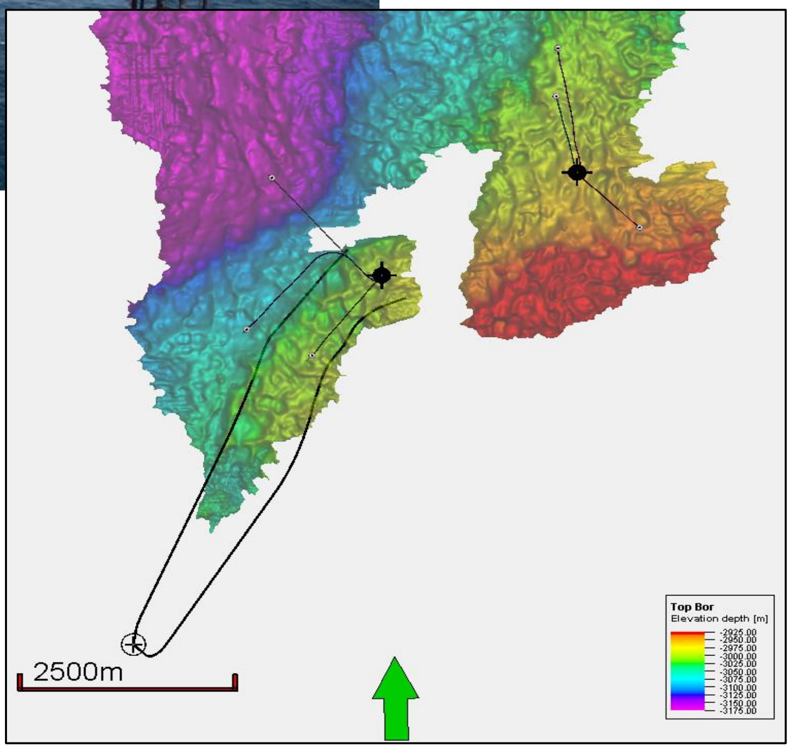
INEOS

January 2022

SOLSORT UNIT
(LICENSE 4/98, 3/09 & 7/89)
NORTH SEA – DENMARK
ESPOO REPORT
SOLSORT WEST LOBE



Top photo shows Syd Arne Main with bridgelinked East Well-head Platform and North Well-head Platform in the distance
Bottom picture shows the two Solsort wells to be drilled from North Well-head Platform.

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1 Introduction

1.1 Reading Guide

This report comprises the Espoo documentation of Denmark elaborated under the Solsort West Lobe Development Project. It contains a description of the project-related transboundary environmental impacts, which are caused by project impacts generated in Denmark and potentially affecting the marine territories (EEZ and/or territorial waters) of Norway, Sweden and Germany.

Chapters 2-3 provide relevant background information on the Solsort West Lobe Development Project. This includes a project description, the legal framework and the mechanisms of the Espoo process, as well as a section on risk assessment and the assessment methods applied. The central part of this report is Chapter 5 including the screening of potential transboundary impacts and Chapter 6 dealing with the assessment of transboundary impacts. The assessment chapters are organized by environmental receptors that are likely to be affected by various project pressures. For each receptor the assessment results are presented, with information on the expected transboundary impact in Norway, Sweden and Germany. A separate chapter deals with the assessments made on Natura 2000 areas and applicable legislation. The results of the assessment are summarized in the conclusion of Chapter 7.

The Espoo report and procedure are an integrated part of the EIA procedures and approval processes.

1.2 Abbreviations

The following abbreviations are used in the document:

AP	Affected Party
BAT	Best Available Technique
BEP	Best Environmental Practice
CO	Carbon Oxides
CRI	Cutting Re-Injection
Cs/K	Caesium/Potassium
DEA	Danish Energy Agency
DEPA	Danish Environmental Protection Agency
EC	European Council
EIA	Environmental Impact Assessment
EU	European Union
HOCNF	Harmonised Offshore Chemical Notification Form
IMO	International Maritime Organization
NH4+	Ammonia
NOx	Nitrogene Oxides
NO2	Nitrogene Dioxides
OBM	Oil Based Mud
OSCAR	Oil Spill Contingency And Response
OSPAR	OSlo PARis convention
OSRL	Oil Spill Response Limited
PLONOR	Pose Little Or NO Risk
PoO	Party of Origin
PPB	Parts Per Billion
PPM	Parts Per Million
RBA	Risk Based Approach
ROV	Remotely Operated underwater Vehicle

SA	South Arne
SAC	Special Areas of Conservation
SA-WHPE	South Arne Wellhead Platform East
SA-WHPN	South Arne Wellhead Platform North
SEL	Sound Exposure Levels
SINTEF	Stiftelsen for INdustriell og TEknisk Forskning
SO2	Sulphur diOxides
TD	Total Depth
VOC	Volatile Organic Compounds
WBM	Water Based Mud
WHP	Well Head Platform
WHPE	Well Head Platform East
WHPN	Well Head Platform North

1.3 Project background

Several development concepts have been considered for a combined development of the Solsort East and West lobes. In May 2020, the Solsort Unit decided to discontinue the unphased development of the East and West Lobes through tie-back of the Solsort discovery to South Arne. The decision was taken based on comprehensive and thorough investigations of development concepts since 2015.

Following the decision to halt the combined Solsort East and West development, the Solsort Unit partnership continued to investigate the attractiveness of a separate Solsort West lobe development.

On this basis, INEOS Oil & Gas Denmark now intends to develop the West Lobe of the Solsort oil and gas field in the Danish Sector of the North Sea. The East Lobe development may take place at a later point and will instigate an EIA to be developed for the East Lobe development.

The development involves drilling of two wells from the South Arne North platform into the Solsort West Lobe reservoir, one producer and one injector. The project also includes associated modifications at the South Arne installations to allow for receiving, transporting, processing and exporting the Solsort West Lobe fluids.

The Solsort produced fluids will be commingled with South Arne production at South Arne WHP North, transported to the South Arne main platform for processing and export.

The location of the Solsort field in relation to South Arne is shown in Figure 1-1 below.

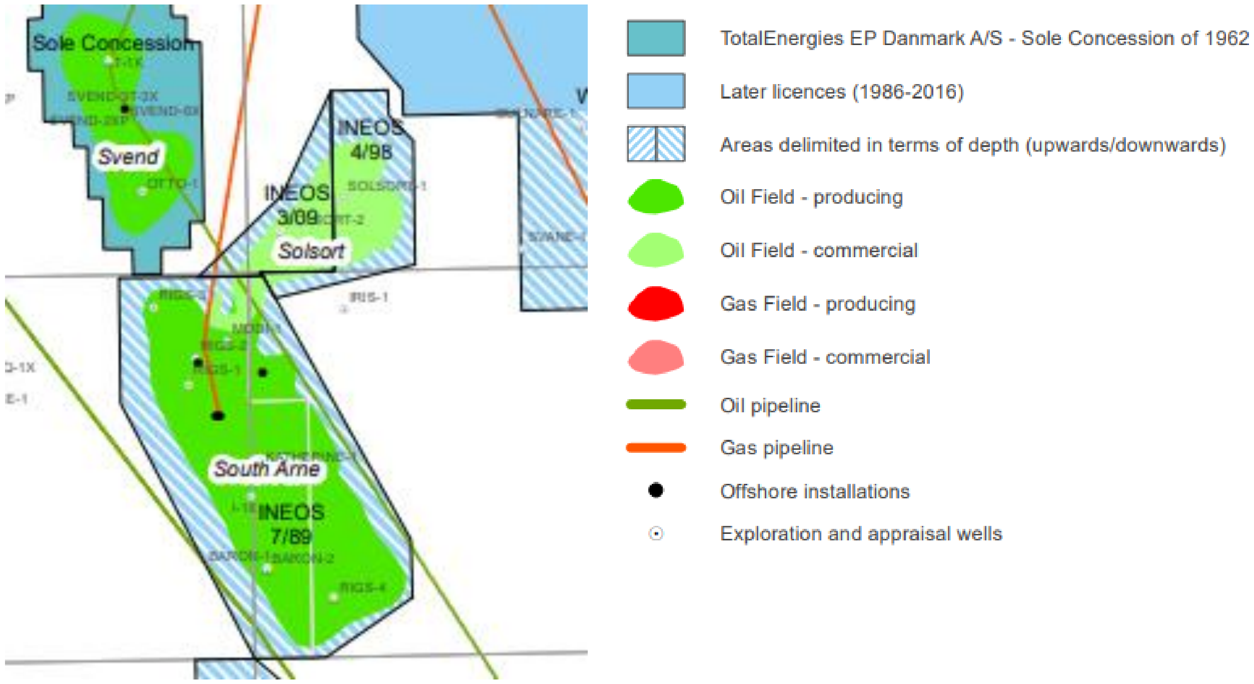


Figure 1-1 Location of the Solsort field in relation to South Arne

INEOS Oil & Gas Denmark has commissioned COWI to carry out an environmental impact assessment (EIA) for the site survey, construction, operation and decommissioning of the West Lobe of the Solsort field.

The present report documents the EIA process, findings and conclusions with special focus on transboundary environmental impacts. The EIA has been carried out in compliance with the Danish EIA regulation (Consolidation Act No. 1976/2021).

The report also includes a screening of potential impacts of the development on Natura 2000 sites and Annex IV species.

1.4 The Solsort field

The Solsort West Lobe discovery is an oil field. The discovery of the field was confirmed by the Solsort-1 exploration well drilled in the East Lobe in 2010. Solsort-1 was followed by the Solsort-2 appraisal well in the West Lobe in 2013, see Figure 1-2. Solsort-2 proved the presence of 17 meters hydrocarbon bearing reservoir at a depth of 3008 - 3025 meters.

The Solsort West Lobe is a Bor Sandstone reservoir compared to South Arne being a Chalk reservoir.

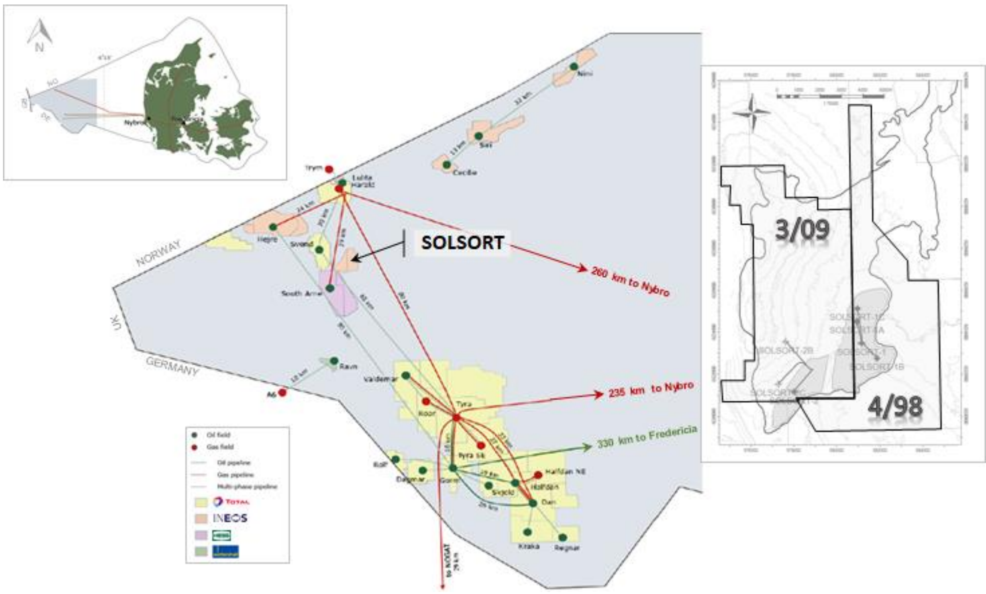


Figure 1-2 Location of the Solsort field along with oil and gas installations in the Danish sector of the North Sea.

2 Legal framework and ESPOO consultation process

A development project such as the Solsort Development Project must comply with numerous international conventions as well as directives and laws on the EU and national levels. This chapter provides an overview of the legal framework and national approval processes, which apply to the Solsort West Lobe Development Project and which also contains the procedures to be followed under the Espoo Convention.

2.1 The ESPOO Convention and ESPOO consultation process

2.1.1 The Espoo Convention

The "Convention on Environmental Impact Assessment in a transboundary context of 25th of February 1991" (Espoo Convention) sets out the obligations of the contracting Parties to assess the environmental impact of certain activities at an early stage of project planning. It also lays down the general obligation of States to notify and consult one another on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

According to the Espoo Convention a transboundary impact is "any non-global impact within the jurisdiction of the Party due to the planned activities, the physical cause of which is wholly or partially located on the area under the jurisdiction of the other Party."

The Party of Origin (PoO) is the Contracting Party or Parties to the Convention, under whose jurisdiction the planned operation is to take place, which in this case is Denmark only.

The Affected Party (AP) is a Contracting Party or Parties to the Convention that may be exposed to a transboundary impact of the planned activities. In relation to the Solsort Development Project Denmark is both AP and PoO, while Norway, Sweden, Germany, the Netherlands and UK are APs.

The convention states that the PoO shall, consistent with the provisions of the convention, ensure that APs are notified of a proposed activity: Offshore hydrocarbon production. Extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 metric tons/day in the case of petroleum and 500 000 cubic metres/day in the case of gas (#15 - Appendix I of the convention) that is likely to cause a significant adverse transboundary impact.

2.1.2 The Espoo consultation process

The consultation process foreseen under the Espoo Convention's Articles 3-6 is coordinated by the Espoo Focal Point in the PoO. The consultation process consists of the following major steps:

- Notification in accordance with Article 3: For a proposed activity listed in Appendix I that is likely to cause a significant adverse transboundary impact, the Party of Origin shall, for the purposes of ensuring adequate and effective consultations under Article 5, notify any Party which it considers may be an Affected Party as early as possible and no later than when informing its own public about that proposed activity.

- Preparation of the environmental impact assessment documentation (Espoo report) pursuant to Article 4: The Party of Origin shall furnish the Affected Party, as appropriate through a joint body where one exists, with the environmental impact assessment documentation. The concerned Parties shall arrange for distribution of the documentation to the authorities and the public of the Affected Party in the areas likely to be Affected and for the submission of comments to the competent authority of the Party of Origin, either directly to this authority or, where appropriate, through the Party of Origin within a reasonable time before the final decision is taken on the proposed activity.

- Consultation pursuant to Article 5: The Party of Origin shall, after completion of the environmental impact assessment documentation, without undue delay enter into consultations with the Affected Party concerning, inter alia, the potential transboundary impact of the proposed activity and measures to reduce or eliminate its impact. Consultations may relate to:

    a. Possible alternatives to the proposed activity, including the no-action alternative and possible measures to mitigate significant adverse transboundary impact and to monitor the effects of such measures at the expense of the Party of Origin;

    b. Other forms of possible mutual assistance in reducing any significant adverse transboundary impact of the proposed activity; and

    c. Any other appropriate matters relating to the proposed activity.

  The Parties shall agree, at the commencement of such consultations, on a reasonable timeframe for the duration of the consultation period. Any such consultations may be conducted through an appropriate joint body, where one exists.

- Final Decision pursuant to Article 6: The Parties shall ensure that, in the final decision on the proposed activity, due account is taken of the outcome of the environmental impact assessment, including the environmental impact assessment documentation, as well as the comments thereon received pursuant to Article 3 and 4, and the outcome of the consultations as referred to in Article 5. The Party of Origin shall provide to the Affected Party the final decision on the proposed activity along with the reasons and considerations on which it was based. If additional information on the significant transboundary impact of a proposed activity, which was not available at the time a decision was made with respect to that activity and which could have materially affected the decision, becomes available to a concerned Party before work on that activity commences, that Party shall immediately inform the other concerned Party or Parties. If one of the concerned Parties so requests, consultations shall be held as to whether the decision needs to be revised.

The consultation process and content of the environmental impact assessment documentation for the Solsort Development project is considering recommendations given from the Economic Commission for Europe (UNECE, 1996) and the European Commission (European Commission, 2013).

The following countries have requested to be part of the Espoo process: Sweden and Germany. Norway only wants to be informed of the project and process.

The consultation process started 20 July 2021, when the Danish EPA as Espoo focal point distributed a letter of notification together with an Espoo Scoping report to the APs.

2.2 Further national and international legal requirements

2.2.1 Protection of the marine environment

The Marine Environment Act (Consolidation act no. 1165 of 25/11/2019) regulates discharges and emissions from platforms.

Discharges to sea

The associated regulation on discharges to the sea of compounds and material from certain marine facilities (Regulation no. 394 of 17/07/1984) defines the information needed to obtain a permission for discharges

Danish Environmental Protection Agency (DEPA) is the permitting authority.

The discharge permit regulates discharge of oil and chemicals to the sea and, among others, define requirements on:

- Maximum oil concentration in discharged produced water
- Limitations for total amount of oil to be discharged
- Monitoring programme for oil concentration in discharge water
- Continuous control of total oil discharge
- Classification of offshore chemicals
- Use and discharge of offshore chemicals depending on classification (explained below).
- Regular reporting on discharge of oil and chemicals.

Classification of offshore chemicals

Chemicals are classified according to the DEPA colour coding system, which follows the OSPAR classification (substitution, ranking and PLONOR) and relates to the environmental hazard of offshore chemicals. The codes are:

Black chemicals are the most critical and not acceptable to be used offshore.

Red chemicals are environmentally hazardous to such an extent that they should generally be avoided and be substituted where possible. Substances that are inorganic and highly toxic and/or have a low biodegradation are classified as red.

Green chemicals are considered not to be of environmental concern (so-called PLONOR-substances that "Pose Little Or NO Risk" to the environment) and also includes organic substances with EC/LC > 1 mg/l, acids and bases categorized as green chemicals.

Yellow chemicals are those that do not fall into any of the above categories, i.e. substances exhibiting some degree of environmental hazard, which in case of significant discharges can give rise to concern. Substances that meet one of three criterias of low biodegradation, high bioaccumulation or toxicity are classified as yellow. If substances meet two or three criteria, it will be classified as red.

Emissions

In addition, air emissions from platforms and ships are regulated in the regulation on certain air polluting emissions from combustion installations on offshore platforms (Executive order no. 1449 of 20/12/2012) and in the regulation on prevention of air pollution from ships (Executive order no. 1522 of 13/12/2019).

2.2.2 Offshore safety

To prevent and mitigate pollution, the Offshore Safety Act (Consolidation act no. 125 of 06/02/2018) requires response contingency plans for offshore platforms carrying out exploration, production and transport of petroleum hydrocarbons. The required content of such plans is specified in the associated regulation on contingency plans in case of pollution of the marine environment from oil and gas pipelines and other platforms

(Executive order no. 909 of 10/07/2015 as a result of protection of the marine environment act no. 1165 of 25/11/2019 § 34 a.).

2.2.3 National emission ceilings

Emission criteria for nitrogen oxides (NO_X), volatile organic compounds (VOC), ammonia (NH_4^+) and sulphur dioxide (SO_2) from 2010 onwards are set forth in the NEC Directive (Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001). The directive is implemented in Danish legislation through the regulation on emission ceilings for sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia (Regulation no. 1421 of 25/06/2021).

2.2.4 Industrial emissions

To minimize industrial polluting emissions to the atmosphere, water and soil, the EU has laid down a set of requirements for industrial activities with a major pollution potential. These requirements are set forth in Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). The directive is implemented in Danish legislation through the Environmental Protection Act (Consolidation act no. 1218 of 25/11/2019) and the associated regulation on certain air polluting emissions from combustion installations on offshore platforms (Executive order no. 1449 of 20/12/2012). Combustion installations with a fired effect larger than 50 MW needs an environmental approval specifying the emission limit values.

2.2.5 CO_2 emission quotas and NOX emission taxes

To reduce industrial greenhouse gas emission and to combat climate change, the EU has set up an emission trading system (EU ETS) for emission allowances of greenhouse gas. The system is set forth in Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 on establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. The system is implemented in Danish legislation through the CO_2 Quotas Act (Consolidated Act no. 62 of 19/01/2021).

Oil and gas production facilities with a total effect of 20 MW or more (including flaring and energy used for extraction of oil and gas) must prepare a CO_2 emission monitoring plan for the Danish Energy Agency approval. Also, the production facilities are obliged to monitor and measure their CO_2 emission and report the results to the Danish authorities.

According to the Act on Taxes on Nitrogen Oxides (Consolidation act no. 1214 of 10/08/2020), the offshore sector must pay an emission tax. In addition, new offshore facilities are required to be low emission units following the principles of Best Available Technique (BAT) and Best Environmental Practice (BEP). The host platform is obliged to monitor emission of NO_2 equivalents according to the regulation on monitoring nitrogen oxide (NO_X) emissions and on reimbursement of duty (Regulation no. 723 of 24/06/2011).

2.2.6 Natura 2000 areas

Natura 2000 is a network of nature protection areas established under the EU Habitats (Council Directive 92/43/EEC of 21 May 1992) and Birds (Council Directive 79/409/EEC of 2 April 1979) Directive. The network consists of Special Areas of Conservation (SACs) designated by the member states under the Habitats Directive. The network also consists of Special Protection Areas (SPAs) designated under the Bird Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats.

The directives are implemented in Danish legislation through:

› The Environmental Goal Act (Consolidation Act no. 119 of 26/01/2017)

- The Nature Protection Act (Consolidated Act no. 1986 of 27/10/2021)
- The Subsoil Act (Consolidation Act no. 1533 of 16/12/2019)
- The regulation on EIA (Consolidated Act no. 1976 of 27/10/2021)
- The Offshore Appropriate Assessment Order (Administrative Order no. 434 of 02/05/2017)
- The Habitats Order (Administrative Order no. 2091 of 12/11/2021)

Prior to any decision on projects with potential impact on a Natura 2000 area, documentation must be presented that the activity will not lead to negative effects on the favourable conservation status of species or habitats that are part of the selection basis or affects the integrity of the area negatively.

2.2.7 The OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic or OSPAR Convention is the main legislative instrument regulating international cooperation regarding the marine environment in the North Sea. The convention regulates international cooperation in the North-East Atlantic and sets European standards for the offshore oil and gas industry, marine biodiversity and baseline monitoring of environmental conditions. The focus of the convention is on BAT, BEP and clean technologies.

The OSPAR Convention has implemented several strategies on environmental issues such as hazardous substances, biodiversity and radioactive compounds. The strategies include prohibition of the discharge of oil-based mud (OBM) and how drill cuttings are managed in the construction phase. In addition, hazardous substances are regulated after principles of substitution, where less hazardous substances or preferably non-hazardous substances substitute these substances if possible. The convention requires a HOCNF (Harmonised Offshore Chemical Notification Format) and a pre-screening of substances in relation to their toxicity, persistence and biodegradability. Compounds that cannot be substituted must be ranked if not listed on the PLONOR (Pose Little Or No Risk) list, which contains the substances with no or little environmental effect.

The OSPAR commission recommends an elimination of discharges of produced water, so that in 2020 the discharge of produced water will not result in unwanted effects in the marine environment. Discharged produced water should not contain more than 30 mg dissolved oil per liter. The commission is establishing a risk-based approach (RBA) to assess the discharge of produced water. The RBA recommendation 2012/5 and the associated RBA guideline 2012-07 were adopted in 2012, and all contracting parties finalised their implementation plans in 2013 which is followed by full implementation in 2020.

OSPAR agreement 2017-02 recommends procedures for monitoring of environmental impacts of discharges from offshore installations including monitoring of sediment and water column characteristics. The monitoring programmes should comprise both baseline surveys prior to any petroleum development and follow-up surveys during exploration, production and decommissioning.

In OSPAR decision 98/3 on the disposal of disused offshore installations, OSPAR sets up the rules for leaving disused installations offshore. A disused offshore installation is defined as an offshore installation that no longer serves the purpose it was originally placed in the area for, or not serving another legitim purpose. Offshore pipelines are not covered by the decision.

The general rule is that offshore installations are not allowed to be left in a maritime area. Derogation from decision 98/3 may be considered for parts of an installation if certain conditions are met.

2.3 National approval procedure in Denmark

2.3.1 Environmental Impact assessment (EIA)

An Environmental Impact Assessment (EIA) is required to obtain an approval for offshore exploration and production of oil and gas. This requirement is set forth in Directive on the assessment of the effects of certain public and private projects on the environment (EIA Directive (Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011)). The directive is implemented in Danish legislation through the:

› Consolidated Act on Environmental Assessment of Plans and Programs and of Specific Projects (Consolidation act no. 1976 of 27/10/2021)

› Subsoil Act (Consolidation act no. 1533 of 16/12/2019)

› Regulation on EIA, impact assessment regarding international nature conservation areas and protection of certain species during offshore exploration and production of hydrocarbons, subsoil storage, pipelines, etc. (Executive Order no. 434 of 02/05/2017)

The EIA document on which this Espoo report is based is compliant with the above-mentioned legislation.

The public hearing process for offshore projects is as follows:

The project owners' application, the environmental impact assessment report and a draft permit from the authority will be available on the website of the Danish Energy Agency, and the public will have the opportunity to comment on the EIA through an eight-week public hearing phase. After the hearing period the DEA will decide if a permit for the project will be granted.

Decisions regarding the project and the EIA will be published on the DEA website, and any party with relevant and individual interests in the decision may file a written complaint on environmental issues to the Energy Board of Appeal within four weeks of the publication.

3 Technical description of project

3.1 Field description

The Solsort field is located within License 7/89, 3/09 and 4/98 in Denmark, approximately 250 km west of the Danish Coast, see Figure 3-1. The field is an oil field.

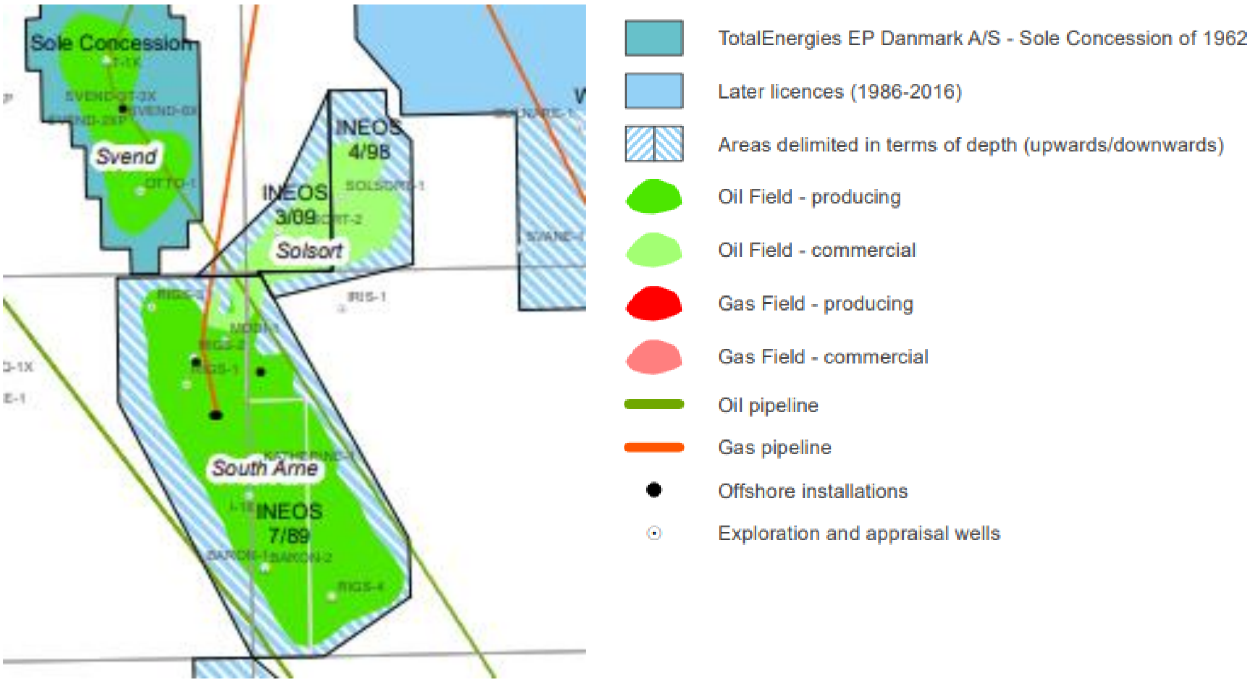


Figure 3-1 Location of Solsort field in relation to South Arne, Map of Danish oil and gas fields

An overview of surrounding infrastructures in the vicinity of the Solsort field is shown in Figure 3-2.

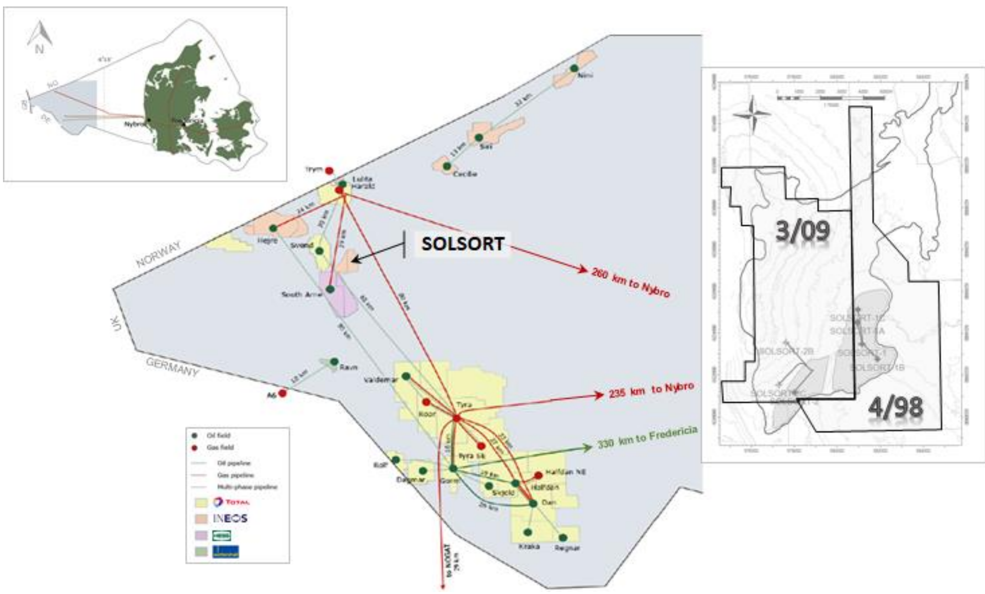


Figure 3-2 Solsort field location and surrounding infrastructure in the Danish sector of the North Sea.

The Solsort field reservoir sand is a basin floor fan system deposited in a ponded basin. The Bor Member is the oldest of the Palaeogene sand members of the North Sea. These sands are all fine grained and rich in glauconite. The sand was shed from the Stavanger Platform and transported by density flows through the Siri Canyon to their current position in the Tail End Graben to form the Solsort lobe complex. Sediment transport in the Tail End Graben was towards the South through a feeder channel system oriented parallel to the Coffee Soil Fault. Just south of the Amalie area, the transport was diverted in a south-westerly direction towards a small basin located along the evolving rim syncline east of Svend and Syd Arne salt structures and delimited to the south by the Iris inversion structure.

The field was discovered by the Solsort-1 exploration well drilled in the East Lobe in 2010 (see Figure 3-3). The Solsort-1 exploration well was drilled as a vertical well with 3 deviated appraisal side-tracks Solsort-1A, Solsort-1B and Solsort-1C that outlined the oil accumulation in the East Lobe.

Solsort-1 was followed by the Solsort-2 appraisal well in the West Lobe in 2013 as a deviated well with two deviated side-tracks appraising the Solsort-2 discovery. Solsort-2 proved the presence of 17 meter TVD hydrocarbon bearing reservoir in the West Lobe at a depth of 3008 - 3025 meters. The two appraisal side-tracks both drilled water filled reservoir.

In Figure 3-3 is indicated the outline of the 2 planned development wells in the West Lobe, one horizontal producer well and one horizontal water injection well. The horizontal sections are around 2000 meter long. Both wells are drilled from the South Arne Well Head platform North.

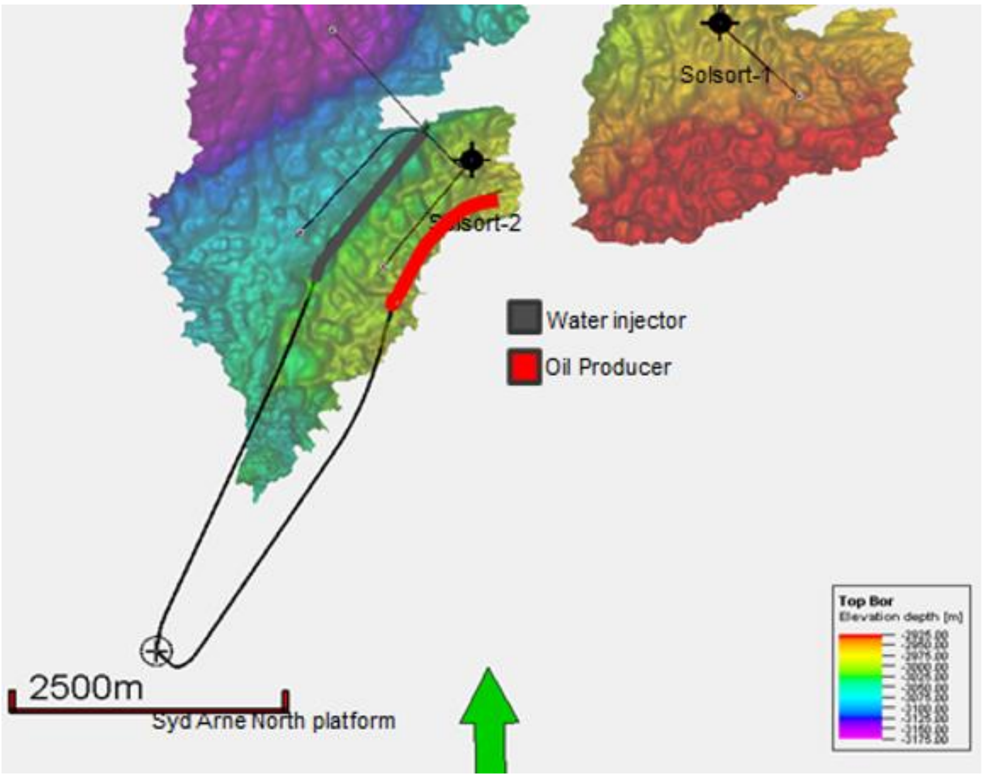


Figure 3-3 Depth map of the Solsort field East and West lobes indicating the existing exploration and appraisal wells Solsort-1, 1A, 1B, 1C and Solsort-2, 2B, 2C and the 2 new wells.

The position of the South Arne Well Head Platform North and the Solsort West Lobe wells are shown in Table 3-1.

Table 3-1 Position of South Arne Well Head Platform North and the Solsort West Lobe wells

Projection ED 50 – UTM31	**South Arne North Platform Block: 5604/29,30 Licence: 7/89**		**Solsort Block: 5604/26,30 Licence: 4/98 Block: 5604/25,26,29,30 Licence: 3/09**		
	SA Surface Location (RT 62m):		Reservoir Entry and TD:		
	East (X)	North (Y)	East (X)	North (Y)	Z m TVDSS
Producer *(WL-P-01)*	575.947,46 m	6.217.612,91 m	578.040,00	6.220.510,00	2.992,0
			579.154,00	6.221.963,00	2.992,0
Injector *(WL-WI-01)*	575.943,57	6.217.620,68	577.420,00	6.221.080,00	3.040,0
			578.503,00	6.222.606,00	3.048,0

The fluid characteristics for the Solsort West Lobe are shown in Table 3-2.

Table 3-2 Solsort West Lobe reservoir and fluid characteristics.

Parameter (unit)	Value
Reservoir depth (m)	2,900 – 3,050
Reservoir pressure (bar)	416 - 417
Saturation pressure (bar)	265 - 315
Reservoir temperature (°C)	108-109
Oil °API	35-36

3.2 Project overview

The Solsort West Lobe project involves 2 new wells - 1 producer incl. optional lift gas and 1 water injector for permanent water injector - from the Solsort West Lobe drilled from South Arne Wellhead Platform North (SA-WHPN) using South Arne (SA) as host.

The project includes:

- Drilling of up to a total of 2 wells into the Solsort West Lobe drilled from South Arne Wellhead Platform North (SA-WHPN)
- Modifications of the SA-WHPN platform including installation of equipment as for example a Solsort multi-phase meter and a scale inhibitor injection pump. No structural changes are planned for.
- A new wax inhibitor injection pump at South Arne Wellhead Platform East (SA-WHPE).
- Modifications at South Arne main including a new produced water injection booster pump for mixed seawater and produced water, modification of existing water injection pump and a new produced water filter.
- Plugging and abandonment of Solsort West Lobe wells.

3.2.1 South Arne host platform

The facilities at South Arne main, see Figure 3-4 consist of a combined wellhead, processing and accommodation platform, connected by a bridge to a wellhead platform, SA-WHPE, and an unmanned satellite platform, SA-WHPN. SA-WHPE is placed about 80 m east of the existing South Arne platform and connected to the platform by a combined foot and pipe bridge while SA-WHPN is an unmanned platform with a helideck about 2.5 km north of the existing South Arne platform. A bundle pipeline has been established between SA-WHPN and SA-WHPE, which incorporates a production pipeline, lift gas and water-injection pipelines and power supply cables. South Arne main has accommodation facilities for 75 persons.

The processing facilities at South Arne consist of a plant that separates the hydrocarbons produced and an 87,000 m^3 oil storage tank on the seabed from which the oil is exported to shore by tanker. The treated gas is exported by a pipeline to Nybro. All the produced water is processed and treated, after which as much as possible is reinjected and the rest is discharged to sea.

Figure 3-4 South Arne and well head platform East, well head platform North in the background.

The amounts of oil, gas and water produced at South Arne in 2020 are listed in Table 3-3 , together with amounts of gas for fuel and flared gas.

Table 3-3 Key activity figures from South Arne 2020 (South Arne OSPAR report 2021).

Activity	Unit	Value
Oil production	thousand Sm^3	479
Gas production*	million Sm^3	82
Produced water, discharged	thousand Sm^3	290
Displacement water discharged	thousand Sm^3	481
Injected water	thousand Sm^3	2,218

* Including for flaring and used locally as fuel

3.3 Drilling activities

3.3.1 Site Survey for relief well

A new site survey might be required to ensure a safe position for a relief well and drilling rig in case of a well control situation and if a safe location cannot be found within current survey areas.

A site survey will collect data to determine the risk level of shallow gas down to surface hole True Depth (TD), as this section is drilled with an open drilling fluid system and a diverter system. The survey will also ensure a safe seabed for rig positioning.

The site survey to be conducted with the following equipment:

- Sparker System (surface-towed Low-frequency)
- Sub-bottom profiler (Chirp) system
- Multibeam sounder
- Dual Channel side scan sonar
- Underwater positioning system
- Magnetometer

The exact equipment that is to be used is not known by now, as the contractor performing the survey has not been chosen yet. The above equipment is what is normally used during geophysical site surveys like the planned survey for the location of a rig.

Emissions

The duration of the site survey for relief well are estimated to be approximately 21 days. The conduction of the survey itself will take between 2 and 4 days, but due to potential standby in case of weather conditions and transport onshore/offshore the activities regarding the survey are set to be operational for 21 days. Emissions to air from survey activities are related to:

› Supply vessel fitted with needed equipment

The needed crew and fitted equipment are transported to and from the area by the same vessel. Thus, the whole duration of the operation including transport is accounted for regarding the associated emissions.

Underwater noise

Equipment expected to be used during the survey is listed above. Most of the equipment has been assessed as having no significant impact inside the Natura 2000, based on the frequency range, which is either too high or too low for marine mammals to hear, compared to their hearing threshold according to the report ”Environmental assessment of pipeline route survey” prepared by RAMBØLL on behalf of INEOS Oil & Gas Denmark. Noise propagation has been calculated for three of the listed instruments, which has been assessed as having the largest noise impact. The three instruments are:

› Surface-towed Low-frequency SBP GeoSpark 200TIP. Source level is estimated to be 188 dB re 1 µPa2s at 1 meter SEL.

- High Res. Sub-bottom profiler (CHIRP, Innomar SES2000 Medium). Source level is esti- mated to be 243 dB re 1 µPa2s at 1 meter SEL, corrected for beam directivity.

- Singlebeam Echosounder (Kongsberg EA 400). Source level is estimated to be 147 dB re 1 µPa2s at 1 meter SEL

3.3.2 Location assessment

Before rig arrival a site survey in form of a basic ROV will inspect the area for setting the spud cans to ensure no obstacles can intervene with the jack-up process. The ROV inspection will be carried out from a simple fishing- or supply vessel.

The area next to the South Arne North platform have had a rig standing next to it relatively recently. However, it might be required to perform new geophysical drilling activities to confirm the soil integrity for supporting another type of rig.

3.3.3 Well design and drilling

Two wells are envisaged to be drilled from the South Arne WHPN, one production well and one water injection well, into the Solsort West Lobe (WL) reservoir.

The wells are expected to be drilled by a three-legged jack-up rig from the South Arne WHPN. The drilling of the wells is planned to take place in 2023 and possible in to 2024. The planned drilling period is estimated to last 240 days, with 120 days per well. The expected depth of reservoir drilling is around 2,900 - 3,100- meters True Vertical Depth (TVD). Additionally, there is a possibility of drilling a technical side-tracks or geological side-tracks (to be decided later).

The well design considered consists of five sections: a 26" conductor pipe, an 18-5/8” surface casing, a 13-3/8" intermediate casing, a 9-5/8” production casing, and an 8-½" open hole section.

When drilling the wells, first the conductor is drilled and cemented into the seabed or hammered in position. Installation of the conductor typically takes between 24 and 86 hours. Soft start procedures will be applied if hammering of the conductor.

3.3.4 Drilling rig

INEOS Oil & Gas Denmark plan to use a jack-up rig for drilling the wells. The drilling rig is designed to minimize discharges during drilling operations.

The jack-up rig will be towed to the South Arne WHPN. When the rig is in position, the rig's legs with spud cans will be lowered into the seabed to ensure that the rig will stay stabilized during drilling operations. A spud can is a flat conical shaped foot attached to the leg of the rig, which ensures that the rig will not sink too deep into the seabed. The spud cans will typically penetrate 0.5-3 m into the seabed, depending on the underlying sediment. If necessary, the spud cans can be supported by rock dumps.

The jack-up rig will be positioned alongside the South Arne WHPN. The drilling derrick will then be positioned over the platform so that the wells can be drilled through the selected slots on the platform.

3.3.5 Use of chemicals in the construction phase

Chemicals will be used for a variety of purposes in the construction phase of Solsort West Lobe wells. Thus, several chemicals are added to the drilling muds to optimise the drilling process and subsequently for cementing and completion of the wells prior to initiation of the production. Also, chemicals are needed on the rig itself (utility chemicals).

The processes and the associated use of chemicals are described in more detail in the following sections, which include tables providing an overview of the expected amounts of chemicals with different functionalities to be used in the different construction sub-phases. Each chemical is assigned to an environmental category by use of colour codes.

It should be noted that many of the chemicals mentioned in the following tables are not or only to some extent being discharged to the sea after use. Some will remain completely or partially in the formation, while others are brought onshore e.g., along with cuttings/mud for treatment and disposal.

3.3.6 Drilling muds

Offshore drilling typically applies two types of drilling mud: water-based mud (WBM or Formate fluid) and low toxicity oil-based mud (OBM). Both types of drilling mud will be applied during drilling of the Solsort West Lobe wells (see Table 3-4).

For the Solsort West Lobe wells, WBM is applied in the 26" and 21-1/2" (18-5/8" casing) sections, and OBM is applied in the sections below 17-1/2" (13-3/8" casing) and 12-1/4" (9-5/8" casing). It will be evaluated if drilling a 12-1/4" x 13-1/2" underreamed hole have to be drilled due to hole stability issues. In addition, specifically for the horizontal reservoir drilling section (8-½"), Cs/K formate brine (WBM) drilling fluid will be used. Table 3-5 and Table 3-6 show the planned usage of chemicals for the drilling the two wells.

Table 3-4 Types of drilling mud for Solsort West Lobe wells. Water based mud (WBM), low toxicity oil-based mud (OBM) and Cs/K formate mud (horizontal sections).

Section	Drilling mud
26"	WBM
21-1/2" (18-5/8" casing)	WBM
17-1/2" (13-3/8" casing)	OBM
12 1/4"	OBM
9-½"	Cs-K Formate

Drilling muds have six primary purposes:

- Moving the cuttings (produced by the drill bit) from the well to the surface.
- Lubricating and cooling the drill bit during operation.
- Maintaining hydrostatic pressure in the well so that gas and fluids in the surrounding environment do not enter the well, thereby minimizing the risk of a kick-out or a blowout.
- Building a protective layer on the well wall to prevent loss of fluids.
- Supporting and preventing collapse of the well bore.
- Inhibiting wellbore and cuttings

The drilling rig circulates the mud by pumping it through the drill string to the drill bit. From there it travels back up the annulus space between the drill string and the walls of the hole being drilled and the last casing installed. During drilling of the lower part of the well using OBM and drilling the reservoir section with Cs/K formate, the rig switches to total containment mode to obtain zero discharge, in accordance with OSPAR Decision 2000/3. It is a closed circulating system where the mud is recycled throughout the drilling period for the well.

All WBM and the associated chemicals and cuttings are discharged to the sea a few meters below the sea surface. All OBM and Cs/K formate fluids used to drill the reservoir section and associated drill cuttings are contained and shipped for onshore disposal or recycling, alternatively they are injected into one of the cuttings re-injection (CRI) wells on the WHPN. Hence, neither OBM or Cs/K formate, nor associated chemicals or cuttings, are discharged to the sea.

Table 3-5 Estimated usage of WBM chemicals at Solsort West Lobe (per well). All the usage figures include 50% for contingencies.

Estimated use for WBM drilling	Planned use per well [tons]	Colour code
Barite	147	
Bentonite	71	
Soda ash	2.3	
Viscosifier	5.4	
pH lower	17.6	
pH control	18	
Lost circulation material (total)	242	
Defoamer	1.1	

Table 3-6 Estimated usage of OBM and Cs/K formate chemicals at Solsort West Lobe (per well). All the usage figures include 50% for contingencies.

Estimated use for OBM and Cs/K formate drilling	Planned use per well [tons]	Colour code
Chemicals for vertical OBM drilling		
Barite	1540	
Viscosifier	33	
Calcium chloride	84	
Lime	15	
Calcium carbonate	75	
Lost circulation material (total)	300	
pH lower	26	
pH control	25	
Defoamer	2.2	

Estimated use for OBM and Cs/K formate drilling	Planned use per well [tons]	Colour code
Synthetic paraffin fluid	1365	
Emulsifier	56	
Viscosifier	15	
Filtration control	15	
Chemicals for horizontal Cs/K formate drilling		
Potassium formate	1350	
Potassium bicarbonate	5.3	
Potassium carbonate	5.9	
Polymer	3.6	
Calcium carbonate	38	
Lost circulation material (total)	155	
pH lower	12	
pH control	11	
Cesium formate	165	
Filtration control	2.9	
Friction reducer	42	
H_2S scavenger	7.4	
Defoamer	0.7	

3.3.7 Cementing

Casing is cemented into place in all the sections of the well. When drilling of each section is completed, sections of metal casing, slightly smaller than the well diameter, are placed in the hole to provide structural integrity. These are fixed into place by pumping cement into the annulus space between the casing and the well wall.

The cement fluids are pre-mixed in pits on the drilling rig before being pumped into the well. To minimize the quantities of chemicals used, a cement liquid additive system is used to calculate the volumes of pre-mixed fluids required. Possible dead volumes may remain in the pit after the operation and excess cement may return from the well. In both cases, the cement will be discharged to sea.

Table 3-7 gives an overview of the estimated usage of cementing chemicals at Solsort.

Table 3-7 Estimated usage of cementing chemicals at Solsort (per well). All the usage figures include 25% for contingencies.

Estimated use for cementing	Planned use per well [tons]	Colour code
Cement	740	
Barite	180	
Retarder 1	19	
Sodium silicate	5.8	
Stabilizer/gas migration control	41	
Spacer	7.0	
Friction reducer	11	
Emulsifier	3.5	
Mutual-solvent	3.5	
Retarder 2 (only for contingency)	2.5	
Fluid loss control additive	26	
Defoamer	1.1	

3.3.8 Completion and borehole clean-up

When reaching the reservoir, the completion process begins. A sand control completion is installed in the reservoir section. Then, the top completion takes place installing the production tubing, safety valves, sensor for pressure and temperature measurements and valves for injection required downhole chemicals.

Completion of a well consists of several processes that start after the well has reached total depth (TD). The well must first be circulated clean for drill cuttings and the fluid conditioned to ensure the reservoir completion can be run to TD. The reservoir completion is run in weighted and cleaned drilling fluids. An inner string might be run inside the lower completion for optional annulus displacement to a Breaker system capable of dissolving established filter cakes or other material on the outside of the sand screen, that could plug up the sand screens during clean-up production. Then the top completion is installed and prior to setting the production packer the upper part of the well is displaced to a clean and inhibited completion fluid as the fluid could be static for a longer period between the production casing and the production tubing.

Table 3-8 provides an overview of the estimated amounts of completion chemicals to be used at Solsort WL. Possible amounts for contingencies are included in the figures.

Table 3-8 Estimated usage of completion chemicals at Solsort West Lobe (per well). All the usage figures include 50% for contingencies.

Estimated use for completion	Planned use per well [tons]	Colour code
Hydrate inhibitor (MEG + methanol)	57	Green
Viscosifier	0.3	Green
Weight control	530	Green
Bactericide	0.9	Yellow
Oxygen scavenger	1.8	Yellow
Base oil	27	Yellow
Surfactant	1.8	Yellow

The wellbore displacement to completion fluid will displace the Cs/K formate drilling fluid out of the well and up to the rig, where it will be treated and contained, or if not useable possible reinjected into a CRI well. In this process, a spacer train containing viscous and detergent pills is pumped into the well ahead of the completion fluid to maintain a good interface between the two type of fluids.

As much as possible of the returned drilling fluid from the borehole clean-up will be collected for reuse, recycling, reinjection or disposal onshore.

3.3.9 General clean-up

After completing and preparing the wells for production, a well clean-up process will be performed.

The wells are opened on the tree and the weighted drilling and completion fluid is initially removed/flowed from the wells. Once the completion fluid is produced back reservoir fluids will come to surface. As much as possible of the returned drilling and completion fluid from the well will be reinjected or shipped to shore for reuse or disposal. The wells will be cleaned-up via rig-based equipment from which the well fluids are directed to the rig-based burners and burned. Minor droplets of oil can reach the sea surface creating a thin sheen at surface, which cannot be collected with the measures in place. In case of serious oil drop-out to sea surface creating more than a sheen the oil spill response set-up will be mobilized as per normal procedure. Drilling fluid remaining after well clean-up and completion fluid below the completion tubing will be produced with the formation fluid to the clean-up surface package.

A well clean-up period is typically 24-48 hours during which flaring will take place. The well is cleaned up until the returned fluid has a quality acceptable to be handled by production facilities.

3.3.10 Well intervention/Well Service

Over the lifetime of the Solsort field, there will be some visits due to well intervention activities (wireline, coil tubing, workovers). Some of these will be planned maintenance activities, while others are contingency activities that will only take place if something is wrong with the wells.

In total, up to 6 to 8 months of rig visits to Solsort West Lobe wells are expected over the lifetime of the field. The rig type is assumed to be similar to that used for the drilling activities. It is not given that the full number and duration of rig visits will be needed.

3.3.11 Utilities

A limited number of chemicals will be used at the rig during the construction and testing of the Solsort West Lobe wells (utility chemicals), mainly for cleaning, sealing and lubricating purposes. Table 3-9 lists the estimated amounts of utility chemicals planned to be used at Solsort West Lobe.

Table 3-9 Estimated usage of utility chemicals at Solsort West Lobe (per well).

Estimated use for utility	Planned use per well [tons]	Colour code
Rig wash	48	
Pipe dope	0.5	
Jacking grease	0.3	
Casing grease	0.3	
POB control line fluid	0.3	

About 50% of the rig wash chemical is expected to be discharged to sea while only about 10% of the other rig chemicals will be discharged.

3.4 Overview of usage of chemicals during drilling

In summary, the expected usage of chemicals in the different stages of the construction are listed in Table 3-10 segregated into the main hazard categories (DEPA colour classification black, red, yellow and green). All hazard categories have been included in the table although chemicals in the category black are not planned to be used. Possible amounts for contingencies are included in the figures (50% for drilling chemicals and 25% for cementing chemicals).

Table 3-10 Overview of expected usage (in tons) per well of chemicals classified as black, red, yellow and green for the main construction activities at Solsort. No chemicals classified as black is planned to be used. All the usage figures include amounts for contingency

Activity	Black chemicals (tons)	Red chemicals (tons)	Yellow chemicals (tons)	Green chemicals (tons)
Drilling, WBM	0	0	1.1	503
Drilling, OBM + Cs/K formate	0	15	1656	3679
Cementing	0	0	48	993
Completion	0	0	32	587
Utility	0	0	49	0

3.5 Discharges to the sea during drilling

During the construction of a well, a number of the materials or chemicals being used or generated will be discharged to the sea. In terms of tonnage, the discharge of cuttings and water-based drilling mud, WBM, are the most significant. WBM consists mainly of a brine with added bentonite and barite and a number of agents aimed at regulating viscosity and stabilising clay. OBM and cuttings including Formate fluids and cuttings from the reservoir sections will not be discharged to sea.

Table 3-11 provides an overview of the amounts of cuttings and muds from different drilling sections (per well) and their fate.

Table 3-11 Estimated generation and discharge of cuttings and drilling mud at Solsort West Lobe (per well).

Section	Amount of cuttings [MT]	Drilling mud [m^3]	Discharge to sea
26''	269	858 (WBM)	Cuttings: 1392 MT WBM: 858 m³
23''	1123		
17 ½''	1322	1247 (OBM)	0 (OBM, not dis-charged)
12 ¼''	574		
9 ½''	386	563 (Cs/K formate)	0 (Cs/K formate, not discharged)

As can be seen in the table, all OBM and Cs/K formate cuttings with adhered mud will be reinjected or shipped onshore for further treatment and disposal, and, thus, there will be no discharge from the sections drilled with OBM and/or Cs/K formate.

The construction of a well at Solsort includes drilling, cementing and completion. Stimulation or fracking will not be necessary. In addition to these, the operation of the rig itself requires a number of utility chemicals for e.g. rig wash etc. Some of the chemicals will be discharged to sea. The amounts of chemicals estimated to be discharged from the different activities are shown in Table 3-12 according to colour coding. The largest amount of chemicals discharged will be from the green category. The figures include amounts for contingencies set conservatively at 50% for all drilling chemicals and 25% for all cementing chemicals.

Table 3-12 Overview of estimated discharge of black, red, yellow and green chemicals per well for the main construction activities at Solsort. No chemicals classified as black is planned to be used.

Main activity	Black chemicals per well [tons]	Red chemicals per well [tons]	Yellow chemicals per well [tons]	Green chemicals per well [tons]
Drilling, WBM	0	0	1.2	470
Drilling, OBM and Cs/K formate	0	0	0	0
Cementing	0	0	12	274
Completion	0	0	2.3	338
Utility	0	0	24	0

3.6 Emissions during drilling

Emissions to air in relation to drilling activities are related to:

- Energy production at the rig
- Crew transport activities by helicopter, standby boat and supply boat
- Flaring during well clean-up
- Volatile Organic Compound (VOC) emissions from the oil-based mud

The vessel types in Table 3-13 will be used for transport.

Table 3-13 Type of transport related to drilling activities for 2 wells (provided by INEOS Oil & Gas Denmark).

	Numbers	Days	Fuel consumption [m^3/day]
Drilling			
Rig	1	280[1]	11.4
Supply vessel	3	128[2]	4.8
Standby boat	1	280[3]	4.8
Tugs	2	15[4]	20
Helicopters (kerosene)		36[5]	1.2

[1] The rig is operating 140 days per well.
[2] 3 supply vessels operating 11 hours/day in 280 days equivalent to 43 days per vessel per well.
[3] Standby boat is available 24 hours/day while rig is operating.
[4] Operation of tugs for transportation of the rig
[5] Helicopters are operating 3 hours/day equivalent to 10 days per well.

An estimation of the emissions related to drilling activities is included in the Environmental Impact assessment.

3.7 Modification at South Arne Installations

The wells will be drilled utilising the most appropriate slots on South Arne North platform. The production and injection flowlines will be installed within the existing allocated future flowline space envelope and utilise existing future slot control provisions on WHPN and in the well head control panel. Production fluids will be metered by a new dedicated multiphase flow meter (MPFM). Post metering, the Solsort West Lobe produced fluids will be routed to the existing production header and comingled with native South Arne production at WHPN and then transported onto South Arne main platform via the existing multiphase subsea production pipeline via WHPE. The West Lobe produced water will be reinjected as part of the South Arne produced water reinjection.

3.7.1 Water injection

Mixed water (Sulphur Removal Package (SRP) plus produced water (PW)) will be supplied from the existing WHPN water injection manifold for injection into the West Lobe reservoir. A new produced water filter is anticipated to be required within the existing produced water pump train at the South Arne main platform to achieve the Solsort mixed water suspended solids specification. An additional Produced Water booster pump might be installed later, either for capacity reasons or for improving uptime.

3.7.2 Gas Lift

Gas lift of the West Lobe production well is only required as a contingency if the reservoir pressure is depleted or the well productivity is very poor, i.e. the gas lift is a risk mitigator rather than a production optimisation. In this case the gas lift pressure system available on South Arne WHPN will be used.

3.7.3 Chemicals

All West Lobe chemical injection requirements will be supplied from South Arne. It is expected that new dedicated scale inhibitor pumps are required at WHPN to accommodate Solsort injection rates. Chemicals in use at South Arne for the same services are assumed to be suitable for Solsort.

South Arne currently does not carry Wax Dissolver chemical for intermittent start-up. Base case assumption is supply from a temporary system mobilised as required to South Arne WHPN rather than provide permanent facilities.

Continuous wax inhibition injection via the existing umbilical from WHPE to the WHPN subsea pipeline is done for mitigating against wax formation in the South Arne crude oil coolers, storage and export systems. For this purpose, a new wax inhibitor pump will be installed at the SA-WHPE.

Use of chemicals during production is described in the Environmental impact assessment for Solsort West Lobe.

3.7.4 Emissions

Emissions to air during modification of the South Arne installations are related to:

- Supply boat
- Standby boat.
- Crane operations

The South Arne supply boat will be utilised also for the South Arne modifications, thus no additional emissions related to this activity is expected. It is expected that lift of equipment can be handled by the lifting equipment on board the South Arne installations.

Based on the above no additional emissions are expected due to the modifications required due to tie-in of the Solsort West Lobe wells.

4 Potential transboundary impacts

4.1 Procedure for risk assessment

Environmental risk is the combination of the significance (severity) of an impact and the probability that an impact may arise. This implies for instance that an incidence that may cause severe impacts but is not very likely to occur has a low environmental risk.

For each operation or incidence, the assessment of environmental risk includes three steps:

› Assessment of environmental significance (severity) of an impact.

› Assessment of the probability that an impact will occur.

› Assessment of risk by combining severity and probability.

4.1.1 Assessment of environmental significance (severity) of an impact

Qualitative assessments of environmental severity of impacts of different operations and events will be carried out for both the EIA screening and the Natura 2000 screening. The assessment of severity includes the following steps:

› Assessments of nature, extension, duration and magnitude of impacts using the criteria shown in Table 4-1, including whether the impact is positive or negative, temporary or permanent.

› Assessment of the severity of impacts combining the assessments of extension, duration and magnitude of the impacts using the criteria shown in Table 4-2.

Table 4-1 Criteria for assessment of nature, extension, duration and magnitude of impacts.

Criterion	Description
Nature	***Nature of the environmental change***
Positive	Beneficial environmental change
Negative	Adverse environmental change
Extension	***The geographical area that may affected by the impact***
Local	Only the place where the activities directly related to construction and drilling operations may occur - within 500 meters of the activity
Regional	Effects may occur in the Central North Sea (Beyond 500 meters)
National	Effects may occur in Danish waters
International	Effects may occur in the entire North Sea
Duration	***Period along which the impact is expected to occur***
Short-term	Less than 8 (eight) months
Medium-term	Between 8 (eight) months and 5 (five) years
Long-term	More than 5 (five) years
Magnitude	***The magnitude of impacts on environmental and social processes***
Small Medium Large	If possible, the magnitude of an effect is assessed from results of environmental modelling. Otherwise, the magnitude of an effect is based on an expert assessment based on previous experience from other projects. The following factors are taken into consideration: › The extent to which potentially affected habitats and organisms are unaffected by human activity › The numbers/areas of an environmental feature that will be potentially affected › The uniqueness/rarity of potentially affected organism and habitats › The conservation status of habitats or organism (Natura 2000 areas, Annex IV species etc.). › The sensitivity of the habitat/organism › The robustness of the organism/habitats against impacts, i.e. and evaluation of the ability to adapt to the impact without affecting the conservation status, uniqueness or rarity › The potential for replacement i.e. an assessment of to what extent the loss of habitats or populations of organisms can be replaced by other.

Table 4-2 Criteria for assessment of severity of potential impacts of the project.

Severity rating	Relation with the criteria on nature-, extension-, duration- and magnitude that describe the impact
Positive impact	The assessed ecological or socioeconomic feature or issue is improved compared to existing conditions
No impact	The assessed ecological or socioeconomic feature or issue is not affected
Insignificant impact	Small magnitude, with local extension and short-term duration.
Minor impact	1) Small magnitude, with any combination of other criteria (except for local extension and short-term duration, and long-term duration and national or international extension) or 2) Medium magnitude, with local extension and short-term duration.
Moderate impact	1) Small magnitude, with national or international extension and long-term duration; or 2) Medium magnitude, with any combination of other criteria (except for: local extension and short-term duration; and national extension and long-term duration 3) Large magnitude, with local extension and short-term duration;
Major impact	1) Medium magnitude, with national or international extension and long-term duration; 2) Large magnitude, with any combination of other criteria (except for local extension and short-term duration)

4.1.2 Assessment of the probability that an impact will occur

The probability that an impact will occur will be assessed using the criteria shown in Table 4-3.

Table 4-3 Criteria for assessment of the probability and if the impact will occur.

Probability criterion	Degree of possibility of impact occurrence
Very low	The possibility of occurrence is very low, either due to the project design or due to the project nature, or due to the characteristics of the project area
Low	The possibility of occurrence is low, either due to the project design or due to the project nature, or due to the characteristics of the project area
Probable	There is possibility of impact occurrence
Highly Probable	Possibility of impact occurrence is almost certain
Definite	There is certainty that the impact will occur

4.1.3 Risk assessment

The environmental risk of different operations and incidences will be assessed combining significance (severity) and probability of an impact according to a risk matrix as outlined below (Table 4-4).

Table 4-4 Qualitative risk assessment matrix.

	Significance /severity of impact			
Probability	Insignificant Impact	Minor impact	Moderate impact	Major impact
Definite	Negligible risk	Low risk	Significant risk	High risk
Highly probable	Negligible risk	Low risk	Significant risk	High risk
Probable	Negligible risk	Negligible risk	Low risk	Significant risk
Low	Negligible risk	Negligible risk	Low risk	Low risk
Very low	Negligible risk	Negligible risk	Negligible risk	Low risk

5 Screening of potential transboundary impacts

A screening of potential transboundary impacts has been carried out based on the methodology described in section 4 and the detailed assessments made in the EIA report.

Based on the results of the detailed assessment, the Espoo report presents a screening of the same impacts in relation to their potential transboundary effects. Because of the low range for most of the project impacts, significant transboundary impacts can be ruled out with certainty in many cases. Subsequently, these impacts are not further elaborated on in this chapter, and focus is given to those impacts for which significant transboundary impact cannot be excluded in the first round.

An overview of potential transboundary impacts has been prepared, see Table 5-1 below.

Table 5-1 Screening of potential transboundary impacts

Activity	Potential impact	Transboundary evaluation
Environmental impacts of activities during the construction phase		
Presence of drilling rig	› Impacts on fisheries and shipping due to exclusion zones around drilling rigs	› Local impact only.
Discharge of drill cuttings, drilling mud (WBM) components and cementing chemicals (only discharge of green and yellow chemicals) and of treated sewage	› Physical smothering of seabed mainly affecting benthic fauna › Water contamination from suspended cuttings, solids and drilling chemicals and impact on pelagic organisms › Sediment contamination from drilling chemicals affecting benthic fauna › Discharge of treated sewage	› Local impact only at short distances from the platform. › Local impact only. Several field studies have consistently shown that drilling waste solids are diluted and deposited within 30 meters from the rig. › Local effect only in the vicinity of the drilling sites › Negligible local impact
Well completion	› Discharges of completion fluids can impact on water quality and marine fauna. However, only green chemicals are discharged.	› Local or no impact.
Noise from site survey, drilling operation and ramming of well conductor casing	› Impact on marine mammals and fish	› Impacts from site survey and ramming in Danish waters only (up to 20 km from site). The site is more than 20 km from the UK, NO and GE border, and therefore negligible

Activity	Potential impact	Transboundary evaluation
		local impact. Soft start procedures will be used. › Noise from site survey and drilling operations are local.
Accidental spills and blowout	› Mainly birds, marine mammals, fish, coastal ecosystems, fisheries, aquaculture and tourism may be affected. Blowouts are extremely rare events › Economic loss to fisheries, aquaculture and tourism due to oiling	› Potential transboundary impacts are possible › Potential transboundary impacts are possible
Environmental impacts of activities during the production and decommissioning phase		
Accidental spills Blowout	› Extremely rare events. Experience from previous blowouts and oil spills at sea have shown that it is mainly birds, marine mammals, fish, coastal ecosystems, fisheries, aquaculture and tourism than may be affected › Economic loss to fisheries, aquaculture and tourism due to oiling › Mainly birds, plankton, fish eggs and larvae may be affected.	› Potential transboundary impacts are possible › Potential transboundary impacts are possible › Potential transboundary impacts are possible

6 Environmental assessment of accidental oil and chemical spills

The impacts of the following types of accidental spills have been assessed in this chapter:

- Spill of oil and emission of gas during an accidental blowout. This may occur during the construction, operation and decommissioning phase.
- Accidental spill of chemicals from the drilling rig during the construction of wells.
- Accidental spill of chemicals from the host platform during the production phase.

Blowouts causing discharge and dispersal of oil are extremely rare events. However, in case of blowout the environmental impacts may be severe. Experience from previous blowouts and oil spills at sea have shown that it is mainly birds, marine mammals, fish and coastal ecosystems that may be affected by large oil spills.

6.1 Environmental impact of an oil release during a blowout incident

The worst-case scenario in terms of accidental oil spill is an uncontrolled blowout during drilling of a well or during normal production.

A blowout is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed. A drilling blowout can result from a range of causes. These include loss of well control because of design, equipment and/or human failure. Loss of well control is among the major emergency incidences that would have low probability of occurring but high risk of causing large uncontrolled gas or oil release into the marine environment that could cause wide reaching effects.

6.1.1 Risk of blowout

Blowout is an extremely rare event and extensive preventative/control measures are implemented to reduce the likelihood of such events. It has been estimated that the risk (frequency) of a blowout occurring at Solsort is 9.7×10^{-6} per year (IOGP – Risk Assessment Data Directory – Report No. 434-2, March 2010).

A blowout will last until the well is under control again. This may take anywhere from a few hours if control can be regained using the safety systems present, up to several months if an additional well needs to be drilled to regain control over the original well. History shows that most wells can be brought back under control within one to a few days.

6.1.2 Fate and effect of oil

During a blowout the oil is spread with the currents, simultaneous undergoing a wide array of processes including evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation. Oil components and their breakdown product may affect marine and coastal habitats and species. In general, the most severe impacts of an oil spill will occur if the oil slick passes concentrations of seabirds or if the oil ends up in near coastal waters and on shorelines.

6.1.3 Methodology

Impacts of oil released during a blowout has been assessed from the results of oil spill modelling, known dose-response relations between concentrations of oil components and effects on marine organisms and effects observed during previous oil-spills.

Oil Spill modelling

Oil Spill Response Limited UK carried out an oil spill modelling of blowouts at Solsort using the OSCAR statistical oil drift model developed by SINTEF, Norway. OSCAR is a 3D modelling tool used to predict the movement and fate of oil on the sea surface and throughout the water column. Details of the modelling are reported in Oil Spill Modelling Report for Solsort Development (DONG 2015).

Four blowout scenarios were modelled:

- Scenario 1. Seabed release with a release rate of 4,432 m³/day during summer (April-September)
- Scenario 2. Seabed release with a release rate of 4,432 m³/day during winter (October-March)
- Scenario 3. Surface release with a release rate of 4,368 m³/day during summer (April-September)
- Scenario 4. Surface release with a release rate of 4,368 m³/day during winter (October-March).

The setup of the four scenarios is summarized in Table 6-1.

Table 6-1 Oil spill modelling. Summary of setup for spill scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total oil Volume released	332,400 m³	332,400 m³	327,600 m³	327,600 m³
Release rate	4,432 m³/day	4,432 m³/day	4,368 m³/day	4,368 m³/day
Duration of release[1)]	75 days	75 days	75 days	75 days
Depth of release	62.4 m	62.4 m	0 m	0 m
Time of year	Summer (April-September)	Winter (March-October)	Summer (April-September)	Winter (March-October)
Total Run Duration	82 days	82 days	82 days	82 days

1) The duration of release of 75 days was chosen, as it is the time that will take to drill a relief well.

The modelling represents worst-case scenarios without unmitigated spills and a release duration of 75 days. The release duration is a conservative estimate of the time taken to drill a new relief well. Efficient contingency measures will reduce the spreading of spills significantly and thereby the extent and magnitude of environmental damage.

The South Arne oil spill contingency plan will be updated for drilling activities and work-over activities accordingly to ensure that the set up for oil spills is “fit for purpose”.

Environmental assessment

The assessment of the environmental impacts of accidental blowout is based on a matrix using all four scenarios representing a worst-case scenario in which no mitigating oil spill response measures are taken. The simulations have been made using both stochastic and deterministic modelling.

Stochastic modelling possesses some inherent randomness versus a deterministic model where the output is fully determined by the parameter values and the initial conditions.

The use of a stochastic model means that the blowout can be analysed statistically. However, the prediction represents the gross area that may potentially be affected by a spill as it combines the impact area of several single spill events and therefore does not represent how a blowout will look realistically.

In contrast, the deterministic model simulates a single spill at a chosen date under the weather conditions at that point in time. Thus, it predicts the actual trajectory of a single spill event, but it does not consider the statistical uncertainty of the fact that the spill trajectory will be different under different weather conditions.

Efficient oil spill response measures will reduce the spreading of spills significantly and thereby the extent and magnitude of environmental damage is most likely smaller than the model results indicate.

Table 6-2 provides a list of the threshold used in the impact assessment.

Table 6-2 Sea surface, water column and shoreline thresholds for impact scoring

Species/habitat exposed to oil	Threshold	Justification
Seabirds, emulsion on water surface	1 µm	The 1 µm threshold is considered below levels which would cause harm to seabirds from exposure of oil. Exposure above threshold will lead to effects such as transferring oil to eggs reducing hatching success (French-McCay 2009).
	10 µm	The 10 µm threshold for oil on water surface has been observed to lead to 100% mortality of impacted seabirds and other wildlife associated with the water surface (French-McCay 2009).
Seabirds, shoreline	"Light oiling" or above on shoreline	Light oiling of shoreline may result in mortal impact on seabirds.
Marine mammals (fur-bearing), oil emulsion water surface	10 µm	The 10 µm threshold for oil on water surface has been observed to mortally affect fur-bearing marine mammals such as seals (French-McCay 2009).
Marine mammals (fur-bearing), oil emulsion on shoreline	"Light oiling" or above on shoreline	Light oiling impacting shoreline may result in mortal impact on fur-bearing marine mammals such as seals, if they get impacted when hauling onto or resting at beaches.
Marine mammals (cetaceans), oil emulsion on water surface	100 µm	Cetaceans are less sensitive to oil compared to seals, as it does not stick to their skin. Cetaceans can inhale oil and oil vapour when surfacing to breathe leading to internal injuries (French-McCay 2009).
Fish, THC in water column	25 ppb	Following guidelines from the Norwegian Oil Industry Association effects of acute oil pollution on fish eggs and larvae will be seen in THC concentrations >25 ppb

Species/habitat exposed to oil	Threshold	Justification
	70.5 ppb	According to OSPAR 2014/5 concentrations >70.5 ppb is considered as having potential for chronic impacts to juvenile fish and larvae that might be entrained within the oil plumes
	500 ppb	The 500 ppb threshold is considered conservative high exposure level in terms of potential for toxic effects leading to mortality of 50% of all marine life if impacted by an acute oil spill
Seabed habitat	25 ppb	Seabed habitats considered are protected reefs and areas with protected cold-water corals; areas with a high ecological production. This threshold is used to identify when the most sensitive marine life (fish eggs and larvae) begins to be affected by acute oil pollution on. Based on guidelines from the Norwegian Oil Industry Association.
Shoreline habitats	"Light oiling" or above on shoreline	The Environmental Sensitivity Index (ESI) is used for assessing the sensitivity of various types of shoreline to acute oil pollution.

6.1.4 Modelled dispersion of oil during a blowout with no deployment

Spreading of oil

Figure 6-1 shows the modelled probability that the sea surface in 10x10 km grid cells could be hit by >1 tonnes of oil released at Solsort during summer (April-September) and during winter (October-March), respectively.

A number of individual trajectories were analysed to create the stochastic results for each scenario. Each trajectory began on a different start date, so that each oil spill was simulated using a range of wind and current conditions. Thus, Figure 6-1 shows the combined probabilities of 142 trajectories (summer) and of 119 trajectories (winter), respectively. This means that the simulation does not show the result of a single oil spill, but rather the combined probabilities for a cell in the model to be impacted by oil.

It is seen that released oil during a blowout incident will mainly be transported towards northeast with the prevailing currents, but may also be transported to German, Dutch and UK waters.

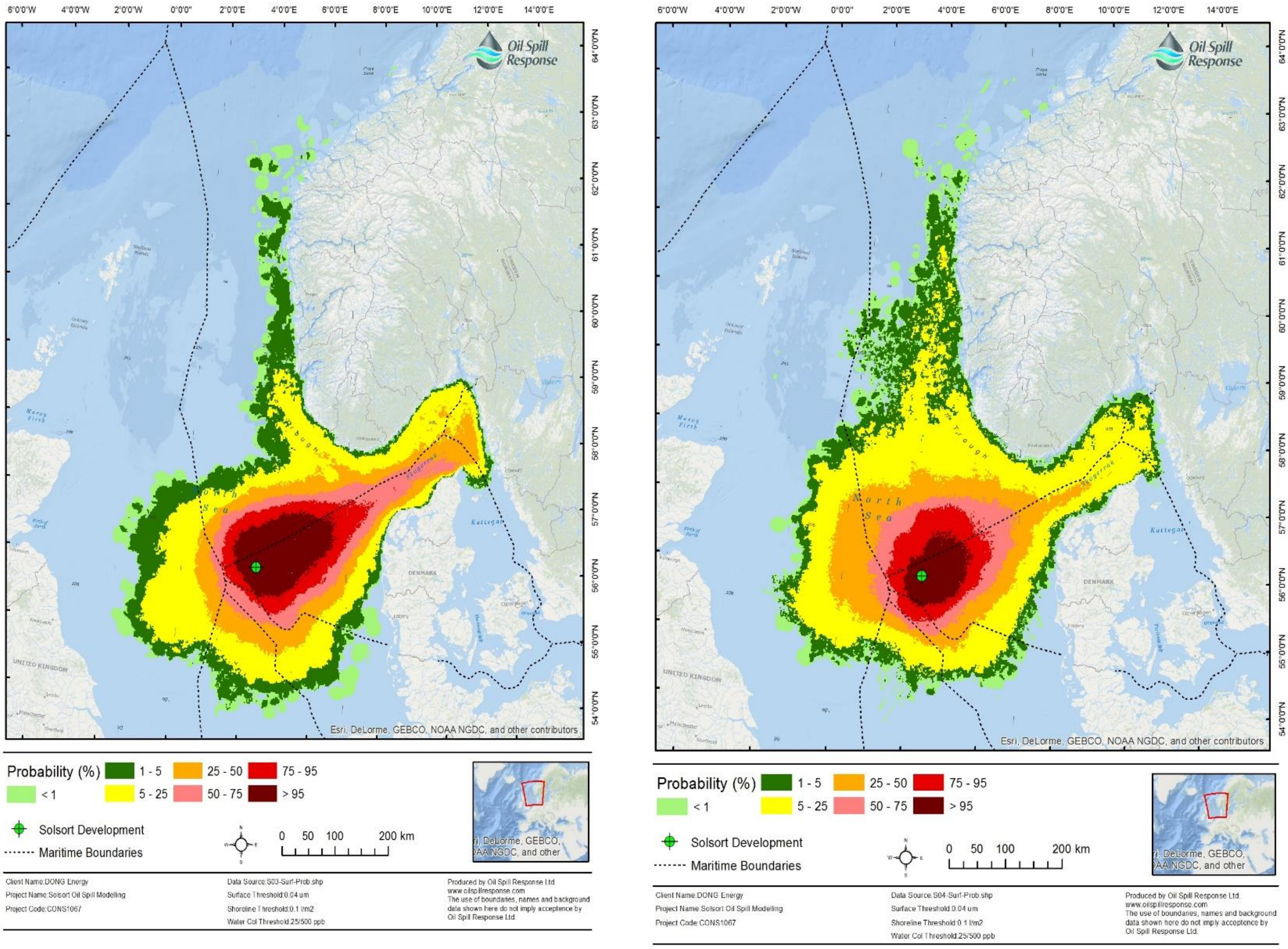


Figure 6-1 Result of oil spill modelling of a worst case, unmitigated surface release of a blowout at Solsort during summer (April-September) (left) and winter (October-March) (right). Combined probability of 142 trajectories that the sea surface in 10x10 km grid cells could be impacted by oil release from Solsort West Lobe wells (DONG Energy 2015).

Figure 6-1and Figure 6-2 shows the seasonal resolution of arrival times (since start of the release) within the influence area to 10 x 10 km grid cells (drift time). It is seen that it will take approximately 2 weeks for oil to reach shore. However, it should be noted that although all shores are statistically affected by oil in case of a blowout according to Figure 6-1, Figure 6-3 shows that the amount of oil that hits the shore has a thickness smaller than 5 µm.

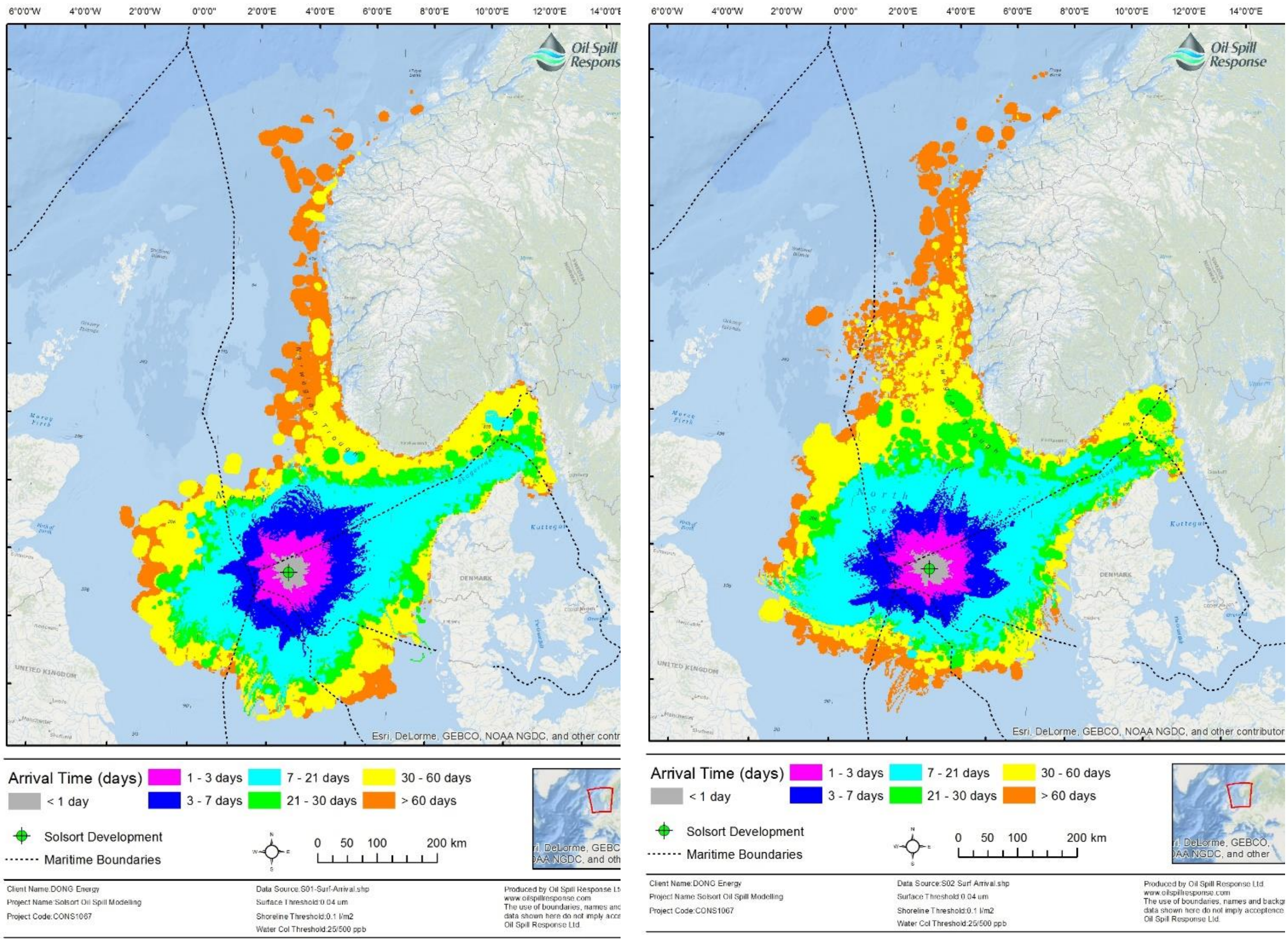


Figure 6-2 Result of stochastic oil spill modelling of a worst case, unmitigated surface release of oil during a blowout at Solsort during summer (April-September) (left) and winter (October-March) (right). The figures show the seasonal resolution of arrival times (since start of the release) within the influence area to 10 x 10 km grid cells (DONG Energy 2015).

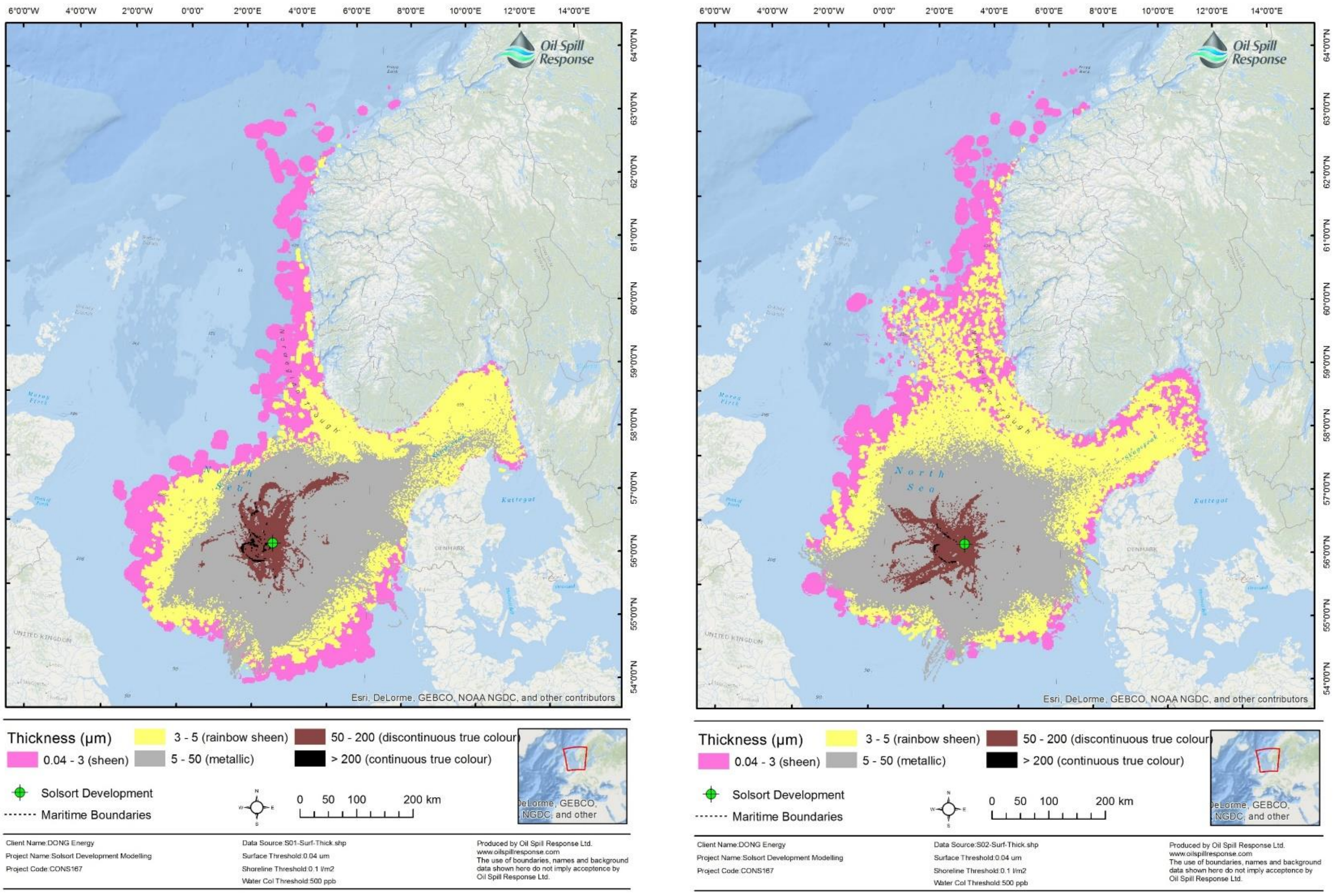


Figure 6-3 Seasonal resolution of surface oil thickness within the influence area to 10 x 10 km grid cells. Result of oil spill modelling of a worst case, unmitigated surface release of a blowout at Solsort during summer (April-September) (left) and winter (October-March) (right). (From DONG Energy 2015). The thickness named sheen marked as pink is 0.04-0.3 and not as stated in the figure and the rainbow sheen marked as yellow is 0.3-5.

A worst-case trajectory that results in most oil ashore has been selected and the result of the simulation is shown in Figure 6-4.

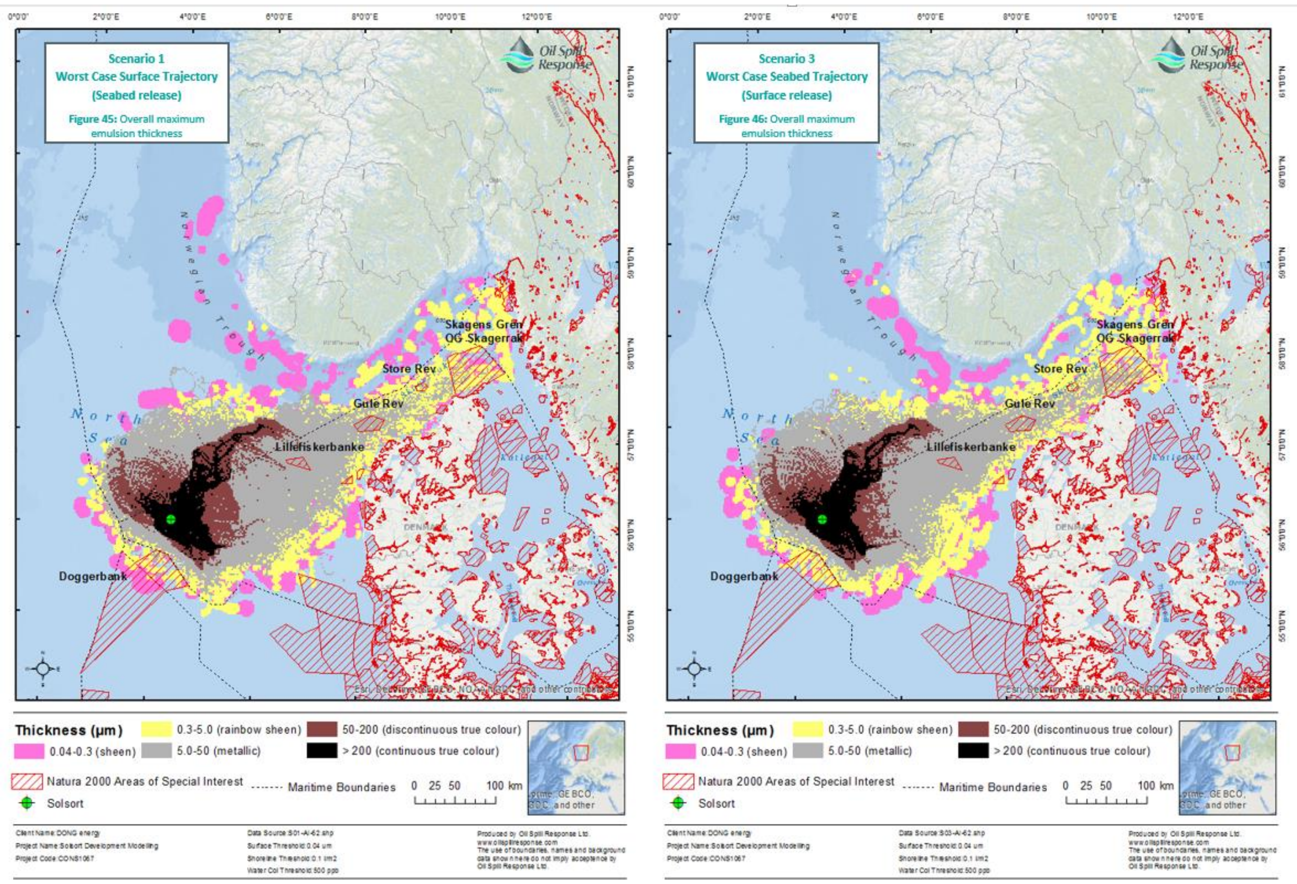


Figure 6-4 Result of oil spill modelling of a worst case, unmitigated surface and seabed release (DONG Energy 2015).

Table 6-3 shows the expected surface oil layer thickness corresponding to the oil mass according to the Bonn Agreement (2016). Five levels of oil appearances are distinguished in the Bonn Agreement.

Birds are generally considered to be affected by surface oil when the emulsion thickness exceeds 1 µm whereas seals and cetaceans (incl. harbour porpoise) are more tolerant to surface oil. Latter being affected when emulsion thickness exceeds 10 µm and 100 µm for seals and cetaceans respectively (French-McCay 2009).

Table 6-3 Levels of oil appearances distinguished according to the Bonn Agreement (2016).

Code	Description -Appearance	Layer thickness (µm)	Tonnes per 100 km^2
1	Silver/gray	0.04 - 0.30	4 - 300
2	Rainbow	0.30 - 5.0	300 - 500
3	Metalic	5.0 - 50	500 – 50,000
4	Discontinuous true oil colour	50 - 200	50,000 - 200,000
5	Continuous true oil colour	> 200	> 200,000

The modelling showed a similar picture for seabed release of oil. However, it should be noted that oil released from a seabed may behave differently to oil spilled on the surface. Although oil spilled on the surface may reach the water column through natural dispersion caused by wind energy, the majority will typically remain on the surface and undergo weathering processes such as evaporation and spreading. Large underwater oil plumes can be caused by oil spilled from the seabed due to buoyancy fluxes in the water column. In some cases, oil becomes trapped at a certain density gradient and does not reach the surface.

The modelling shows that the maximum total oil concentration in the water column is <150 ppb and the maximum dissolved oil concentration is <10 ppb (for seabed release). For comparison, 25 ppb is the threshold at which the most sensitive marine life will begin to be affected. It is based on guidelines from the Norwegian Oil Industry Association concerning the effects of acute oil pollution on fish eggs and larvae. 500 ppb is the threshold at which acute toxicity is caused to over 50% of the marine life based on a literature review conducted by BP.

In the following, the model results are assessed in relation to potential impacts on sea birds, marine mammals, fish eggs- and larvae, shorelines and Natura 2000 sites.

6.1.5 Impacts on sea birds of oil released during a blowout incident

It is well-documented that seabirds are extremely vulnerable to oil spills and that large amounts of seabirds are often killed in connection with an oil spill in areas where seabirds are concentrated. The reason for seabirds being especially vulnerable is that they are often in contact with surface water and that the oil destroys the buoyancy and the isolating quality of the plumage. Birds smothered in oil will usually die of cold, starvation or drown. Even very small spots of oil may be fatal, especially during winter. Mainly seabirds that stay on the sea surface for longer periods are at risk, but all types of seabirds may be affected (Trosi et al 2016). The threshold for emulsion thickness considered as harmful for birds is 1 µm (French-McCay 2009) (roughly 100 t per 100 km^2, Table 6-3). Exposure above this threshold will lead to effects such as transferring oil to eggs reducing hatching success. Emulsion thickness of more than 10 µm will lead to immediate killings.

In the unlikely event of a blowout incident at Solsort West Lobe well the oil will most likely be transported towards northeast with the prevailing currents and pass the internationally important bird areas in the north eastern part of the North Sea. The probability that this area will be impacted is high in case of an oil blowout (75-> 95%). The drift time to these areas are 1-7 days (DONG Energy 2015).

The area is important for gulls and auks (i.e. mainly little auk, but also guillemot and razorbill (Skov et al. 1995, Skov et al. 2007). The auks are particularly vulnerable to oil spills as they spend most of their time on the sea surface. The birds are particularly vulnerable during winter where most species are clustering. It is estimated that around 1 million birds are present in the North Sea during winter (Skov et al. 2007). The northern part of the Danish EEZ in the North Sea is considered an intermediate important conservation area for seabirds (Skov et al. 2007). Consequently, there is a high risk of oiling and killing of birds in this area in the unlikely event of a blowout. On the other hand, the important bird areas in and immediately off the Wadden Sea will not be affected.

6.1.6 Impacts on marine mammals of oil released during a blowout incident

The modelling shows that oil from a blowout may hit areas where harbour porpoise, grey seals or harbour seal may be encountered. Harbour porpoises and seals are generally less vulnerable to oil spill than birds (i.e., threshold for seals is estimated to 10 µm while the threshold for cetaceans is 100 µm, French-McCay 2009) (10 µm corresponds to ca.100 t oil per 100 km^2 (Table 6-3). As their heat insulation is due to their layer of blubber a porpoise or seal smothered in oil will not be fatal as is the case with a bird.

Harbour porpoise

Comparative little is known about the effects of oil on cetaceans (whales, dolphins and porpoises), but based on scant records of cetacean mortality associated with oil spills, it has been suggested that an oil spill may only affect small numbers of cetaceans. Several authors suggest that the threat of most immediate concern is inhalation of evaporated volatile toxic components from the oil slick on the sea surface if they emerge at the surface to breathe in the middle of an oil slick. This risk is greatest near the source of a fresh spill because volatile toxic vapours evaporate and disperse relatively quickly. When concentrated vapours are inhaled, mucus membranes may become inflamed, lungs can become congested, and pneumonia may ensue. Inhaled fumes from oil may accumulate in blood and other tissues, leading to possible liver damage and neurological disorders. As porpoises rely on blubber for insulation their thermoregulatory ability does not seem seriously hampered by contact with oil (Helm et. al. 2015).

Harbour porpoises in the Central North Sea, may be affected in the unlikely incidence of a blowout at Solsort. However, as the oil slick during a blowout is transported in a relatively narrow band in the direction of the currents and as the density of porpoises is relatively low (0.01-8 individuals/km^2 only a tiny fraction of the populations of Harbour porpoise in the North Sea is likely to be affected. It is therefore not likely that a potential oil contamination from a blowout will significantly affect the population sizes of the Harbour porpoises in the North Sea.

Seals

Seals may be affected by direct contact with oil in a variety of ways. Oil can coat all or portions of their body surface and they may inhale toxic fumes of hydrocarbons, which affects their lungs. In addition, they may ingest oil directly or ingest oil-contaminated prey. As seals rely on blubber for insulation their thermoregulatory ability does not generally seem seriously to be hampered by contact with oil. However, observations suggest that some individuals have become so encased in oil that they were not able to swim and subsequently drowned. In addition, observation also suggest that eyes, oral cavity, respiratory surfaces and urogenital surfaces are particularly sensitive to contact with oil (Helm et al. 2015).

It cannot be excluded that seals in the Central North Sea may be affected. However, as the oil slick during a blowout is transported in a relatively narrow band in the direction of the currents and as seals are relatively rare in the Central North Sea only a tiny fraction of the populations of seals is likely to be affected. It is therefore not likely that a potential oil contamination from a blowout will significantly affect the population sizes of the seals.

6.1.7 Impacts on fish eggs and larvae of oil release during a blowout incident

Eggs and larvae are considered the most sensitive life stages of fish in terms of acute impacts of spilled oil.

The Norwegian Oil Industry Association use 25 ppb as the concentration at which fish eggs- and larvae and other sensitive marine life begin to be affected by oil components. A literature review conducted by BP suggested that oil content greater than 500 ppb will cause acute toxicity to over 50% of the marine life in the area (DONG Energy 2015).

Figure 6-5 and Figure 6-6 show the simulated probability that the water column in 10x10 km grid cells might be impacted by concentrations ≥ 25 ppb (upper figure) and ≥ 500 ppb (lower figure) during a surface release of oil at Solsort during summer and winter, respectively.

It is seen that high probabilities of encountering concentrations above 25 ppb that may affect fish eggs and larvae are found within up to 75 km from Solsort. Eggs and/or larvae of cod, mackerel, plaice, herring and sandeels that may be encountered in this area may therefore be affected by an oil-blow-out.

There is only a small probability (< 1-5%) that larvae in the important nursery areas for larvae of cod, whiting, Norway pout, haddock and sandeel at the productive hydrographical front in the north-eastern part of the North Sea will be affected by an oil blow-out.

The modelling showed a similar picture for a seabed release of oil (DONG Energy 2015).

There is no evidence to date that any oil spill in open offshore waters has affected the size of fish populations although oil is very toxic to fish eggs and larvae. Several studies have demonstrated that massive kills of fish eggs and larvae near oil spills may occur without causing any detectable effects on fish populations. The lack of effects on numbers in subsequent adult populations following massive kills of eggs and larvae is probably because most fish species produce vast numbers of eggs and larvae and because most species have extensive spawning grounds (ITOPF 2019, IPIECA 2000, Falk-Petersen & Kjørsvik 1987, Serigstad & Adoff 1985).

It is therefore assessed that an oil blow-out will not affect the fish stocks despite increased mortality of fish eggs and larvae.

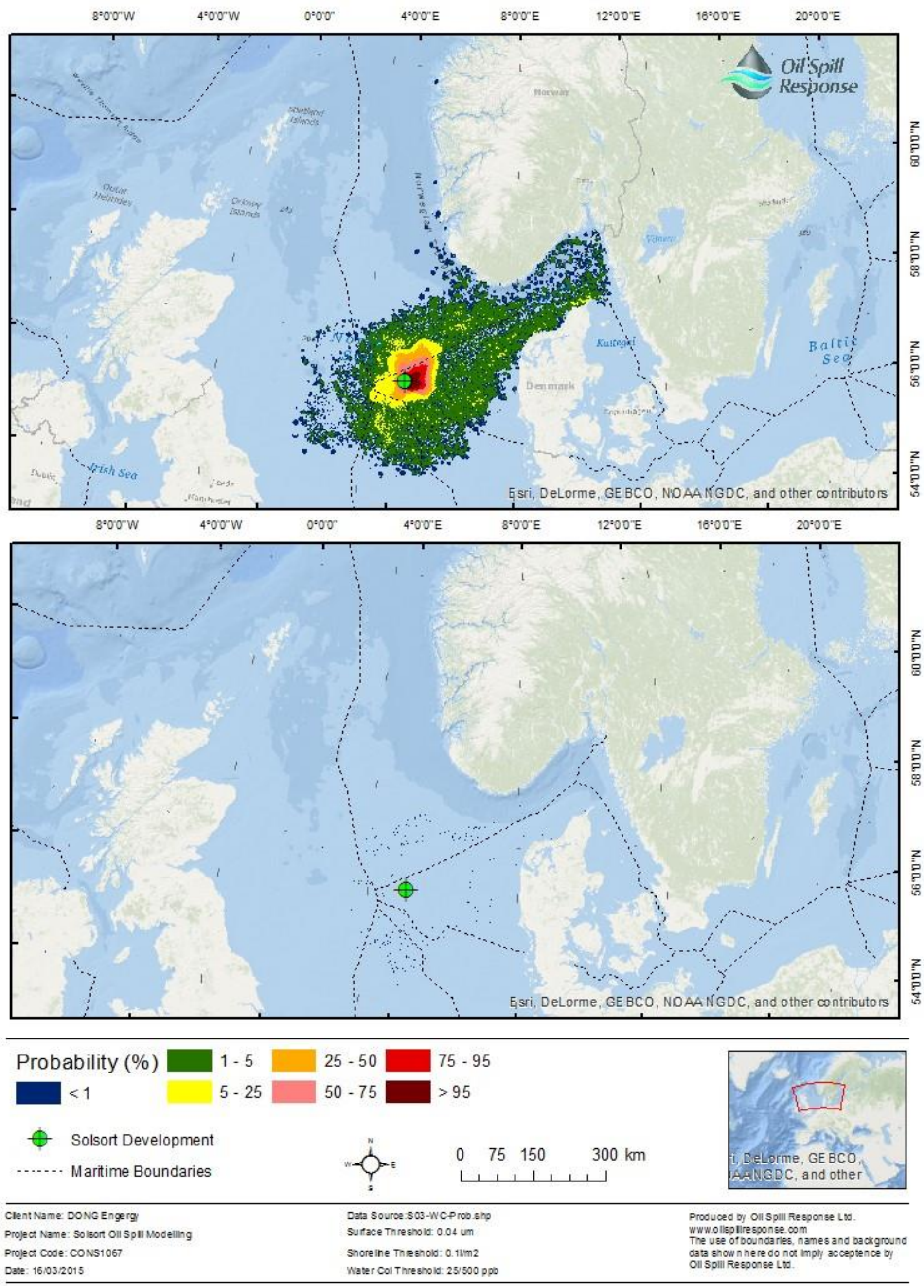


Figure 6-5 Water column contamination due to surface release during summer (April–September) at Solsort. Probability that 10x10 km grid cells could be impacted by concentrations ≥ 25 ppb (upper figure) and ≥ 500 ppb (lower figure). (From DONG Energy 2015).

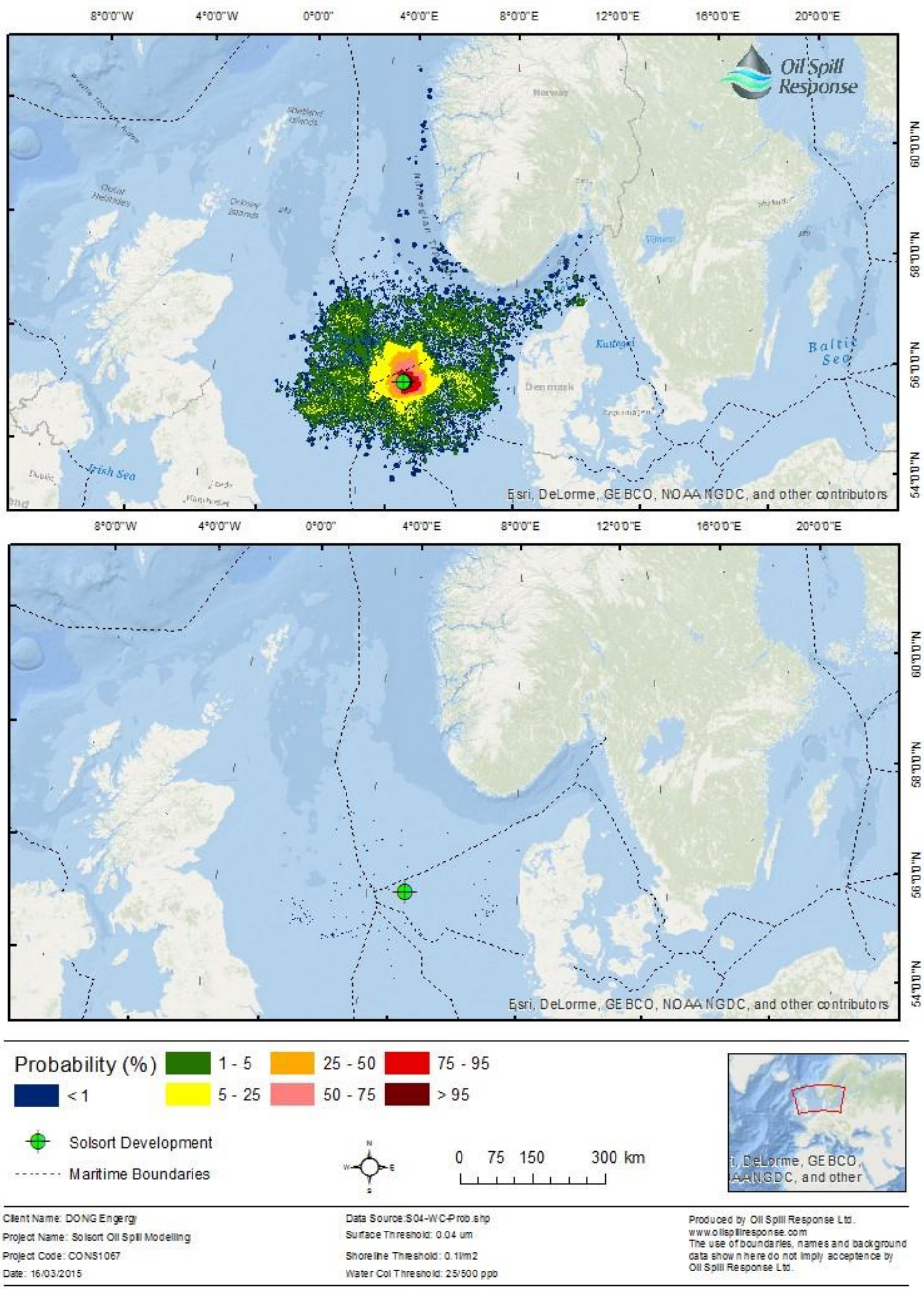


Figure 6-6 Water column contamination due to surface release during winter (October-March) at Solsort. Probability that 10x10 km grid cells could be impacted by concentrations ≥ 25 ppb (upper figure) and ≥ 500 ppb (lower figure). (DONG Energy 2015).

6.1.8 Impacts of oil stranded on shorelines during a blowout incidence

Shorelines, more than any other part of the coastal environment, are exposed to the effects of floating oil. Oil stranded on beaches often gives rise to concern because it may affect sensitive coastal habitats and important socioeconomic conditions. Further, the cleaning of oiled beaches may be costly. The vulnerability of shorelines to oil spills differs considerably depending on the type of habitat and with respect to how easy they are to clean up after an oil spill.

The OSCAR modelling showed, that in case of a blow-out with surface release during summer, oil may strand on beaches along the west coast of Vendsyssel, Thy and the western side of Harboøre Tange. Oil may also strand on the south coast of Norway and in a very small area in the northern part of the Swedish Skagerrak coast. The probability is, however, quite low in most of the areas, i.e. 1-5%. In some areas, the probability is 5-25% and at Skagen it is 25-50% (Figure 6-8). Along the affected Danish coast, the degree of oiling will only be light to moderate. The oiling on the Norwegian south coast and the Swedish coast will mostly be light (Figure 6-9).

The Danish coastlines, which may be hit by stranded oil are generally exposed, gently sloping sandy beaches. These types of beaches are not particularly vulnerable to oil as they are not very productive ecologically. In addition, the oil does not penetrate the sand readily, facilitating mechanical removal (IPIECA 1996). As the drift time from Solsort to the shoreline will be in the range 30-60 days (DONG Energy 2015), the stranded oil will mostly be in the form of tar balls. This can be seen from Figure 6-7, which illustrates the breakdown processes of oil over time. The most volatile components have evaporated, and emulsification and dispersion have almost terminated after approximately a week, leaving only hard degradable oil components that can form tar balls by wave impacts. Tar balls are even easier to remove on sandy beaches compared to less weathered oil. However, the stranded oil in the summer period may be a nuisance to holidaymakers bathing from the beach.

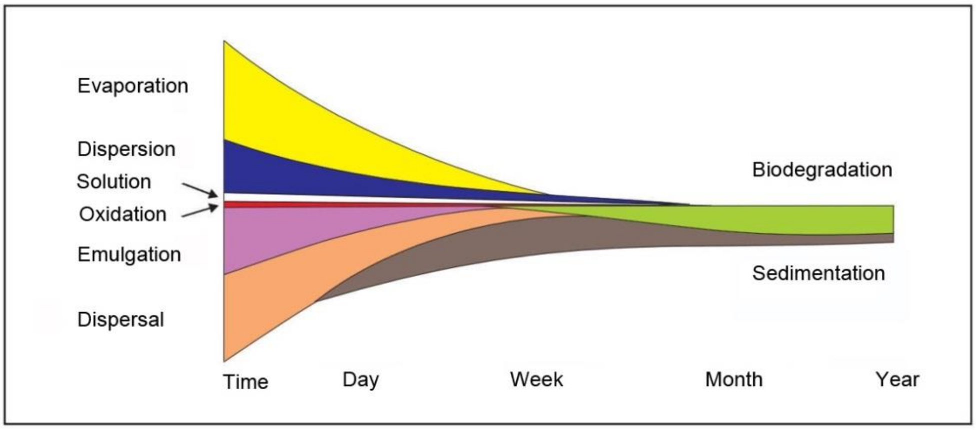


Figure 6-7 Overview of the relative significance of the different physical and chemical processes that affects spilled oil at sea as a function of time (after ITOPF 2002).

The biologically highly productive tidal flats and saltmarshes in the Wadden Sea in the southern part of the Danish coast will not be affected.

The Norwegian and Swedish coastlines that may be hit by oil are rocky shores that are more sensitive to oil spills compared to the Danish sandy shores. However, with a drift time of 30 to more than 60 days (DONG Energy 2015) most of the oil will be in the form of tar balls, which are considerably less damaging as they are no longer sticky or toxic.

The overall probability of shoreline impact of an unmitigated blow-out ranges between 80-98% for winter and summer releases, respectively. Shoreline oiling is likely to range between very light and moderate, as defined by ITOPF's recognition of shoreline oiling guidelines. Under the worst-case metocean conditions, the quickest impact on the shoreline in Denmark will be between 14-19 days. Shoreline impact may also happen in Norway (after 24-37 days) and Sweden (after 27-45 days). There will be no shoreline impact in UK, Germany or the Netherlands.

In case of a blow-out with surface release during winter, the extent of affected shorelines will be considerably smaller than for a release during summer. Along the Danish coast, only the stretch on the west coast of Vendsyssel between Hirtshals and Skagen may be hit by oil. In addition, a considerably smaller area along the Norwegian coast may affected and the Swedish coast will not be hit . A worst-case mass release onshore result during surface release in summer (April-September) result in 3 MT ashore after 21 days and 120 MT after 82 days. A worst-case winter mass release result in 6 MT after 21 days and 30 MT after 82 days. The modelling showed that the risk, the extent, and the degree of oiling of shorelines during a seabed release of oil is quite similar to a surface release (DONG Energy 2015).

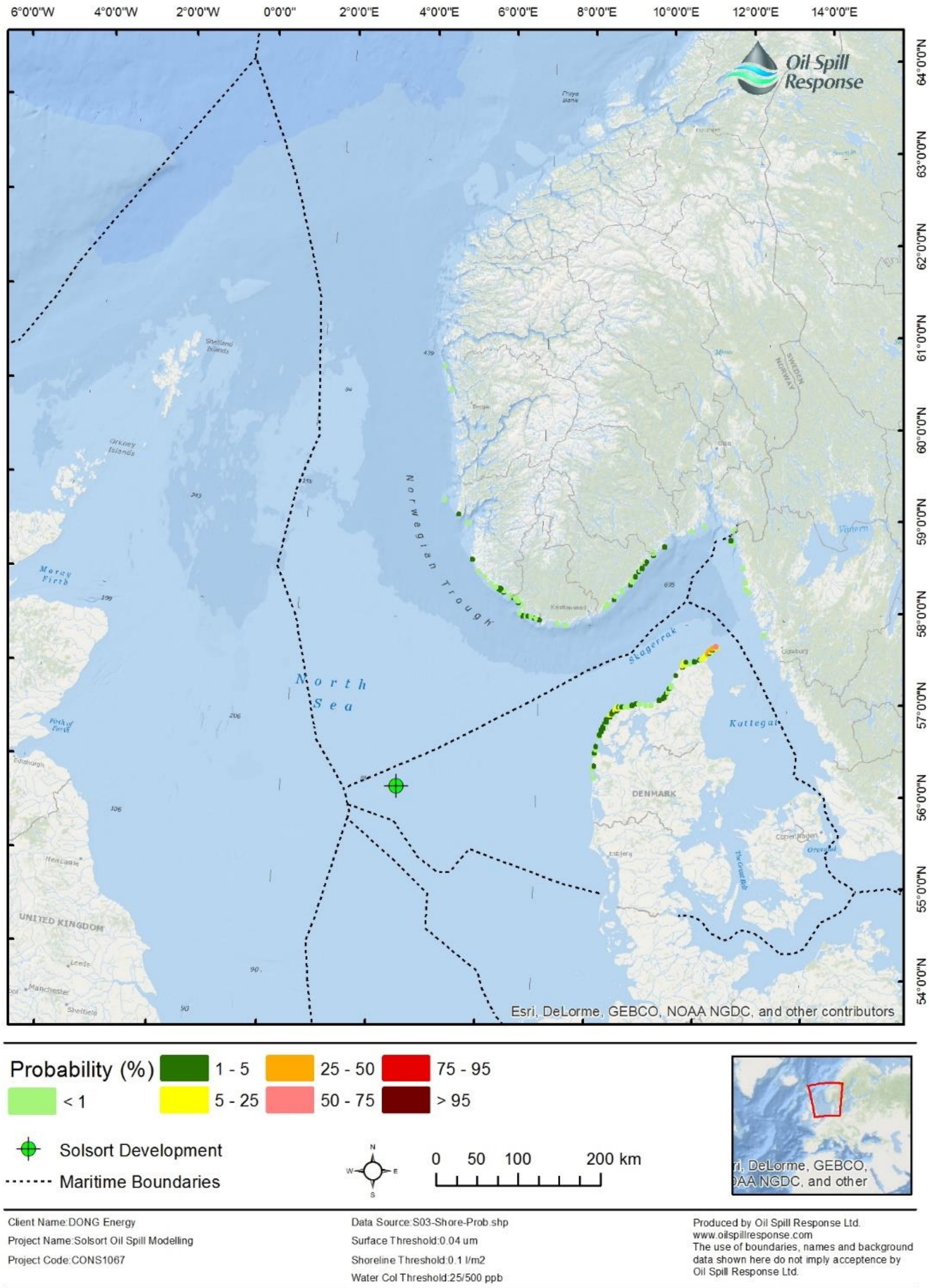


Figure 6-8 Shoreline contamination from a worst case, unmitigated surface release during summer (April–September). Combined probability of 142 trajectories that 10x10 km coastal grid cells will be impacted by oil release at Solsort. (DONG Energy 2015).

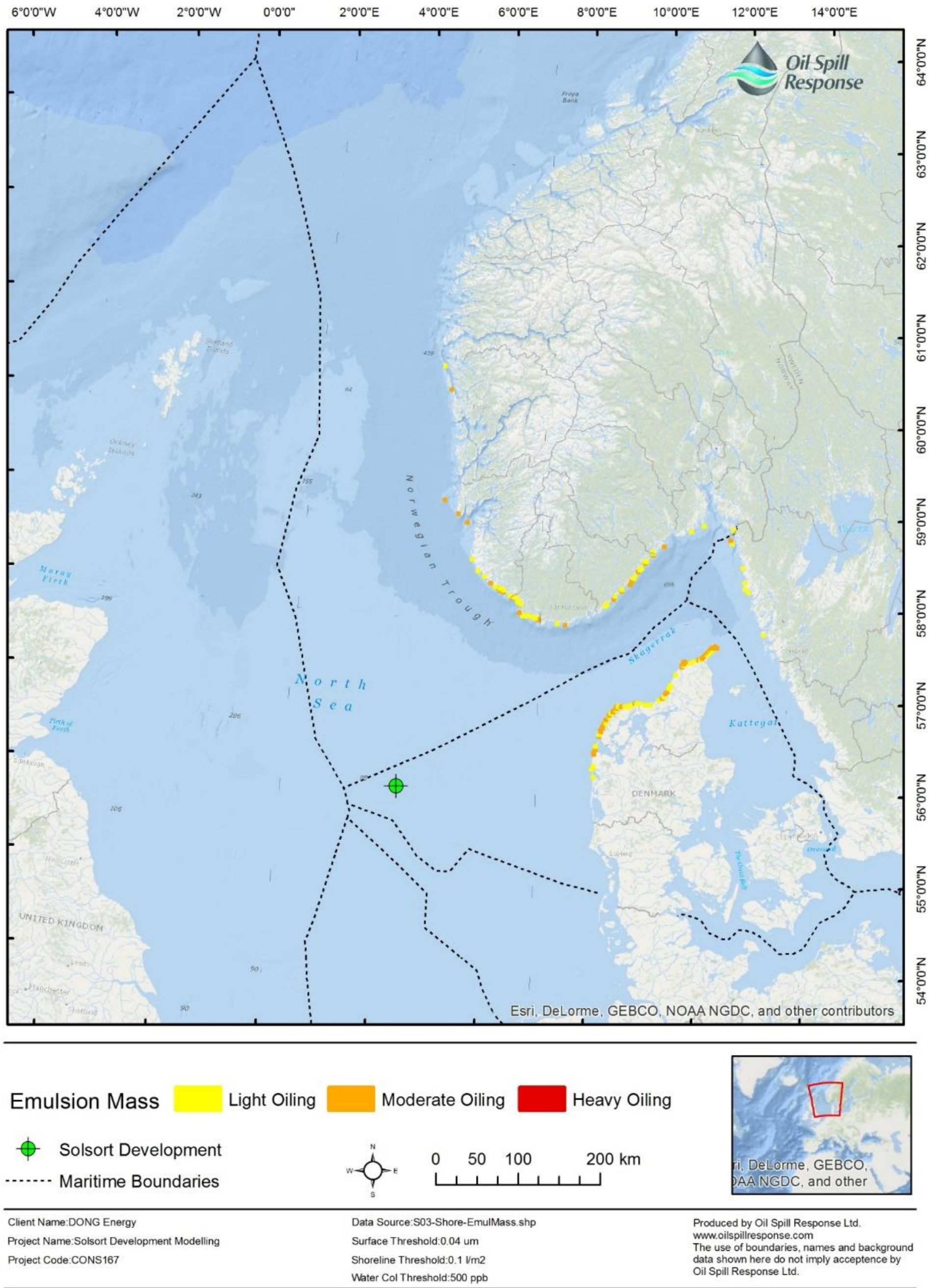


Figure 6-9 Shoreline contamination due to surface release during summer (April–September). Degree of oiling due to oil release at Solsort. (DONG Energy 2015).

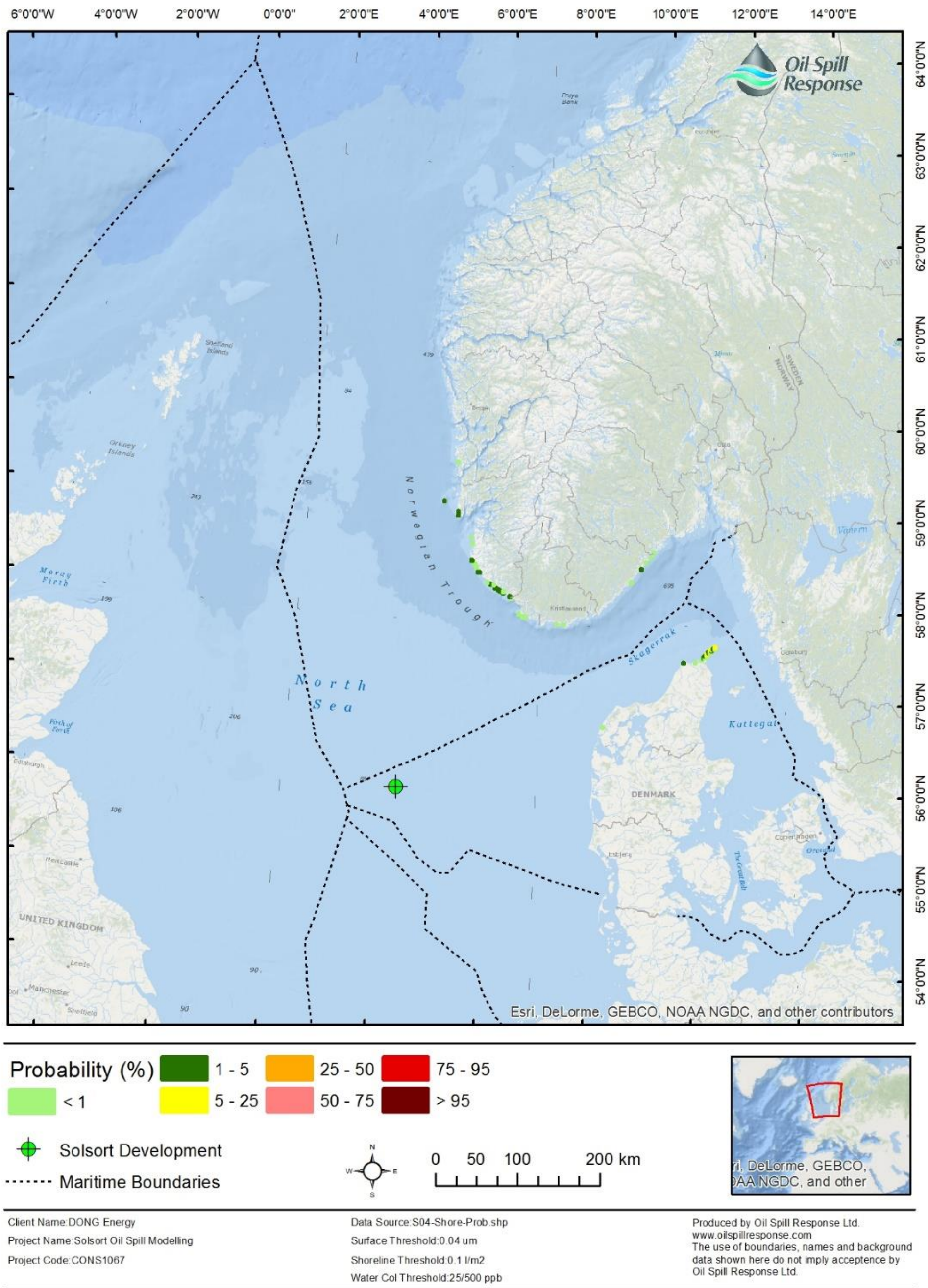


Figure 6-10 Shoreline contamination due to surface release during winter (October-March). Combined probability of 142 trajectories that 10x10 km coastal grid cells could be impacted by oil release at Solsort. (DONG Energy 2015).

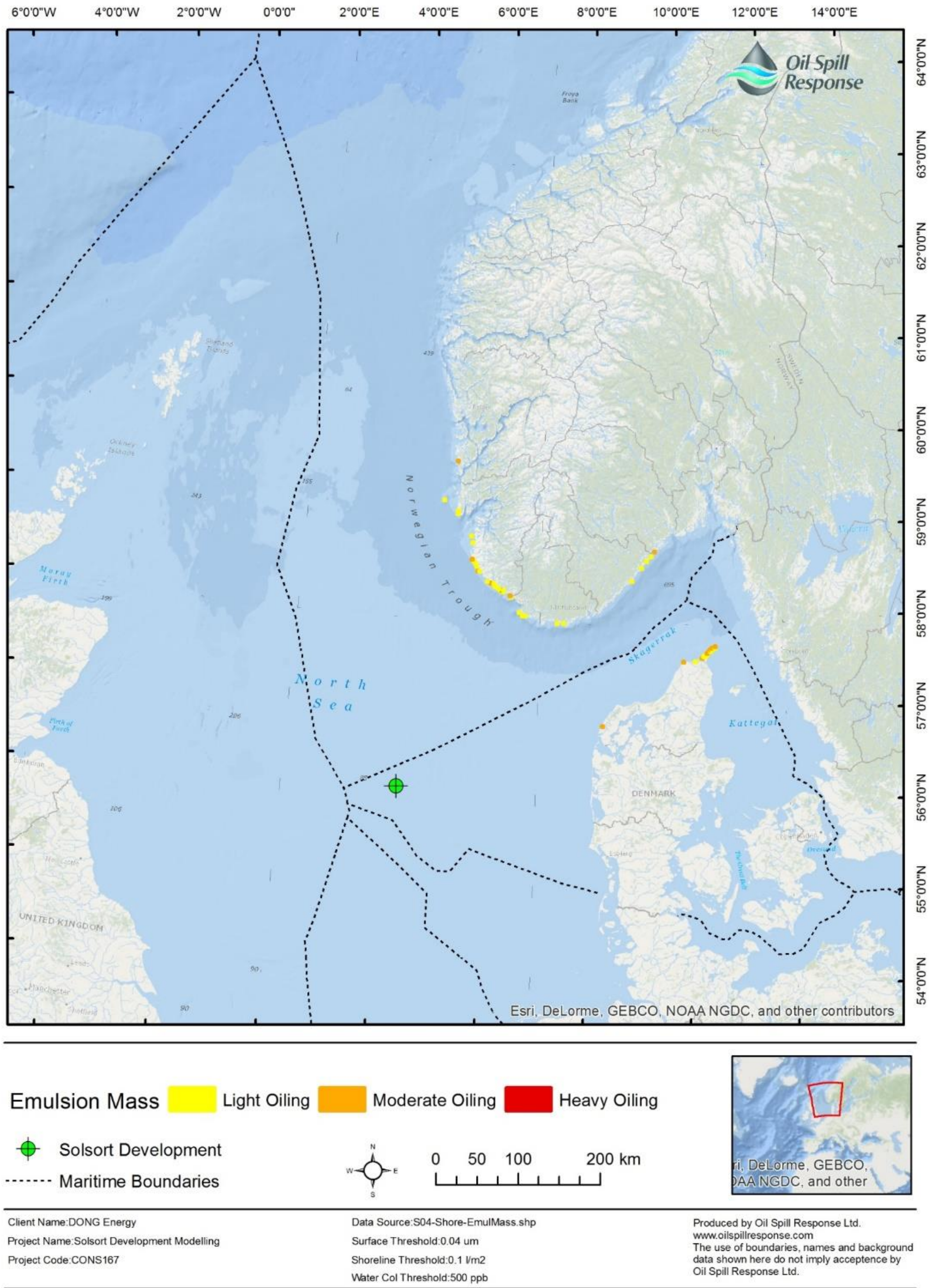


Figure 6-11 Shoreline contamination due to surface release during winter (October-March). Degree of oiling due to oil release at Solsort. (DONG Energy 2015).

Table 6-4 Model results. Fastest time for oil to reach the shoreline of different countries (DONG Energy 2015).

Scenario	Description	Country	Fastest time to reach shoreline	Shoreline oiling thickness
Scenario 1	Seabed release (summer)	Denmark	14 days and 1 hour	0.04-5.00 µm
		Sweden	27 days and 17 hours	0.04-5.00 µm
		Norway	33 days and 12 hours	0.04-5.00 µm
		United Kingdom	No shoreline oiling	
		Netherlands	No shoreline oiling	
		Germany	No shoreline oiling	
Scenario 2	Seabed release (winter))	Denmark	13 days and 14 hours	0.04-5.00 µm
		Sweden	37 days and 12 hours	0.04-3 µm
		Norway	30 days	0.04-5.00 µm
		United Kingdom	No shoreline oiling	
		Netherlands	No shoreline oiling	
		Germany	No shoreline oiling	
Scenario 3	Surface release (summer)	Denmark	14 days and 18 hours	0.1 mm – 10 mm (light to moderate)
		Sweden	42 days and 7 hours	0.1 mm – 10 mm (light to moderate)
		Norway	36 days	0.1 mm – 10 mm (light to moderate)
		United Kingdom	No shoreline oiling	
		Netherlands	No shoreline oiling	
		Germany	No shoreline oiling	
Scenario 4	Surface release (winter)	Denmark	19 days and 4 hours	0.1 mm – 10 mm (light to moderate)
		Sweden	45 days and 22 hours	0.1 mm – 1.0 mm (light oiling)
		Norway	24 days and 21 hours	0.1 mm – 10 mm (light to moderate)
		United Kingdom	No shoreline oiling	
		Netherlands	No shoreline oiling	
		Germany	No shoreline oiling	

6.1.9 Impacts on Norwegian SVOs

The modelling shows that Norwegian SVOs may be hit by oil in case of an unmitigated blowout (Figure 6-2) i.e.:

- There is a probability of 5-25 % probability that SVO "*Makrellfelt*", which is a spawning area for mackerel from May to July will be hit by oil. The calculated drift time from Solsort is 30-60 days.

- Sandeel field south may also be hit (probability 50-75%; drift time 3-7 days. The Sandeel field south is spawning and foraging areas for sandeel (*Ammodytes* sp.). Furthermore, the Sandeel field south is a valuable habitat for common guillemot (*Uria aalge*) and northern fulmar (*Fulmaris glacialis*) from April to December. The model results show that the concentration of oil in these areas above 25 ppb, which is above the concentrations that are harmful to fish eggs and larvae. Spawning in this area is therefore at risk. Likewise, there is a risk of oiling and killing of birds on the Sandeel field South.

6.1.10 Impacts on German, Dutch and UK Natura 2000 areas south-southeast of Solsort

In the unlikely event of a blowout, the German and Dutch Natura 2000 areas south-south-west of Solsort are likely to be affected by the spill, especially the German area i.e. (cf. Table 6-5):

- There is a 50-95 % probability that oil hits the German *DE 1003301 Doggerbank* and the drift time of oil to this area is 1-7 days.

- The Dutch *NL 2008-001 Doggerbank* may be hit, the probability being 1-75 % and the drift time 3->60 days depending on the distance from Solsort.

The model shows that the UK SAC, *UK0030352 Doggerbank* is not likely to be hit.

Table 6-5 Results of oil OSCAR spill modelling of oil spill following a blowout at Solsort. Probabilities that the German and the Dutch Natura 2000 sites close to Solsort are hit by oil and drift time of oil during summer and winter in case of seabed release and surface release.

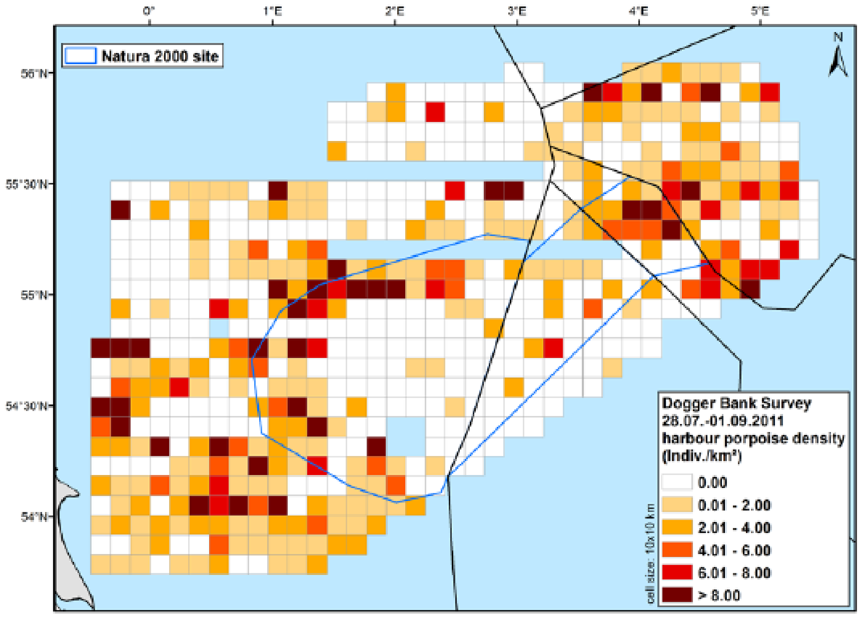
Type of blow-out	Season	Site	Probability that the area may be hit by oil	Drift time from blowout to site
Seabed release	Summer	DE 1003301 Doggerbank	50-95 %	1-7 days
		NL 2008001 Doggerbank)	1-75 %	3-30 days
	Winter	DE 1003301 Doggerbank	50-95 %	1-7 days
		NL 2008001 Doggerbank	1-50 %	3-60 days
Surface release	Summer	DE 1003301 Doggerbank	50-95 %	1-7 days
		NL 2008001 Doggerbank	1-75 %	3-60 days
	Winter	DE 1003301 Doggerbank	50-95 %	1-7 days

Type of blow-out	Season	Site	Probability that the area may be hit by oil	Drift time from blowout to site
		NL 2008001 Doggerbank	1-75 %	3 ->60 days

The basis for the designation of the two areas are the habitat type 1110 *Sandbanks* and the habitat species 1351 *Harbour porpoise*, 1365 *Harbour seal* and 1364 *Grey seal*.

Impacts on harbour porpoise

It cannot be excluded that harbour porpoises in the Central North Sea may be affected in the unlikely incidence of a blowout at Solsort. However, as the oil slick during a blowout is transported in a relatively narrow band in the direction of the currents and as the density of porpoises is relatively low (0.01-8 individuals/km² (cf. Figure 6-12), only a tiny fraction of the populations of harbour porpoise in the North Sea is likely to be affected. It is therefore not likely that a potential oil contamination from a blowout will significantly affect the population sizes of the harbour porpoises in the North Sea.



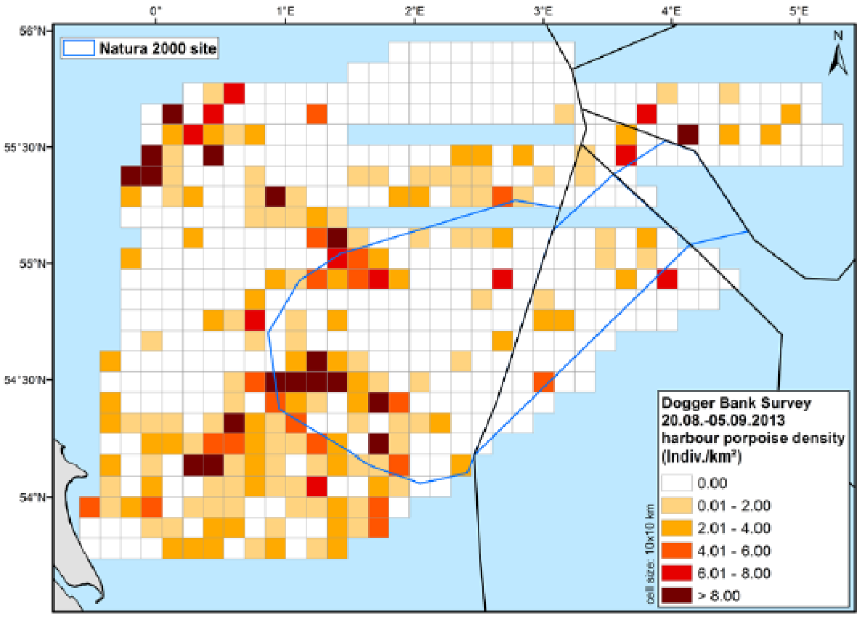


Figure 6-12 Spatial distribution of harbour porpoise density (number/km^2) in the Doggerbank area during 2011 (top) and 2013 (bottom) (Geelhoed et al. 2014).

Impacts on seals

Seals may be affected by direct contact with oil in a variety of ways. Oil can coat all or portions of their body surface and they may inhale toxic fumes of hydrocarbons, which affects their lungs. In addition, they may ingest oil directly or ingest oil-contaminated prey. As seals rely on blubber for insulation their thermoregulatory ability does not generally seem seriously to be hampered by contact with oil. However, observations suggest that some individuals have become so encased in oil that they were not able to swim and subsequently drowned. In addition, observation also suggest that eyes, oral cavity, respiratory surfaces and urogenital surfaces are particularly sensitive to contact with oil (Helm et al. 2015).

It cannot be excluded that seals in the German and Dutch Natura 2000 areas may be affected. However, as the oil slick during a blow-out is transported in a relatively narrow band in the direction of the currents and as seals are relatively rare in the Central North Sea only a tiny fraction of the populations of seals is likely to be affected. It is therefore unlikely that a potential oil contamination from a blow-out will significantly affect the population sizes of the seals.

Impacts on habitat type 1110 sandbanks

In addition, there may be a risk of sedimentation of oil on the habitat type 1110 *Sandbanks* which are slightly covered by sea water all the time, especially in the German area, thereby affecting the benthic infauna community that has been characterised as a Bathyporeia-Fabulina (Amphipod-Tellina) community, with the crustacean *Bathyporeia elegans* and the bristle worms *Spiophanes bombyx* and *Spio decorata* as characterising species.

Impacts on Danish Natura 2000 areas

In case of a blowout, nine Danish Natura 2000 areas east and north-east of Solsort are at risk of oil contamination to a larger and lesser extent dependent on distance from the blow-out and the position in relation to the axis of the prevailing direction of the oil slick drift.

The different sites can be grouped in terms of risk of being hit by oil and drift time as follows (Table 6-6):

- DK00VA257 *Lille Fiskebanke* and DK00VA259 *Gule Rev* are closest to Solsort in the prevailing direction of the oil slick drift. There is a relatively high risk that these sites will be hit by oil i.e. 50-75 % probability during summer and the drift time is 7-21 days.

- DK00VA258 *Store Rev* DK00FX112 *Skagens Gren* og *Skagerrak* are situated at larger distances from Solsort in the prevailing direction of the oil slick drift. The risk of being hit by oil is therefore smaller compared to *Lille fiskebanke* and *Gule rev* (i.e. 25-50 % during summer). The drift time will be 7-21 and 7-30 days, respectively

- DK00VA301 *Lønstrup Rødgrund* is located outside the axis of the prevailing drift direction at a quite large distance from Solsort. The risk that the area is hit by oil is therefore less than 5-25 % during summer and a drift time of 21-30 days

- DK00VA348 *Thyborøn stenvolde*, DK00EX023 *Agger Tange*, DK00VA340 *Sandbanker ud for Thyborøn* and DK00VA340 *Sydlige Nordsø* are at the edge of the prevailing direction of the oil slick drift. The probability of being hit by oil is small i.e. 1-5 % and the drift time 30-60 days.

For all sites, the probability of being hit by oil is a little less during winter.

Table 6-6 Results of OSCAR oil spill modelling following a blowout at Solsort. Probabilities that Danish Natura 2000 sites north-east of Solsort are hit by oil and drift time of oil during summer and winter in case of seabed release. Surface release is identical in terms of probability and drift time.

Season	Site	Probability that the area will be hit by oil	Drift time from blowout to site
Summer	DK00VA257 *Lille Fiskebanke*	50-75 %	7-21 days
	DK00VA259 *Gule Rev*	50-75 %	7-21 days
	DK00VA258 *Store Rev*	25-50 %	7-21 days
	DK00FX112 *Ska-gens Gren og Skag-errak*	25-50 %	7-30 days
	DK00VA301 *Løn-strup Rødgrund*	5-25 %	21-30 days
	DK00VA348 *Thy-borøn Stenvolde*	1-5 %	30-60 days
	DK00EX023 *Agger Tange*	1-5 %	30-60 days
	DK00VA340 *Sand-banker ud for Thy-borøn*	1-5 %	30-60 days
	DK00VA347 *Sydlige Nordsø*	1-5 %	30-60 days
Winter	DK00VA257 *Lille Fiskebanke*	25-50 %	7-21 days
	DK00VA259 *Gule rev*	25– 50 %	7-21 days
	DK00VA258 *Store Rev*	5-25 %	7-21 days
	DK00FX112 *Ska-gens Gren og Skag-errak*	1-25 %	21-30 days
	DK00VA301 *Løn-strup Rødgrund*	1-5 %	21-30 days
	DK00VA348 *Thy-borøn stenvolde*	1-5 %	30-60 days
	DK00VA347 *Sydlige Nordsø*	1-5 %	>60 days
	DK00EX023 *Agger Tange*	Not affected	
	DK00VA340 *Sand-banker ud for Thy-borøn*	Not affected	

The basis of the designation of these Natura 2000 areas are listed in Table 6-7. The table also provide an overview of the assessments of impacts on the Habitat types and Habitat species in the areas. The assessments are substantiated in the following.

Table 6-7 Habitats and species that are basis for the designation of Danish Natura 2000 areas northeast of Solsort that may be affected by oil spill, in the unlikely event of a blowout at Solsort. Note: only habitats and species that may be affected by an oil spill is shown.

Natura 2000 area	**Basis for designation**
UK0030352 Doggerbank	1110 Sandbanks 1351 Harbour porpoise 1365 Harbour seal 1364 Grey seal
NL 2008 -001 Doggerbank	1110 Sandbanks 1351 Harbour porpoise 1365 Harbour seal 1364 Grey seal
DE 1003-301 Doggerbank	1110 Sandbanks 1351 Harbour porpoise 1365 Harbour seal 1364 Grey seal
DK00VA348 *Thyborøn stenvolde*	1170 Reef 1351 Harbour Porpoise
DK00VA257 Jyske Rev, *Lillefiskebanke*	1170 Reef 1351 Harbour Porpoise
DK00VA340 *Sandbanker ud for Thyborøn*	1110 Sandbanks which are slightly covered by sea water all the time 1351 Harbour Porpoise
DK00VA259 *Gule rev*	1170 Reef 1351 Harbour Porpoise
DK00VA301 *Lønstrup rødgrund*	1170 Reef 1351 Harbour Porpoise
DK00VA258 *Store rev*	1170 Reef 1351 Harbour Porpoise
DK00FX112 *Skagens Gren og Skagerrak*	1110 Sandbanks which are slightly covered by sea water all the time 1180 Submarine structures made by leaking gases 1351 Harbour Porpoise 1365 Harbour seal
DK00EX023 *Agger Tange*	19 different species of sea birds including species of terns, ducks and wading birds.
DK00VA347 *Sydlige Nordsø*	1110 Sandbanks, which are slightly covered by sea water all the time 1351 Harbour Porpoise 1365 Harbour Seal 1364 Grey Seal Red-throated diver, Black-throated diver and Little gull

Impacts on marine mammals

Harbour porpoise and seals are included in the basis for designation in most of the potentially affected Natura 2000 areas. As described above, impacts on harbour porpoise may primarily be caused by toxic fumes from the oil slick on the surface

The oil will have drifted a week or more upon arrival to all the potentially Danish affected Natura 2000 areas (Table 6-8). Within a week, the toxic fumes will have evaporated (Cf. Figure 6-7). It is therefore assessed that the risk of harmful impacts of an oil blowout on harbour porpoise within the Natura 2000 areas is negligible.

Impacts on seabed habitats

The basis for designation at all sites except DK00EX023 *Agger Tange*, includes a seabed habitat (either 1170 Reef or 1110 Sandbanks). The drift time to DK00VA *Lille Fiskebanke,* DK00VA259 *Gule Rev*, DK00VA *Store rev* and DK00FX112 *Skagens Gren* and *Skagerrak* are in the range 7-30 days (Table 6-6).

The sedimentation of oil is at its maximum after a drift time of a week (Cf. Figure 6-7). Consequently, there may be a risk that the seabed habitats in these areas may be affected by settled oil.

The probability of oil entering the other areas are low i.e. 1-5 % (5-25 % at DK00VA301 *Lønstrup Rødgrund*. In addition, the drift time to these sites are 1-2 months (Table 6-6), by which time sedimentation is relatively low (Figure 6-7). It is therefore assessed that the risk of harmful impacts of an oil blow-out on seabed habitats in these areas is negligible.

Impacts on birds

Species of seabirds are included in the basis for designation at DK00EX023 *Agger Tange* and DK00VA347 *Sydlige Nordsø.*

Seabirds are very vulnerable to oil spill because they often are in contact with surface water and exposure to the sticky oil destroys the buoyancy and the isolating quality of the plumage. Birds smothered in oil will usually die of cold, starvation or drowning. Seabirds that stay on the sea surface for longer periods are mainly at risk, but all types of seabirds may be affected.

However, the probability of an oil slick entering the two areas are low (1-5 %) and the drift time has been modelled to 1-2 months (Figure 6-2). By this time most of the oil will be in the form of tar balls, which are considerably less damaging than fresher oil as they are no longer sticky or toxic.

Summary of impacts on Danish Natura 2000 areas

In the below Table 6-8 a summary of the impacts on the Danish Natura 2000 areas and the habitats and species that forms the basis of the designation are shown.

Table 6-8 Assessment of impact on habitats and species that are basis for the designation of Danish Natura 2000 that may be affected by oil spill, in the unlikely event of a blowout at Solsort.

Natura 2000 area	Basis for designation	Assessment of impacts resulting from a blow-out at Solsort
DK00VA257 *Lille Fiskebanke*	1170 Reef 1351 Harbour porpoise	› Some risk of impacts on reef › Negligible risk of harmful effects on harbour porpoise (cf. text above)
DK00VA259 *Gule rev*	1170 Reef 1351 Harbour porpoise	› Some risk of impacts on reef › Negligible risk of harmful effects on harbour porpoise (cf. text above)
DK00VA258 *Store rev*	1170 Reef 1351 Harbour porpoise	› Some risk of impacts on reef › Negligible risk of harmful effects on harbour porpoise (cf. text above)
DK00FX112 *Skagens Gren og Skagerrak*	1110 Sandbanks which are slightly covered by sea water all the time 1180 Submarine structures made by leaking gases 1351 Harbour porpoise 1365 Harbour seal	› Some risk of impacts on sandbanks and submarine structures › Negligible risk of harmful effects on harbour porpoise and harbour seal (cf. text above)
DK00VA301 *Lønstrup Rødgrund*	1170 Reef 1351 Harbour porpoise	› Negligible risk of harmful effects on reef › Negligible risk of harmful effects on harbour porpoise (cf. text above)
DK00VA348 *Thyborøn Sten-volde*	1170 Reef 1351 Harbour porpoise	› Negligible risk of harmful effects on reef › Negligible risk of harmful effects on harbour porpoise (cf. text above)
DK00EX023 *Agger Tange*	19 different species of sea birds including species of terns, ducks and wading birds.	› Negligible risk of harmful effects on birds (cf. text above)
DK00VA340 *Sandbanker ud for Thyborøn*	1110 Sandbanks which are slightly covered by sea water all the time 1351 Harbour porpoise	› Negligible risk of harmful effects on sandbanks › Negligible risk of harmful effects on harbour porpoise (cf. text above)
DK00VA347 *Sydlige Nordsø*	1110 Sandbanks, which are slightly covered by sea water all the time 1351 Harbour porpoise 1365 Harbour seal 1364 Grey seal Red-throated diver, Black-throated diver and Little gull	› Negligible risk of harmful effects on sandbanks › Negligible risk of harmful effects on harbour porpoise, harbour seal and grey seal (cf. text above) › Negligible risk of harmful effects on birds (cf. text above)

Conclusion

It is concluded that the Solsort West Lobe wells will not negatively affect the conservation status of habitats and species, for which potentially affected Natura 2000-sites have been designated as well as species listed on Annex IV of the EU Habitats directive (Directive 98/43EEC of 21 May 1992). Nor will the project affect the integrity of the areas negatively.

The conclusion in based on following arguments:

- The risk that a blowout occur is extremely low since all safety systems and measures are in place on the platform and rig.
- The oil slick is transported in a relatively narrow band in the direction of the surface currents.
- The South Arne Operator's oil spill contingency plan will be activated, and oil spill combat will be carried out, which will reduce the spreading of oil and mitigate impacts of any spill.

6.2 Environmental impacts of gas released during a blowout incident

In the unlikely event of a blowout at Solsort, gas may also escape from the formation.

In general, the extent of environmental impacts of escaped gas is not comparable to the impact of oil blow-outs. The bulk of the gas, bubbles to the surface and escape to the atmosphere within a relatively small area around the platform does not disperse in the water to the same extent as oil. On the other hand, field and laboratory investigations have demonstrated that severe environmental impacts may be observed in the immediate vicinity of the platform. The investigations clearly proved that severe damages and mass mortality on zooplankton, benthic fauna and fish might occur within the small gas affected area (Table 6-9).

Although gas blow-out has smaller environmental impacts than oil blow-outs, the gas may pose a severe safety risk for personnel on rig, platform and vessels. If the gas ignites and cause fires or explosions, installations and equipment will be destroyed and in case personnel are not evacuated in due time, injuries or loss of life of personnel may occur. However, the risk of this is minor due to the existing contingency arrangements involving evacuation of personnel from platforms.

Table 6-9 Field-and laboratory studies on impacts of methane gas in the marine environment.

Study	Observations	References
Field survey in connection with a gas blow-out at drilling rigs in the Azov Sea summer/autumn 1982 and in 1985	95% of the escaped gas was methane. The concentration of methane in the vicinity of the well was 4-6 mg/l. The concentration had decreased to 0.07-1.4 mg/l 200 m from the well. In areas with a high concentration of methane, the biomass of benthos declined. Some declining of the zooplankton biomass also occurred in the vicinity of the accidental well Fish in the vicinity of the well clearly developed significant intoxication symptoms such as impaired movement coordination, weakened muscle tone, pathologies of organs and tissues, damaged cell membranes, disturbed blood formation, modifications of protein synthesis, radically increased total peroxidase activity, and some other anomalies typical for acute poisoning of fish.	Glabrybvod 1983 AzNIRKH 1986
Laboratory investigations of impacts of natural gas on fish	Fish clearly avoided concentrations of dissolved gas of 0.1-0.5 mg/l	Sokolov and Vinogradov 1991
Laboratory investigations of acute toxicity of natural gas on fish and zooplankton	48h LC_{50} for fish = 1-3 mg/l 96h LC_{50} for zooplankton = 5.5 mg/l	Umorin et al 1991
Laboratory investigations of acute toxicity of natural gas on zooplankton, benthic fauna and fish fry	96h LC_{50} for zooplankton, benthic fauna and fish fry = 0.6-1.8 mg/l	Borisov et al 1995
Laboratory investigations of impacts of natural gas on fish	Exposure to 1 mg/L and above induced intoxication symptoms (Impaired movement coordination, impaired oxygen absorption. disorientation. Lethal effects were observed after two days.	Patin 1993

6.3 Environmental impacts of accidental spills of chemicals

The risk of accidental chemical spills at Solsort is considered low as SA-WHPN is being controlled from the platform, which will also (in a closed pipeline system) supply Solsort West Lobe wells with the chemicals necessary for the production. Hence, there will be no transport to or handling of significant quantities of chemicals at SA-WHPN. Hydraulic oil is used in a closed system for wellhead control panel and actuated valves. As this is a closed loop system, there will be no discharge to sea

6.4 Oil spill contingency plan

INEOS Oil & Gas Denmark has established a legal binding cooperation arrangement with Total E&P Denmark, for mutual assistance in case of an oil spill incident from one of the operator's production installations (INEOS Oil & Gas Denmark 2019). This arrangement ensures that four containerized DESMI fast sweep oil collection systems will be available for containing and collecting spilled oil, depending on the magnitude of the spill. In case of blow-out, further resources will be provided by Oil Spill Response Ltd (OSRL).

In Denmark, the preferred response strategy is containment and recovery of spilled oil. Dispersant spraying may be chosen, subject to approval from the DEPA (made official). Details on the specific equipment available for the preferred response strategy (mechanical containment and recovery) for the three tier responses are outlined in Table 6-10.

Study update for effectiveness and capacity of oil spill equipment within INEOS will be conducted. Results from the study will be used for evaluation of capacity and equipment and will feed into the update of the Oil Spill Contingency Plan. The plan will be communicated with the authorities. The oil spill contingency plan will also be updated for drilling and work-over activities.

The period where the risk of an oil spill is highest is during drilling of the reservoir section and lower completion, with a duration of 30 to 40 days per well. INEOS will evaluate if having a strike kit on rig for early mobilisation or onshore to be shipped out for spill combat should be a part of the specific contingency plan for drilling.

Mobilization of the Tier 1 scenario will in 80% of the cases be within 3 hours. The tier 2 scenario will be within 16 hours and for the offshore limitation of the spill in relation to tier 3 scenario it will take 21 hours.

Table 6-10 Characteristics of the Tier 1, Tiers 2 and Tier 3 oil spills and available resources for combatting the three types of spill (INEOS Oil & Gas Denmark 2019)

Tier	Characteristics of oil spill	Resources for each Tier
Tier 1	Tier 1 oil spills are likely to be small. The spill can be managed by using INEOS Oil & Gas Denmark pre-arranged vessel resources. Characteristics of a Tier 1 oil spill: › Spill occurs within immediate site proximity › Minor environmental impact › Spill can be easily managed using oil spill response resources available on site › Spill source has been secured	One containerised DESMI Speed Sweep 1500 system. With an in-built Ro-Skim 1500 skimmer connected to a DOP 250 pump system with a capacity of 100-125 m^3/hour. The sweep system is operated along with a DESMI Ro-Kite 1500 allowing operation of the system by one vessel. The system is stored permanently on *Esvagt Innovator* - the Platform Supply Vessel for Syd Arne Facility - ready for immediate deployment. Esvagt Innovator- liquid storage capability for recovered oil: 1200 m^3. Operated by INEOS Oil & Gas Denmark.
Tier 2	An incident in which Total, DK Tier 2 response resources and support are required to control the spill. Characteristics of a Tier 2 oil spill: › Spill extends beyond the immediate site proximity › Tier 1 resources are overwhelmed, additional combat resources are required › Potential impact to sensitive areas and/or communities › Spill source cannot be immediately secured	One containerized DESMI Speed Sweep 1500 system with in-built skimmer (as described for Tier 1). The system is stored permanently on *Total* Platform Supply Vessel *Maersk Tracker* for Total E&P DK Danish offshore installations-ready for immediate deployment. *Maersk Tracker* liquid storage capability for recovered oil: 750 m^3 One containerised DESMI Speed Sweep 1500 system with in- built skimmer (as described for Tier 1). The System is stored on the Total E&P offshore installation *Maersk Guardian*- in case of mobilization the system-ready for deployment within 8 hours onto one of their supply vessels (Havila type). Total offshore with 750 m^3 liquid storage capability. One containerised DESMI Speed Sweep 1500 system with in-built skimmer (as

Tier	Characteristics of oil spill	Resources for each Tier
		described for Tier 1). The system is stored onshore in Port of Esbjerg ready for deployment onto a vessel of opportunity. The timeline for this will be dependent on vessel availability and location (estimated at 24 hours) All three systems re owned and operated by Total E&P DK. INEOS Oil & Gas Denmark, DK Tier 1 equipment is also available.
Tier 3	An incident where assistance is required from international (Oil Spill Response Ltd (OSRL)) and national resource. Characteristics of a Tier 3 oil spill: › Uncontrolled well blowout/loss of well control/HPHT well incidents/Loss of total storage volume › Spill has crossed international maritime boundaries › Tier 1 and 2 resources are overwhelmed requiring international Tier 3 resources to be mobilised (e.g. OSLR) › Risk of significant impact to sensitive areas and local communities	Tier 1 and 2 equipment available. INEOS Oil & Gas Denmark is an Associated member of OSLR and has immediate Oil Spill Response Ltd (OSRL) and has immediate access to Tiers 3 technical advice, resources and expertise 365 days a year/24 hours/ day. In case of a Tiers 3 oil spill OSRL will provide further equipment. INEOS Oil & Gas Denmark can mobilise up to 50% of the global stockpile of equipment. If there is more than one spill INEOS Oil & Gas Denmark can mobilise 50% of what remains. The nearest stockpile of equipment is in Southampton in UK.

6.5 Risk assessment accidental spills

Based on the above and using the criteria described in chapter 4, it is assessed that the environmental risks related to accidental spills during construction and operation of the Solsort WHP platform is **Low** to **Negligible** (Table 6-11).

Table 6-11 Environmental risk of accidental spills during construction and operation of the Solsort WHP platform.

Impact	Extension of impact	Duration of impact	Magnitude of impact	Severity of impact	Likelihood of impact	Environmental Risk
Impacts of oil release during blow-out	Inter national	Medium term	Large	Major impact	Very low	Low risk
Impacts of gas release during blow-out	Local	Short term	Large	Moderate impact	Very low	Negligible risk
Impacts of accidental spills of chemicals	Local	Short term	Low	Insignificant impact	Low	Negligible risk

7 Conclusion

Most of the environmental impacts from the Solsort West Lobe Development project are local or are confined to Danish waters. These impacts have been assessed in the EIA report to have an insignificant or minor impact on the environment. Underwater noise is assessed to have a moderate but short-term impact and it is confined to Danish waters.

The environmental impact of accidental oil, gas and chemical spills and especially an uncontrolled blow out during drilling of a well or during normal production may, however, have transboundary impacts. These have been assessed in section 6 above.

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