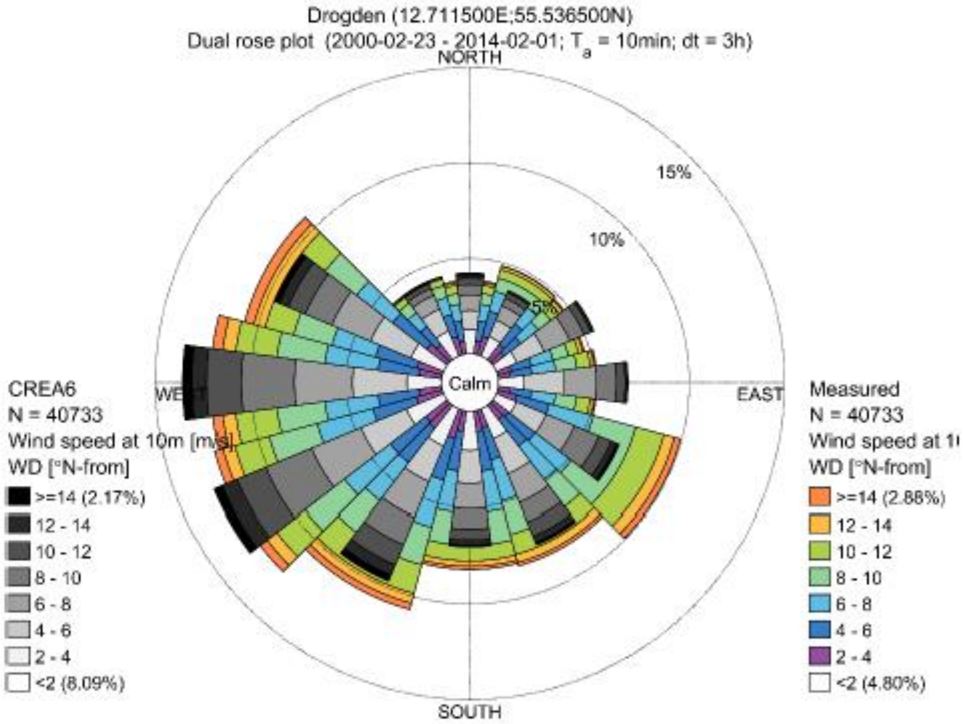



**Figure 7-1 Comparison of measured and CREA6[11] wind at Drogden /11/.**

[11] COSMO-REA62 (CREA6) is a high-resolution reanalysis developed by the Hans-Ertel-Zentrum of the Deutscher Wetterdienst (German meteorological Office) and the University of Bonn in Germany.

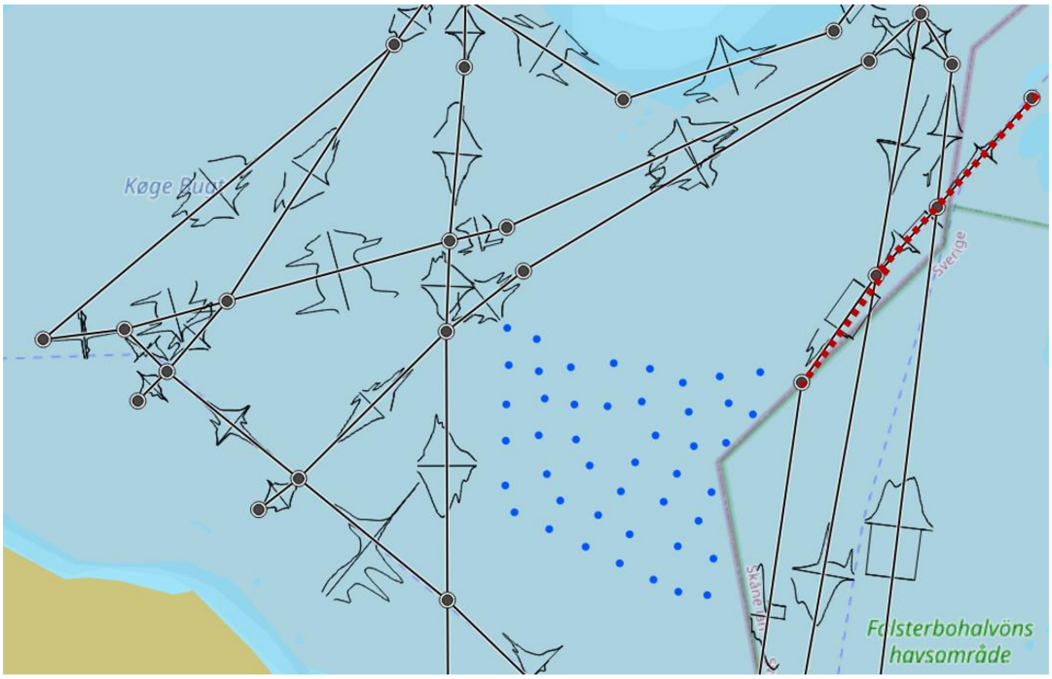



**Figure 7-2 Assumed CTV route to/from Aflandshage OWF (most conservative route assumption). Route illustrated in red.**

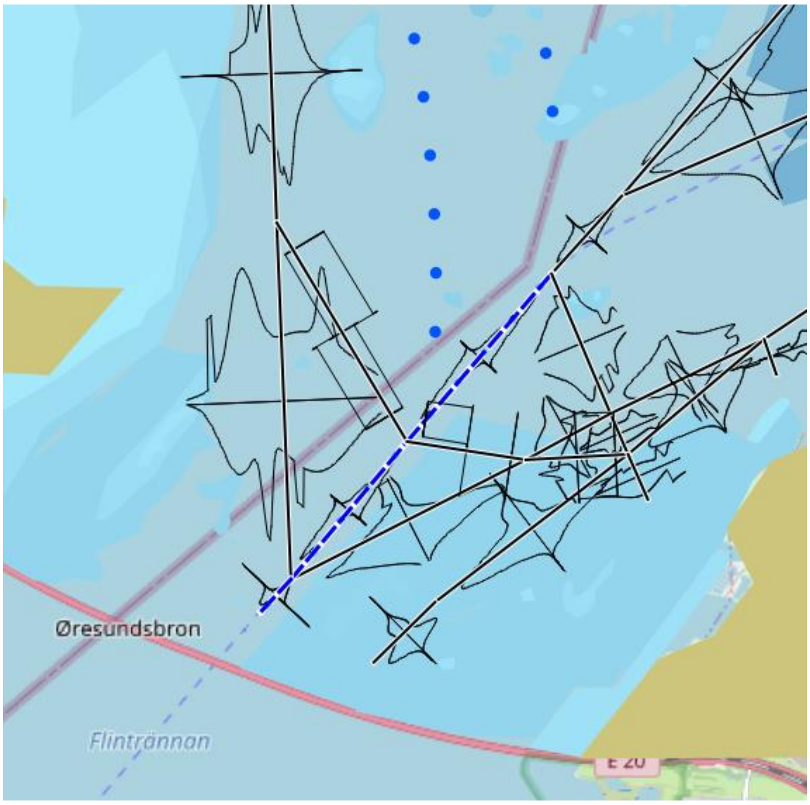


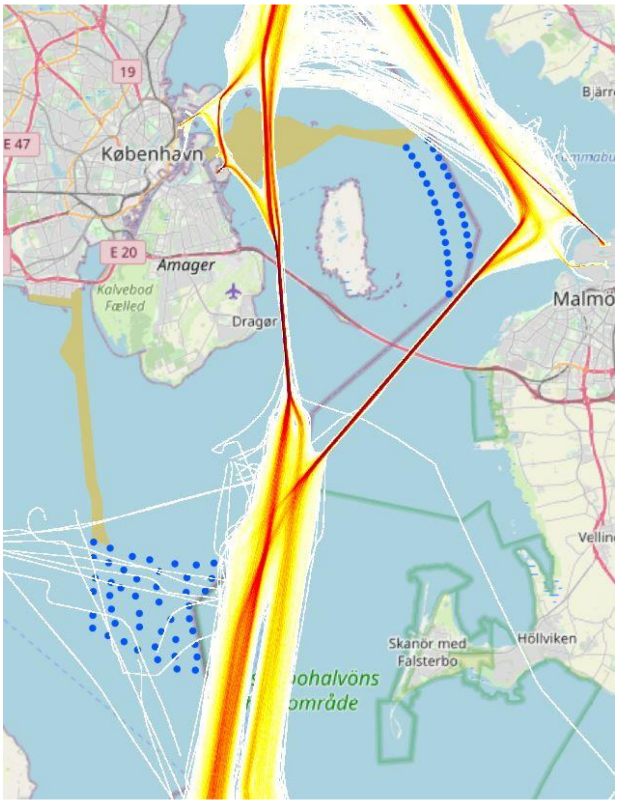

**Figure 7-3 Assumed CTV route to/from Nordre Flint OWF (most conservative route assumption). Route illustrated in blue.**

# APPENDIX B

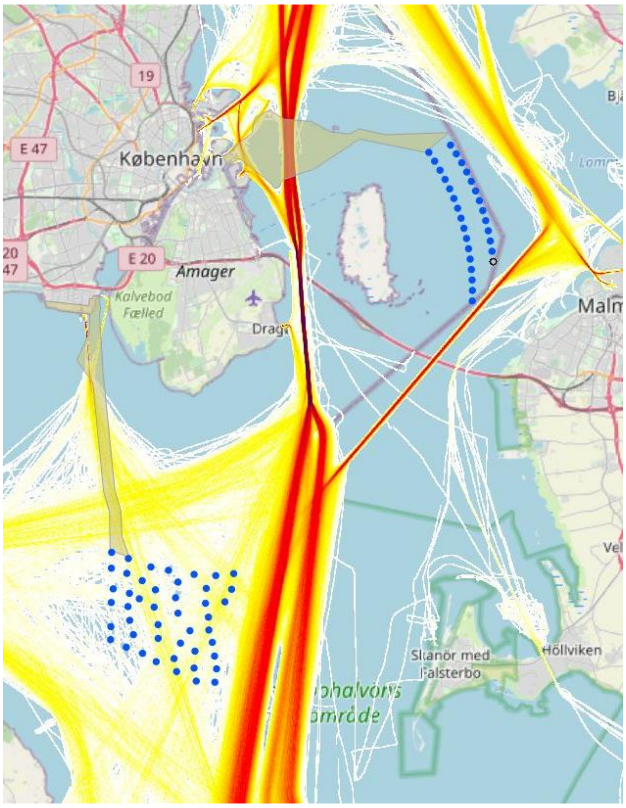
## Traffic density plots per ship type

The colour scheme for the traffic density plots are different for each plot, i.e. comparison of intensity between ship types are not valid. It goes from low (yellow) to high (red) relative to the ship type. The intention of these plots is to show the traffic patterns for each ship type.

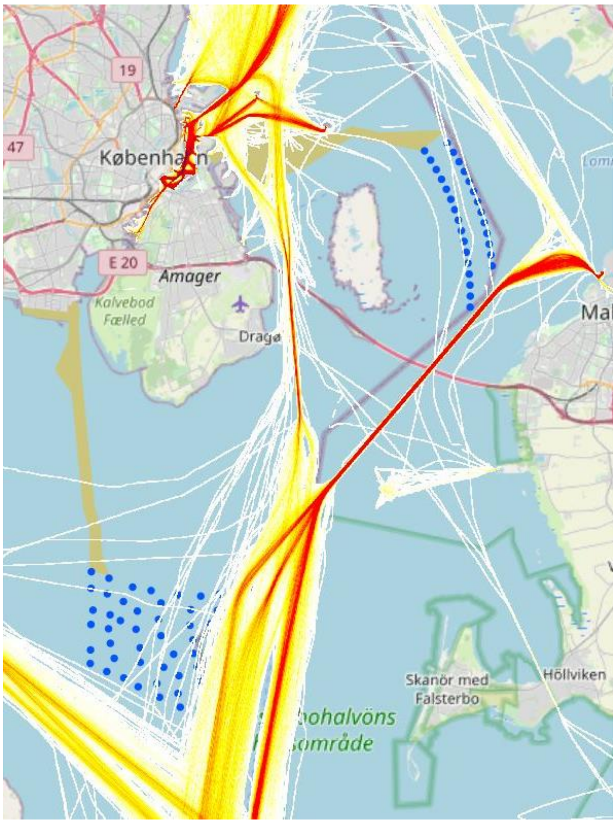
### Tankers



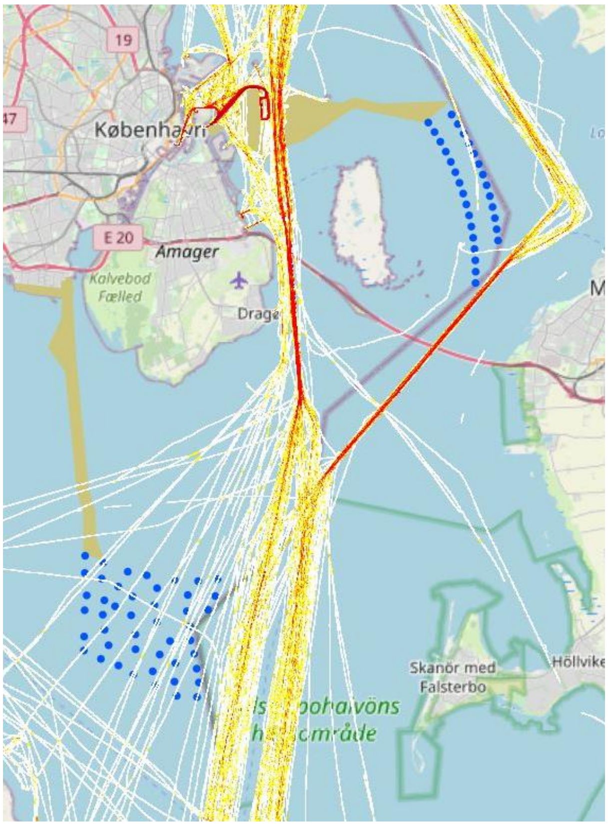

### Bulk, container, roro, general cargo



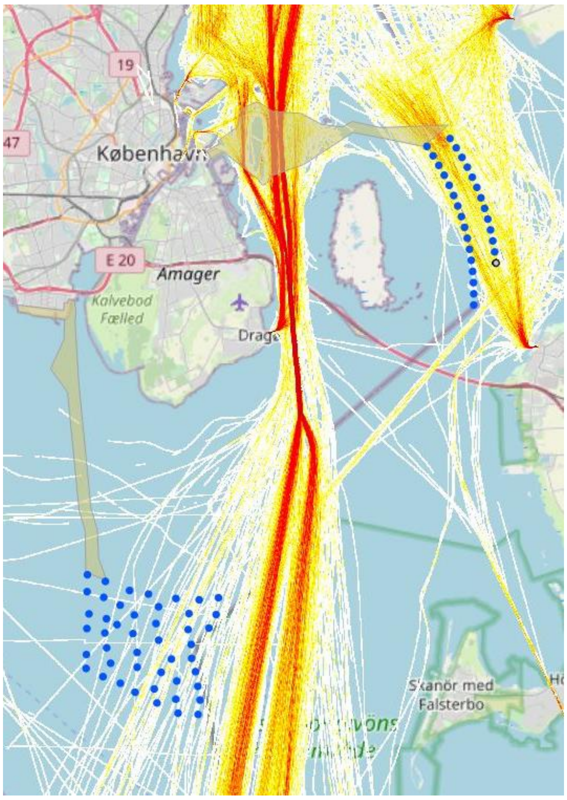

### Passenger, passenger/roro and cruise



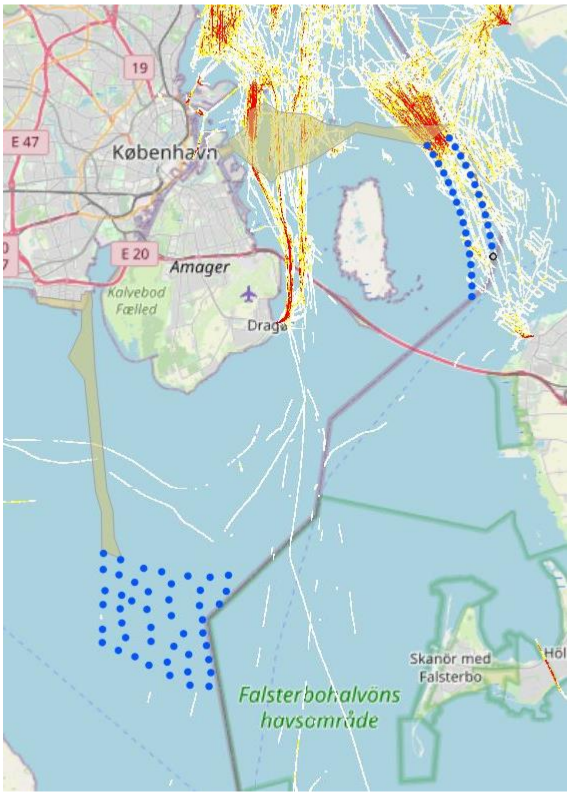

### Offshore



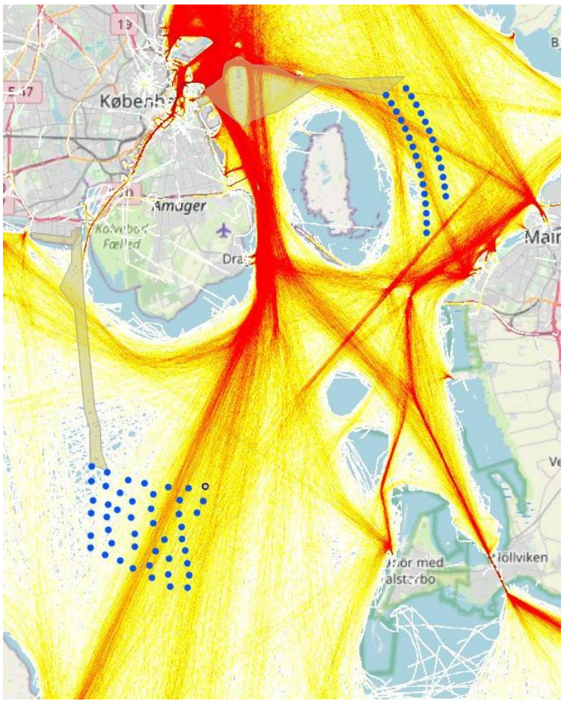
## Fishing



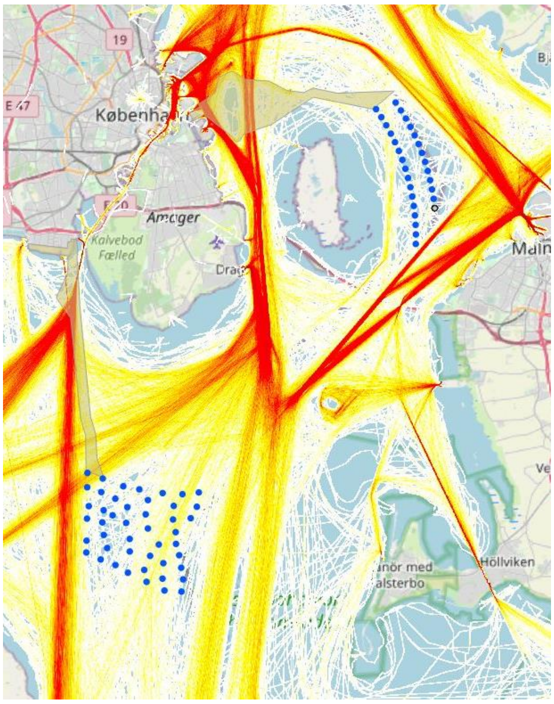

## Fishing below 5knots




## Pleasure crafts




## Tugs and other service vessels



# APPENDIX C
## Traffic composition for Aflandshage (Before establishment)

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1aN (TSS off Falsterbo Northbound)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 112 | 40 | 90 | 7 | **252** | **2%** |
| 30-70 | 51 | 0 | 0 | 5 | 88 | 0 | 2 | 0 | 10 | 6 | 78 | 286 | 19 | 80 | **625** | **6%** |
| 70-100 | 150 | 164 | 24 | 122 | 3 636 | 0 | 10 | 0 | 34 | 15 | 3 | 28 | 3 | 31 | **4 220** | **39%** |
| 100-150 | 110 | 798 | 58 | 69 | 2 288 | 237 | 25 | 0 | 0 | 2 | 9 | 12 | 5 | 22 | **3 635** | **34%** |
| 150-200 | 9 | 54 | 14 | 30 | 640 | 11 | 659 | 15 | 0 | 1 | 0 | 0 | 0 | 1 | **1 434** | **13%** |
| 200-250 | 5 | 0 | 0 | 36 | 134 | 0 | 301 | 44 | 0 | 0 | 0 | 8 | 0 | 0 | **528** | **5%** |
| 250-300 | 7 | 0 | 0 | 1 | 2 | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | **46** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **332** | **1 016** | **96** | **263** | **6 788** | **248** | **998** | **95** | **45** | **25** | **202** | **374** | **117** | **141** | **10 740** | **100%** |
| **%** | **3%** | **9%** | **1%** | **2%** | **63%** | **2%** | **9%** | **1%** | **0%** | **0%** | **2%** | **3%** | **1%** | **1%** | **100%** | |
| **1aS (TSS off Falsterbo Southbound)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 84 | 0 | 98 | 29 | **213** | **2%** |
| 30-70 | 52 | 1 | 0 | 5 | 101 | 0 | 3 | 0 | 8 | 6 | 76 | 39 | 2 | 80 | **373** | **3%** |
| 70-100 | 151 | 175 | 30 | 90 | 3 364 | 0 | 11 | 0 | 19 | 10 | 1 | 1 | 0 | 31 | **3 883** | **33%** |
| 100-150 | 114 | 809 | 60 | 80 | 2 358 | 134 | 21 | 2 | 0 | 1 | 6 | 0 | 1 | 27 | **3 613** | **31%** |
| 150-200 | 94 | 804 | 97 | 350 | 950 | 27 | 204 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | **2 541** | **22%** |
| 200-250 | 158 | 1 | 1 | 354 | 338 | 1 | 91 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | **981** | **8%** |
| 250-300 | 129 | 0 | 0 | 23 | 13 | 0 | 0 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | **200** | **2%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **698** | **1 790** | **188** | **902** | **7 124** | **162** | **332** | **89** | **27** | **17** | **167** | **40** | **101** | **167** | **11 804** | **100%** |
| **%** | **6%** | **15%** | **2%** | **8%** | **60%** | **1%** | **3%** | **1%** | **0%** | **0%** | **1%** | **0%** | **1%** | **1%** | **100%** | |
| **1b (TSS off Falsterbo southbound ‘west’)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 63 | 16 | **93** | **5%** |
| 30-70 | 3 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 2 | 0 | 17 | 11 | 1 | 19 | **65** | **3%** |
| 70-100 | 7 | 19 | 2 | 17 | 299 | 0 | 2 | 0 | 7 | 3 | 1 | 0 | 0 | 1 | **358** | **19%** |
| 100-150 | 33 | 78 | 9 | 5 | 226 | 6 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | **369** | **20%** |
| 150-200 | 12 | 119 | 6 | 68 | 122 | 0 | 317 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | **647** | **35%** |
| 200-250 | 18 | 1 | 0 | 56 | 43 | 0 | 177 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | **300** | **16%** |
| 250-300 | 17 | 0 | 0 | 2 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | **42** | **2%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **90** | **217** | **17** | **148** | **702** | **6** | **498** | **31** | **9** | **3** | **37** | **11** | **64** | **41** | **1 874** | **100%** |
| **%** | **5%** | **12%** | **1%** | **8%** | **37%** | **0%** | **27%** | **2%** | **0%** | **0%** | **2%** | **1%** | **3%** | **2%** | **100%** | **0%** |
| **2 (Drogden-Stevns)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 7 | 35 | 541 | 30 | **616** | **65%** |
| 30-70 | 0 | 0 | 0 | 0 | 96 | 0 | 4 | 0 | 2 | 0 | 1 | 1 | 10 | 48 | **162** | **17%** |
| 70-100 | 1 | 1 | 0 | 0 | 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | **49** | **5%** |
| 100-150 | 3 | 5 | 1 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **17** | **2%** |
| 150-200 | 2 | 3 | 0 | 2 | 7 | 0 | 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **87** | **9%** |
| 200-250 | 1 | 0 | 0 | 0 | 5 | 0 | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **16** | **2%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | **4** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **7** | **9** | **1** | **4** | **160** | **0** | **86** | **5** | **2** | **3** | **8** | **36** | **551** | **79** | **951** | **100%** |
| **%** | **1%** | **1%** | **0%** | **0%** | **17%** | **0%** | **9%** | **1%** | **0%** | **0%** | **1%** | **4%** | **58%** | **8%** | **100%** | |
| **3 (Avedøre-Stevns)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 5 | **21** | **2%** |
| 30-70 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 067 | **1 071** | **98%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | **3** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **5** | **0** | **0** | **0** | **0** | **0** | **2** | **0** | **16** | **1 072** | **1 095** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **1%** | **98%** | **100%** | |
| **4 (Køge-Falsterbro)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 15 | 5 | **22** | **2%** |
| 30-70 | 0 | 0 | 0 | 0 | 119 | 0 | 0 | 0 | 1 | 2 | 5 | 2 | 2 | 62 | **193** | **17%** |
| 70-100 | 0 | 0 | 0 | 3 | 161 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **166** | **15%** |
| 100-150 | 1 | 1 | 0 | 0 | 24 | 0 | 4 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | **33** | **3%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 710 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **710** | **63%** |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **1** | **1** | **0** | **3** | **304** | **0** | **716** | **0** | **1** | **3** | **6** | **4** | **17** | **68** | **1 124** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **27%** | **0%** | **64%** | **0%** | **0%** | **0%** | **1%** | **0%** | **2%** | **6%** | **100%** | |
| **5a (Køge-Avedøre)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **1** | **0%** |
| 30-70 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 705 | **710** | **100%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **4** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **705** | **711** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **1%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **99%** | **100%** | |
| **5b (Strøby-Avedøre)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 30-70 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 569 | **588** | **100%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **18** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **569** | **588** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **3%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **97%** | **100%** | |
| **6a (Køge-Drogden inner)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 16 | 18 | **42** | **7%** |
| 30-70 | 1 | 0 | 0 | 0 | 13 | 0 | 1 | 0 | 2 | 0 | 17 | 1 | 2 | 157 | **194** | **32%** |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70-100 | 0 | 0 | 0 | 3 | 339 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **343** | **57%** |
| 100-150 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | **24** | **4%** |
| 150-200 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **1** | **0** | **0** | **3** | **376** | **0** | **2** | **0** | **2** | **1** | **25** | **1** | **18** | **175** | **604** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **62%** | **0%** | **0%** | **0%** | **0%** | **0%** | **4%** | **0%** | **3%** | **29%** | **100%** | |
| **6b (Køge-Drogden outer)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | **2** | **1%** |
| 30-70 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | **5** | **2%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 289 | **289** | **98%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **3** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **292** | **296** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **1%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **99%** | **100%** | |
| **7 (Avedøre-Falsterbo)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **1** | **1%** |
| 30-70 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | **7** | **5%** |
| 70-100 | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **26** | **17%** |
| 100-150 | 0 | 0 | 0 | 0 | 119 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | **120** | **78%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **146** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **6** | **154** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **95%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **1%** | **4%** | **100%** | |

# APPENDIX D

## Traffic composition for Nordre Flint (Before establishment)

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Route 1a (Malmö port)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 216 | 0 | 227 | 559 | **1 014** | **47%** |
| 30-70 | 8 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 208 | 3 | 7 | 83 | **313** | **14%** |
| 70-100 | 13 | 17 | 30 | 3 | 121 | 0 | 0 | 0 | 7 | 4 | 2 | 0 | 0 | 7 | **204** | **9%** |
| 100-150 | 15 | 116 | 3 | 39 | 160 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | **357** | **16%** |
| 150-200 | 0 | 1 | 0 | 1 | 123 | 24 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **155** | **7%** |
| 200-250 | 1 | 0 | 0 | 0 | 104 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | **126** | **6%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **37** | **134** | **33** | **43** | **520** | **44** | **8** | **22** | **7** | **5** | **426** | **3** | **235** | **652** | **2 169** | **100%** |
| **%** | **2%** | **6%** | **2%** | **2%** | **24%** | **2%** | **0%** | **1%** | **0%** | **0%** | **20%** | **0%** | **11%** | **30%** | **100%** | |
| **Route 1b (Oil terminal Malmö)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 3 | 57 | **120** | **14%** |
| 30-70 | 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 76 | 0 | 0 | 4 | **126** | **15%** |
| 70-100 | 137 | 74 | 0 | 0 | 15 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **227** | **26%** |
| 100-150 | 19 | 295 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **318** | **37%** |
| 150-200 | 6 | 26 | 0 | 22 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **68** | **8%** |
| 200-250 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | **0%** |
| 250-300 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **212** | **395** | **0** | **22** | **33** | **0** | **0** | **0** | **1** | **0** | **136** | **0** | **3** | **61** | **863** | **100%** |
| **%** | **25%** | **46%** | **0%** | **3%** | **4%** | **0%** | **0%** | **0%** | **0%** | **0%** | **16%** | **0%** | **0%** | **7%** | **100%** | |
| **Route 2 (Saltholm Flak North)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128 | 0 | 26 | 33 | **187** | **55%** |
| 30-70 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 126 | 0 | 0 | 3 | **131** | **39%** |
| 70-100 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **8** | **2%** |
| 100-150 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **4** | **1%** |
| 150-200 | 0 | 0 | 0 | 1 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **7** | **2%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **5** | **1** | **0** | **1** | **8** | **5** | **0** | **0** | **0** | **0** | **254** | **0** | **27** | **36** | **337** | **100%** |
| **%** | **1%** | **0%** | **0%** | **0%** | **2%** | **1%** | **0%** | **0%** | **0%** | **0%** | **75%** | **0%** | **8%** | **11%** | **100%** | **0%** |
| **Route 3 (Flintchannel)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 40 | 4 | 115 | 146 | **308** | **5%** |
| 30-70 | 12 | 1 | 0 | 0 | 7 | 0 | 1 | 0 | 3 | 2 | 80 | 6 | 21 | 94 | **227** | **4%** |
| 70-100 | 43 | 188 | 73 | 6 | 264 | 0 | 2 | 0 | 23 | 15 | 4 | 0 | 1 | 24 | **643** | **11%** |
| 100-150 | 142 | 760 | 24 | 80 | 474 | 4 | 5 | 0 | 0 | 1 | 0 | 0 | 1 | 14 | **1 505** | **25%** |
| 150-200 | 59 | 459 | 0 | 148 | 389 | 7 | 1 317 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | **2 383** | **40%** |
| 200-250 | 24 | 1 | 0 | 160 | 111 | 0 | 604 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | **904** | **15%** |
| 250-300 | 42 | 0 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **49** | **1%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **322** | **1 409** | **97** | **397** | **1 249** | **11** | **1 930** | **6** | **27** | **19** | **124** | **11** | **138** | **279** | **6 019** | **100%** |
| **%** | **5%** | **23%** | **2%** | **7%** | **21%** | **0%** | **32%** | **0%** | **0%** | **0%** | **2%** | **0%** | **2%** | **5%** | **100%** | |
| **Route 4 (East of Saltholm)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 224 | 46 | **272** | **92%** |
| 30-70 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 20 | **24** | **8%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **2** | **227** | **66** | **296** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **1%** | **77%** | **22%** | **100%** | |
| **Route 5 (Lomma)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 84 | 3 | **89** | **99%** |
| 30-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **1** | **1%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **85** | **3** | **90** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **2%** | **94%** | **3%** | **100%** | |
| **Route 6a (Trindelchannel)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 13 | 0 | 1 | 0 | 0 | 0 | 12 | 1 | 344 | 1 163 | **1 534** | **99%** |
| 30-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 11 | **18** | **1%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **13** | **0** | **1** | **0** | **0** | **0** | **12** | **2** | **350** | **1 174** | **1 552** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **1%** | **0%** | **0%** | **0%** | **0%** | **0%** | **1%** | **0%** | **23%** | **76%** | **100%** | |
| **Route 6b (Oskarsgrundet)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 117 | 447 | **564** | **99%** |
| 30-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | **5** | **1%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **122** | **447** | **569** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **21%** | **79%** | **100%** | |
| **Route 7a (Nordre Flint - outer)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 227 | 2 | **232** | **99%** |
| 30-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | **2** | **1%** |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **3** | **229** | **2** | **234** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **1%** | **98%** | **1%** | **100%** | |
| **Route 7b (Nordre Flint - inner)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 102 | 194 | 4 | **300** | **100%** |
| 30-70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 70-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 100-150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 150-200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 200-250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 250-300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **102** | **194** | **4** | **300** | **100%** |
| **%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | **34%** | **65%** | **1%** | **100%** | |
| **Route 8 (Hollænderdybet)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 3 | 0 | 24 | 0 | 1 | 7 | 205 | 283 | 717 | 265 | **1 505** | **7%** |
| 30-70 | 8 | 0 | 0 | 10 | 218 | 0 | 10 | 0 | 23 | 14 | 138 | 579 | 29 | 315 | **1 344** | **6%** |
| 70-100 | 106 | 137 | 12 | 226 | 7 561 | 0 | 12 | 0 | 39 | 14 | 2 | 47 | 3 | 34 | **8 193** | **39%** |
| 100-150 | 140 | 900 | 107 | 71 | 4 425 | 370 | 23 | 1 | 0 | 4 | 39 | 24 | 10 | 22 | **6 136** | **30%** |
| 150-200 | 64 | 551 | 121 | 331 | 1 179 | 32 | 13 | 24 | 0 | 1 | 0 | 0 | 0 | 0 | **2 316** | **11%** |
| 200-250 | 170 | 1 | 1 | 315 | 428 | 1 | 0 | 84 | 0 | 0 | 0 | 14 | 0 | 0 | **1 014** | **5%** |
| 250-300 | 118 | 0 | 0 | 25 | 11 | 0 | 0 | 96 | 0 | 0 | 0 | 0 | 0 | 0 | **250** | **1%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **606** | **1 589** | **241** | **978** | **13 825** | **403** | **82** | **205** | **63** | **40** | **384** | **947** | **759** | **636** | **20 758** | **100%** |
| **%** | **3%** | **8%** | **1%** | **5%** | **67%** | **2%** | **0%** | **1%** | **0%** | **0%** | **2%** | **5%** | **4%** | **3%** | **100%** | |

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Route 9 (Kongedybet)** | | | | | | | | | | | | | | | | |
| 0-30 | 0 | 0 | 0 | 0 | 4 | 0 | 35 | 0 | 0 | 7 | 65 | 76 | 2 066 | 453 | **2 706** | **66%** |
| 30-70 | 19 | 0 | 0 | 0 | 21 | 0 | 31 | 0 | 0 | 6 | 29 | 1 | 62 | 345 | **514** | **13%** |
| 70-100 | 54 | 13 | 0 | 1 | 34 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 348 | **463** | **11%** |
| 100-150 | 4 | 40 | 0 | 1 | 75 | 4 | 22 | 1 | 0 | 0 | 10 | 0 | 1 | 9 | **167** | **4%** |
| 150-200 | 0 | 8 | 0 | 0 | 194 | 1 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | **212** | **5%** |
| 200-250 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | **8** | **0%** |
| 250-300 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | **0%** |
| 300-350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| 350- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | **0%** |
| **Sum** | **80** | **61** | **0** | **2** | **328** | **5** | **100** | **16** | **0** | **13** | **104** | **77** | **2 130** | **1 155** | **4 071** | **100%** |
| **%** | **2%** | **1%** | **0%** | **0%** | **8%** | **0%** | **2%** | **0%** | **0%** | **0%** | **3%** | **2%** | **52%** | **28%** | **100%** | |

# APPENDIX E

## Accident frequencies for Aflandshage

## Table 7-1 Total grounding frequency, before establishment, Aflandshage.

| | Oil tankers | Product/chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0-30** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 5.3E-05 | 0.0E+00 | 1.4E-06 | 0.0E+00 | 3.0E-07 | 4.0E-05 | 2.1E-04 | 9.3E-05 | 6.1E-03 | 2.5E-03 | **9.0E-03** | **6%** |
| **30-70** | 2.9E-04 | 6.1E-07 | 0.0E+00 | 2.7E-05 | 8.0E-04 | 0.0E+00 | 7.2E-06 | 0.0E+00 | 1.0E-04 | 4.9E-05 | 3.8E-04 | 4.3E-03 | 9.4E-05 | 3.9E-03 | **1.0E-02** | **7%** |
| **70-100** | 1.8E-03 | 7.5E-04 | 9.3E-05 | 2.0E-03 | 3.5E-02 | 0.0E+00 | 4.9E-05 | 0.0E+00 | 1.6E-04 | 4.7E-05 | 3.7E-05 | 4.0E-04 | 2.6E-05 | 1.8E-03 | **4.2E-02** | **28%** |
| **100-150** | 1.3E-03 | 1.0E-02 | 8.3E-04 | 7.5E-04 | 4.0E-02 | 4.3E-03 | 5.5E-05 | 2.9E-06 | 0.0E+00 | 5.4E-05 | 1.8E-04 | 1.7E-04 | 7.6E-05 | 3.7E-04 | **5.8E-02** | **39%** |
| **150-200** | 4.8E-04 | 3.9E-03 | 5.8E-04 | 1.9E-03 | 1.0E-02 | 1.5E-04 | 4.0E-03 | 3.0E-04 | 0.0E+00 | 2.3E-05 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 3.0E-06 | **2.2E-02** | **14%** |
| **200-250** | 7.5E-04 | 6.9E-06 | 3.2E-06 | 1.8E-03 | 2.7E-03 | 4.4E-06 | 1.7E-03 | 7.2E-04 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.1E-04 | 0.0E+00 | 0.0E+00 | **7.9E-03** | **5%** |
| **250-300** | 6.4E-04 | 0.0E+00 | 0.0E+00 | 1.2E-04 | 7.7E-05 | 0.0E+00 | 0.0E+00 | 7.1E-04 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **1.6E-03** | **1%** |
| **300-350** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **350-** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **Sum** | **5.3E-03** | **1.5E-02** | **1.5E-03** | **6.6E-03** | **8.9E-02** | **4.4E-03** | **5.8E-03** | **1.7E-03** | **2.6E-04** | **2.1E-04** | **8.1E-04** | **5.2E-03** | **6.3E-03** | **8.6E-03** | **1.5E-01** | |
| **%** | **3%** | **10%** | **1%** | **4%** | **59%** | **3%** | **4%** | **1%** | **0%** | **0%** | **1%** | **3%** | **4%** | **6%** | | |

## Table 7-2 Total ship-ship frequency, before establishment, Aflandshage.

| Striking/Struck | Oil tankers | Product/chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oil tankers** | 9.2E-05 | 3.3E-04 | 5.5E-05 | 2.0E-04 | 1.5E-03 | 7.2E-05 | 3.0E-04 | 3.8E-05 | 5.2E-06 | 2.7E-06 | 1.3E-05 | 5.0E-05 | 2.1E-05 | 2.7E-04 | **3.0E-03** |
| **Product/chemical tankers** | 1.3E-04 | 4.0E-04 | 7.7E-05 | 2.3E-04 | 2.0E-03 | 1.1E-04 | 7.4E-04 | 5.7E-05 | 8.5E-06 | 5.1E-06 | 3.2E-05 | 5.7E-05 | 4.0E-05 | 4.0E-04 | **4.3E-03** |
| **Gas tankers** | 1.3E-05 | 3.4E-05 | 4.3E-06 | 1.7E-05 | 1.8E-04 | 9.0E-06 | 4.9E-05 | 5.1E-06 | 7.9E-07 | 5.2E-07 | 3.3E-06 | 6.2E-06 | 4.2E-06 | 4.7E-05 | **3.8E-04** |
| **Bulk carriers** | 5.2E-05 | 1.6E-04 | 3.5E-05 | 8.0E-05 | 9.9E-04 | 5.2E-05 | 2.8E-04 | 2.8E-05 | 4.2E-06 | 2.4E-06 | 1.6E-05 | 3.3E-05 | 2.2E-05 | 2.3E-04 | **2.0E-03** |
| **General cargo ships** | 8.4E-04 | 2.6E-03 | 4.1E-04 | 1.5E-03 | 1.1E-02 | 6.6E-04 | 2.5E-03 | 3.8E-04 | 3.8E-05 | 2.5E-05 | 1.6E-04 | 3.7E-04 | 2.2E-04 | 2.6E-03 | **2.4E-02** |
| **Container ships** | 2.4E-05 | 5.7E-05 | 7.1E-06 | 3.1E-05 | 3.1E-04 | 1.0E-05 | 4.4E-05 | 8.5E-06 | 1.3E-06 | 8.8E-07 | 6.1E-06 | 1.0E-05 | 6.6E-06 | 7.7E-05 | **5.9E-04** |
| **Passenger/Roro** | 1.2E-04 | 3.6E-04 | 2.6E-05 | 1.4E-04 | 1.0E-03 | 2.6E-05 | 3.3E-04 | 1.8E-05 | 6.3E-06 | 4.1E-06 | 2.3E-05 | 2.1E-05 | 2.5E-05 | 1.0E-04 | **2.2E-03** |
| **Cruise ships** | 1.5E-05 | 4.1E-05 | 6.6E-06 | 2.6E-05 | 2.6E-04 | 1.1E-05 | 2.8E-05 | 5.7E-06 | 1.0E-06 | 5.8E-07 | 3.8E-06 | 1.0E-05 | 5.4E-06 | 7.9E-05 | **5.0E-04** |
| **Offshore supply ships** | 6.1E-06 | 2.0E-05 | 2.7E-06 | 1.1E-05 | 8.0E-05 | 4.3E-06 | 2.1E-05 | 2.4E-06 | 2.3E-07 | 1.5E-07 | 8.7E-07 | 2.5E-06 | 1.2E-06 | 1.3E-05 | **1.7E-04** |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Other offshore ships** | 5.1E-06 | 1.6E-05 | 2.2E-06 | 8.9E-06 | 7.0E-05 | 3.3E-06 | 1.5E-05 | 1.8E-06 | 2.3E-07 | 1.1E-07 | 5.8E-07 | 2.3E-06 | 8.7E-07 | 9.7E-06 | **1.4E-04** |
| **Tugs** | 7.4E-05 | 2.1E-04 | 2.6E-05 | 1.2E-04 | 9.3E-04 | 3.7E-05 | 1.5E-04 | 2.2E-05 | 3.7E-06 | 1.9E-06 | 5.1E-06 | 3.3E-05 | 9.1E-06 | 8.6E-05 | **1.7E-03** |
| **Fishing vessels** | 4.1E-05 | 1.3E-04 | 2.1E-05 | 8.0E-05 | 5.6E-04 | 3.2E-05 | 1.1E-04 | 1.9E-05 | 1.7E-06 | 1.0E-06 | 6.5E-06 | 1.5E-05 | 8.9E-06 | 1.1E-04 | **1.1E-03** |
| **Pleasure Crafts** | 4.9E-05 | 1.3E-04 | 1.7E-05 | 8.0E-05 | 6.1E-04 | 2.3E-05 | 1.0E-04 | 1.5E-05 | 2.2E-06 | 1.3E-06 | 5.3E-06 | 1.9E-05 | 1.4E-05 | 8.7E-05 | **1.2E-03** |
| **Other** | 1.1E-04 | 2.2E-04 | 3.1E-05 | 1.4E-04 | 1.4E-03 | 4.8E-05 | 1.8E-04 | 3.6E-05 | 5.4E-06 | 3.7E-06 | 2.2E-05 | 4.6E-05 | 3.6E-05 | 2.6E-04 | **2.6E-03** |
| **Sum** | **1.6E-03** | **4.7E-03** | **7.3E-04** | **2.7E-03** | **2.1E-02** | **1.1E-03** | **4.9E-03** | **6.3E-04** | **7.9E-05** | **4.9E-05** | **3.0E-04** | **6.7E-04** | **4.1E-04** | **4.4E-03** | 4.4E-02 |

## Table 7-3 Total ship-turbine collision, after establishment, Aflandshage.

| | Oil tankers | Product/chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0-30** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 4.7E-08 | 1.6E-07 | 0.0E+00 | 1.0E-04 | 0.0E+00 | 6.8E-08 | 7.7E-08 | 5.9E-06 | 2.1E-06 | 3.7E-05 | 6.8E-06 | **1.6E-04** | **8%** |
| **30-70** | 6.9E-06 | 7.3E-08 | 0.0E+00 | 8.7E-06 | 2.3E-05 | 8.3E-07 | 4.6E-07 | 1.1E-07 | 1.6E-06 | 7.4E-07 | 1.7E-05 | 2.8E-05 | 4.7E-06 | 1.9E-04 | **2.8E-04** | **15%** |
| **70-100** | 1.6E-05 | 1.9E-05 | 2.7E-06 | 1.3E-05 | 3.9E-04 | 0.0E+00 | 8.5E-07 | 0.0E+00 | 3.4E-06 | 1.5E-06 | 7.9E-07 | 1.7E-06 | 1.4E-07 | 5.0E-05 | **5.0E-04** | **26%** |
| **100-150** | 1.6E-05 | 7.5E-05 | 6.4E-06 | 1.6E-05 | 2.3E-04 | 1.3E-05 | 1.9E-06 | 7.6E-08 | 0.0E+00 | 2.0E-07 | 2.6E-06 | 8.3E-07 | 7.6E-07 | 2.8E-06 | **3.6E-04** | **19%** |
| **150-200** | 5.9E-06 | 5.6E-05 | 5.8E-06 | 2.8E-05 | 7.6E-05 | 1.5E-06 | 2.4E-04 | 1.4E-06 | 0.0E+00 | 3.4E-08 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.1E-08 | **4.1E-04** | **22%** |
| **200-250** | 1.1E-05 | 1.5E-07 | 3.9E-08 | 2.6E-05 | 2.3E-05 | 4.4E-08 | 1.0E-04 | 4.1E-06 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 5.4E-07 | 0.0E+00 | 0.0E+00 | **1.7E-04** | **9%** |
| **250-300** | 1.1E-05 | 0.0E+00 | 0.0E+00 | 1.4E-06 | 7.3E-07 | 0.0E+00 | 0.0E+00 | 5.7E-06 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **1.8E-05** | **1%** |
| **300-350** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **350-** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **Sum** | **6.6E-05** | **1.5E-04** | **1.5E-05** | **9.3E-05** | **7.4E-04** | **1.5E-05** | **4.5E-04** | **1.1E-05** | **5.1E-06** | **2.6E-06** | **2.7E-05** | **3.3E-05** | **4.3E-05** | **2.5E-04** | **1.9E-03** | |
| **%** | **4%** | **8%** | **1%** | **5%** | **39%** | **1%** | **24%** | **1%** | **0%** | **0%** | **1%** | **2%** | **2%** | **13%** | | |

# APPENDIX F

## Accident frequencies for Nordre Flint

## Table 7-4 Total grounding frequency, before establishment, Nordre Flint.

| | Oil tankers | Product/ chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/ Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0-30** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.8E-04 | 0.0E+00 | 2.5E-06 | 0.0E+00 | 4.0E-07 | 1.2E-06 | 7.6E-04 | 5.3E-03 | 6.6E-03 | 5.2E-03 | **1.8E-02** | **22%** |
| **30-70** | 9.5E-05 | 1.8E-06 | 0.0E+00 | 0.0E+00 | 1.3E-05 | 0.0E+00 | 1.4E-05 | 0.0E+00 | 4.2E-06 | 2.7E-06 | 7.4E-04 | 1.4E-05 | 1.5E-04 | 2.7E-04 | **1.3E-03** | **2%** |
| **70-100** | 5.4E-04 | 6.5E-04 | 1.4E-04 | 1.8E-05 | 7.6E-04 | 0.0E+00 | 3.5E-06 | 0.0E+00 | 7.9E-05 | 2.7E-05 | 1.7E-05 | 0.0E+00 | 1.3E-05 | 4.4E-05 | **2.3E-03** | **3%** |
| **100-150** | 7.1E-04 | 8.7E-03 | 2.2E-04 | 6.5E-04 | 5.3E-03 | 8.8E-05 | 1.1E-05 | 0.0E+00 | 0.0E+00 | 1.1E-05 | 0.0E+00 | 0.0E+00 | 9.2E-06 | 1.4E-04 | **1.6E-02** | **19%** |
| **150-200** | 7.7E-04 | 6.1E-03 | 0.0E+00 | 1.8E-03 | 4.8E-03 | 1.2E-04 | 2.0E-02 | 4.5E-05 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 8.3E-06 | **3.4E-02** | **40%** |
| **200-250** | 3.4E-04 | 1.5E-05 | 0.0E+00 | 2.1E-03 | 1.6E-03 | 0.0E+00 | 7.6E-03 | 8.7E-05 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 8.7E-06 | 0.0E+00 | 0.0E+00 | **1.2E-02** | **14%** |
| **250-300** | 5.9E-04 | 0.0E+00 | 0.0E+00 | 4.6E-05 | 6.0E-05 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **6.9E-04** | **1%** |
| **300-350** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **350-** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **Sum** | **3.0E-03** | **1.5E-02** | **3.6E-04** | **4.6E-03** | **1.3E-02** | **2.1E-04** | **2.8E-02** | **1.3E-04** | **8.4E-05** | **4.2E-05** | **1.5E-03** | **5.3E-03** | **6.7E-03** | **5.7E-03** | **8.4E-02** | |
| **%** | **4%** | **19%** | **0%** | **6%** | **15%** | **0%** | **33%** | **0%** | **0%** | **0%** | **2%** | **6%** | **8%** | **7%** | | |

## Table 7-5 Total ship-ship frequency, before establishment, Nordre Flint.

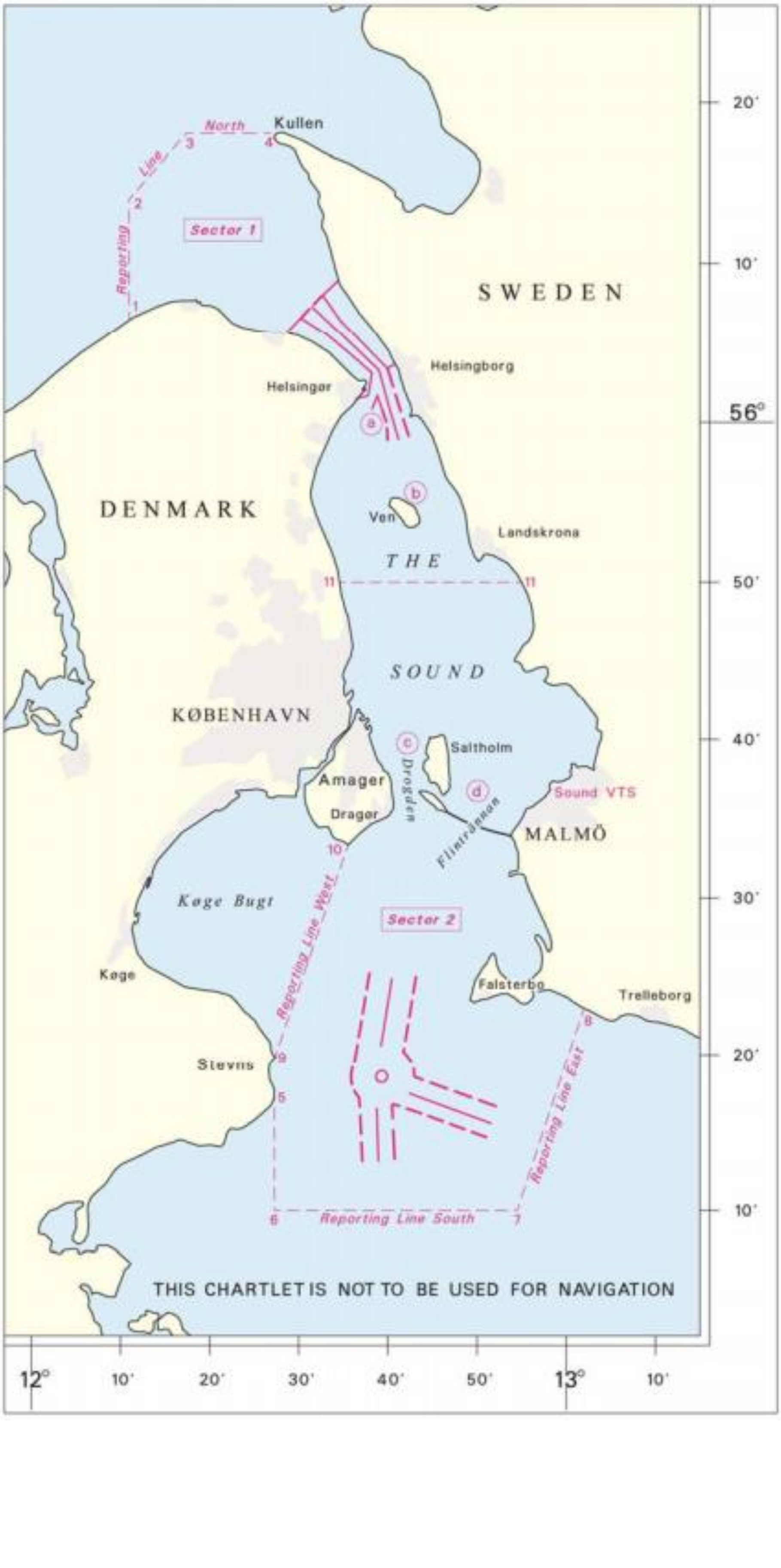
| Striking/Struck | Oil tankers | Product/chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger /Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Oil tankers** | 4.1E-05 | 1.7E-04 | 9.0E-06 | 4.3E-05 | 1.8E-04 | 3.1E-06 | 2.6E-04 | 2.1E-06 | 3.1E-06 | 2.2E-06 | 2.4E-05 | 1.7E-06 | 1.8E-05 | 4.8E-05 | **8.1E-04** |
| **Product/chemical tankers** | 1.5E-04 | 5.4E-04 | 2.9E-05 | 1.6E-04 | 6.0E-04 | 1.1E-05 | 9.6E-04 | 7.1E-06 | 9.8E-06 | 7.1E-06 | 7.2E-05 | 6.2E-06 | 6.1E-05 | 1.5E-04 | **2.8E-03** |
| **Gas tankers** | 7.4E-06 | 2.8E-05 | 1.2E-06 | 9.6E-06 | 3.0E-05 | 6.4E-07 | 5.5E-05 | 4.0E-07 | 4.3E-07 | 3.2E-07 | 3.5E-06 | 3.0E-07 | 3.1E-06 | 8.4E-06 | **1.5E-04** |
| **Bulk carriers** | 3.4E-05 | 1.5E-04 | 1.0E-05 | 3.3E-05 | 1.9E-04 | 3.3E-06 | 3.3E-04 | 1.9E-06 | 3.7E-06 | 2.6E-06 | 2.4E-05 | 2.1E-06 | 2.0E-05 | 5.5E-05 | **8.6E-04** |
| **General cargo ships** | 1.3E-04 | 5.0E-04 | 2.7E-05 | 1.6E-04 | 5.1E-04 | 1.2E-05 | 8.2E-04 | 7.6E-06 | 8.4E-06 | 6.2E-06 | 8.2E-05 | 5.6E-06 | 6.5E-05 | 1.8E-04 | **2.5E-03** |
| **Container ships** | 2.6E-06 | 9.8E-06 | 5.4E-07 | 3.3E-06 | 1.2E-05 | 2.7E-07 | 1.3E-05 | 2.2E-07 | 1.3E-07 | 1.0E-07 | 3.0E-06 | 7.3E-08 | 1.7E-06 | 5.8E-06 | **5.2E-05** |
| **Passenger/Roro** | 1.6E-04 | 6.6E-04 | 3.8E-05 | 2.3E-04 | 6.5E-04 | 1.1E-05 | 1.1E-03 | 6.5E-06 | 1.0E-05 | 7.1E-06 | 6.0E-05 | 7.7E-06 | 6.7E-05 | 1.6E-04 | **3.2E-03** |
| **Cruise ships** | 1.9E-06 | 7.1E-06 | 3.8E-07 | 2.2E-06 | 8.0E-06 | 2.3E-07 | 8.4E-06 | 7.5E-08 | 1.2E-07 | 8.6E-08 | 1.8E-06 | 5.7E-08 | 1.1E-06 | 3.6E-06 | **3.5E-05** |

| Striking/Struck | Oil tankers | Product/chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Offshore supply ships | 3.0E-06 | 1.1E-05 | 5.5E-07 | 3.8E-06 | 1.2E-05 | 2.2E-07 | 1.8E-05 | 1.6E-07 | 1.2E-07 | 1.0E-07 | 1.1E-06 | 1.0E-07 | 1.1E-06 | 2.8E-06 | **5.4E-05** |
| Other offshore ships | 2.2E-06 | 8.3E-06 | 4.1E-07 | 2.8E-06 | 8.6E-06 | 1.6E-07 | 1.3E-05 | 1.1E-07 | 1.1E-07 | 7.1E-08 | 8.3E-07 | 7.7E-08 | 8.1E-07 | 2.1E-06 | **4.0E-05** |
| Tugs | 3.7E-05 | 1.3E-04 | 6.4E-06 | 4.2E-05 | 1.4E-04 | 4.3E-06 | 1.7E-04 | 2.6E-06 | 1.9E-06 | 1.4E-06 | 2.4E-05 | 9.1E-07 | 1.7E-05 | 6.0E-05 | **6.4E-04** |
| Fishing vessels | 3.8E-06 | 1.4E-05 | 5.9E-07 | 5.7E-06 | 1.3E-05 | 1.6E-07 | 2.2E-05 | 1.1E-07 | 1.5E-07 | 1.2E-07 | 7.2E-07 | 1.6E-07 | 2.0E-06 | 4.2E-06 | **6.7E-05** |
| Pleasure Crafts | 4.0E-05 | 1.4E-04 | 6.5E-06 | 5.3E-05 | 1.5E-04 | 4.2E-06 | 1.9E-04 | 2.8E-06 | 1.8E-06 | 1.4E-06 | 2.0E-05 | 2.2E-06 | 2.8E-05 | 1.0E-04 | **7.5E-04** |
| Other | 4.1E-05 | 1.5E-04 | 9.7E-06 | 5.1E-05 | 2.2E-04 | 9.2E-06 | 2.7E-04 | 5.8E-06 | 2.3E-06 | 1.6E-06 | 4.3E-05 | 7.1E-06 | 7.5E-05 | 8.1E-05 | **9.7E-04** |
| Sum | **6.5E-04** | **2.5E-03** | **1.4E-04** | **8.0E-04** | **2.7E-03** | **6.0E-05** | **4.2E-03** | **3.7E-05** | **4.2E-05** | **3.0E-05** | **3.6E-04** | **3.4E-05** | **3.6E-04** | **8.6E-04** | 1.3E-02 |

## Table 7-6 Total ship-turbine collision, after establishment, Nordre Flint.

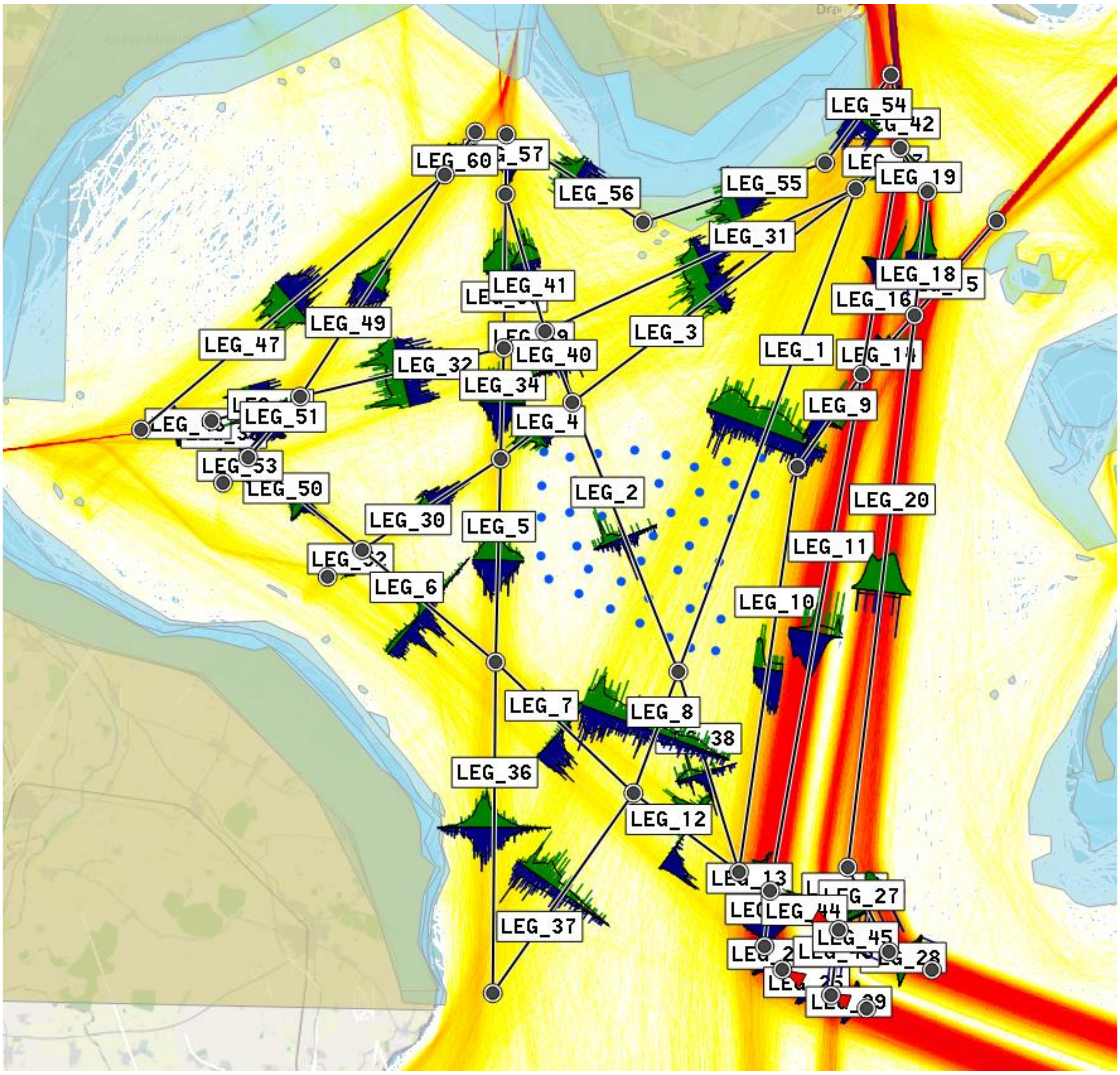
| | Oil tankers | Product/chemical tankers | Gas tankers | Bulk carriers | General cargo ships | Container ships | Passenger/Roro | Cruise ships | Offshore supply ships | Other offshore ships | Tugs | Fishing vessels | Pleasure Crafts | Other | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0-30** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 8.3E-08 | 0.0E+00 | 6.3E-07 | 0.0E+00 | 6.2E-09 | 1.6E-08 | 2.0E-06 | 1.1E-05 | 2.1E-04 | 5.6E-05 | **2.8E-04** | **64%** |
| **30-70** | 8.5E-07 | 3.7E-08 | 0.0E+00 | 0.0E+00 | 2.8E-07 | 0.0E+00 | 2.2E-07 | 0.0E+00 | 8.7E-08 | 6.7E-08 | 7.4E-06 | 2.2E-07 | 3.4E-06 | 1.2E-05 | **2.5E-05** | **6%** |
| **70-100** | 2.5E-06 | 6.1E-06 | 1.9E-06 | 1.8E-07 | 9.1E-06 | 0.0E+00 | 5.7E-08 | 0.0E+00 | 7.2E-07 | 4.8E-07 | 1.2E-07 | 0.0E+00 | 4.6E-08 | 6.1E-07 | **2.2E-05** | **5%** |
| **100-150** | 4.3E-06 | 2.1E-05 | 6.7E-07 | 2.1E-06 | 1.2E-05 | 1.5E-07 | 1.4E-07 | 0.0E+00 | 0.0E+00 | 2.6E-08 | 0.0E+00 | 0.0E+00 | 2.4E-08 | 3.5E-07 | **4.1E-05** | **9%** |
| **150-200** | 1.8E-06 | 1.3E-05 | 0.0E+00 | 4.3E-06 | 9.4E-06 | 3.0E-07 | 2.3E-05 | 1.0E-07 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.0E-08 | **5.1E-05** | **12%** |
| **200-250** | 8.0E-07 | 3.3E-08 | 0.0E+00 | 4.4E-06 | 3.3E-06 | 0.0E+00 | 1.1E-05 | 1.9E-07 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.4E-08 | 0.0E+00 | 0.0E+00 | **1.9E-05** | **4%** |
| **250-300** | 1.4E-06 | 0.0E+00 | 0.0E+00 | 9.9E-08 | 1.3E-07 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **1.6E-06** | **0%** |
| **300-350** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **350-** | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | **0.0E+00** | **0%** |
| **Sum** | **1.2E-05** | **4.0E-05** | **2.6E-06** | **1.1E-05** | **3.4E-05** | **4.5E-07** | **3.4E-05** | **2.9E-07** | **8.2E-07** | **5.9E-07** | **9.5E-06** | **1.1E-05** | **2.1E-04** | **6.9E-05** | **4.4E-04** | |
| **%** | **3%** | **9%** | **1%** | **3%** | **8%** | **0%** | **8%** | **0%** | **0%** | **0%** | **2%** | **3%** | **48%** | **16%** | | |

## APPENDIX G
## Øresund (the Sound) VTS operational area



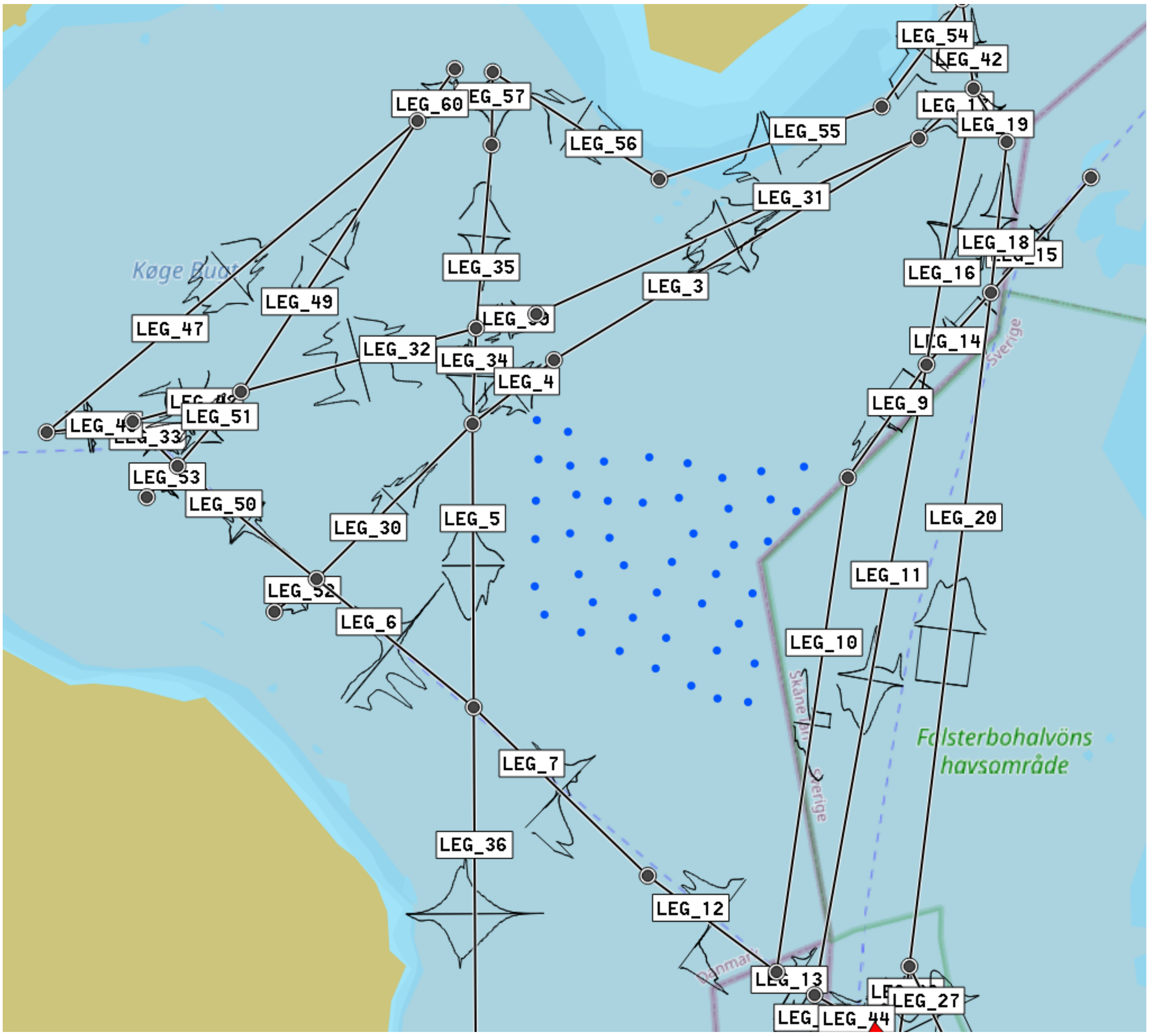
# APPENDIX H
## Detailed IWRAP traffic models

### Aflandshage OWF (before establishment)

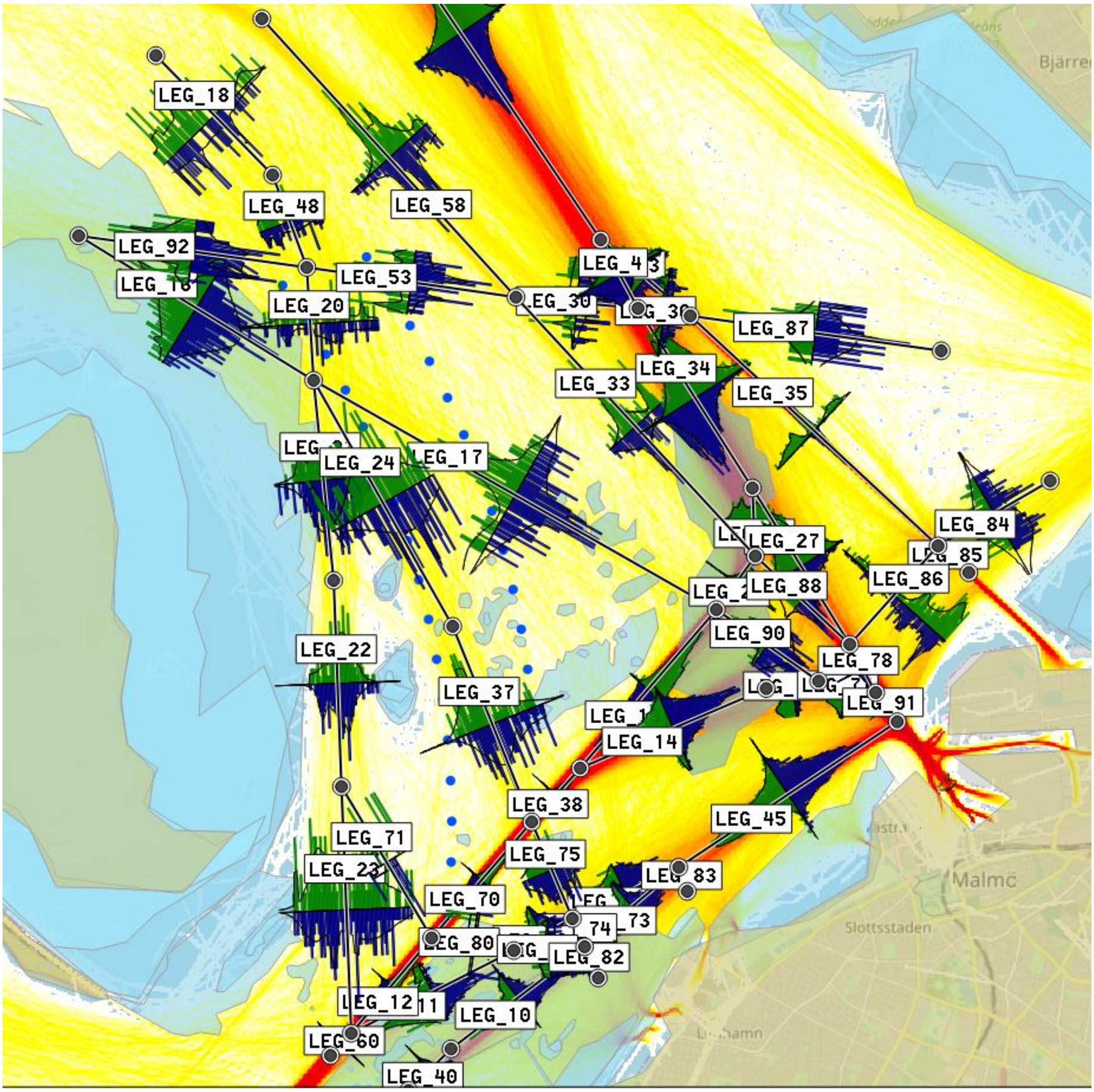



*Note: Position of turbines (blue points) is added to show the planned wind farm location, in order to see which traffic that will be affected. Also, the lateral traffic distribution is unique for the different legs.*

## Aflandshage OWF (after establishment)

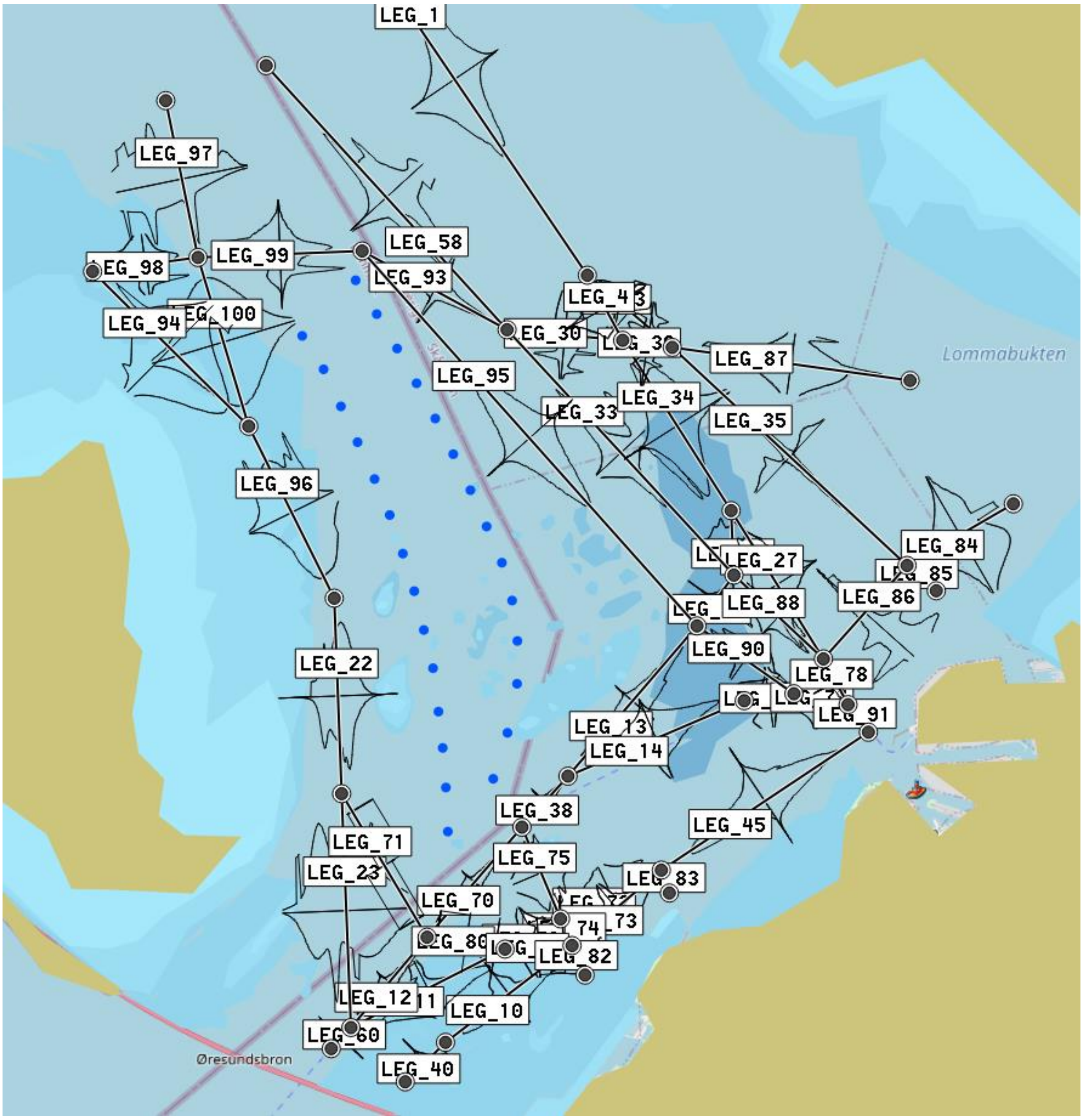


## Nordre Flint OWF (before establishment)




*Note: Position of turbines (blue points) is added to show the planned wind farm location, in order to see which traffic that will be affected. Also, the lateral traffic distribution is unique for the different legs.*

## Nordre Flint OWF (after establishment)



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