Outer Dowsing Offshore Wind

Environmental Statement

Appendix 15.1: Navigational Risk Assessment

Volume 3 Appendices

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Outer Dowsing Offshore Wind Navigational Risk Assessment

Prepared by	Anatec Limited
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	Aberdeen Office	**Cambridge Office**
Address	10 Exchange Street, Aberdeen, AB11 6PH, UK	Braemoor, No. 4 The Warren, Witchford Ely, Cambs, CB6 2HN, UK
Tel	+44 1224 253700	+44 1353 661200
Email	aberdeen@anatec.com	cambs@anatec.com

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Glossary of Terms

Term	Definition
Adverse Weather Route	Preferred routes by certain vessels during periods of adverse weather conditions.
Array area	The area offshore within which the generating station (including wind turbine generators (WTG) and inter array cables), offshore accommodation platforms, offshore transformer substations and associated cabling will be positioned, including the ORBA.
Automatic Identification System (AIS)	A system by which vessels automatically broadcast their identity, key statistics including location, destination, length, speed and current status. Most commercial vessels and European Union (EU)/UK fishing vessels over 15m in length are required to carry AIS.
Allision	Contact between a vessel and a stationary object.
Collision	Contact between two or more moving vessels.
deemed Marine Licence (dML)	A marine licence set out in a Schedule to the Development Consent Order and deemed to have been granted under Part 4 (marine licensing) of the Marine and Coastal Access Act 2009.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the Environmental Impact Assessment (EIA) Regulations, including the publication of an Environmental Statement (ES).
Formal Safety Assessment (FSA)	A structured and systematic process for assessing the risks and costs (if applicable) associated with shipping activity as defined by the International Maritime Organization (IMO).
Landfall	The location at the land-sea interface where the offshore cables and fibre optic cables will come ashore.
Main Route	A route used on a regular basis by one or more vessels.
Marine Guidance Note (MGN)	Guidance released by the Maritime and Coastguard Agency (MCA) for the purposes of providing advice relating to the improvement of the safety of shipping and of life at sea.
Offshore Export Cable	The Offshore Export Cable Corridor (Offshore ECC) is the area within the

Term	Definition
Corridor (ECC)	Order Limits within which the export cables running from the array to landfall will be situated.
Offshore Restricted Build Area (ORBA)	The area within the array area, where no wind turbine generator, offshore transformer substation or offshore accommodation platform shall be erected.
Offshore Reactive Compensation Platform (ORCP)	A structure attached to the seabed by means of a foundation, with one or more decks (including bird deterrents) housing electrical reactors and switchgear for the purpose of the efficient transfer of power in the course of HVAC transmission by providing reactive compensation.
Offshore Substation (OSS)	A structure attached to the seabed by means of a foundation, with one or more decks and a helicopter platform (including bird deterrents), containing— (a) electrical equipment required to switch, transform, convert electricity generated at the wind turbine generators to a higher voltage and provide reactive power compensation; and (b) housing accommodation, storage, workshop auxiliary equipment, radar and facilities for operating, maintaining and controlling the substation or wind turbine generators.
Outer Dowsing Offshore Wind (ODOW)	The Project.
Order Limits	The area subject to the application for development consent. The limits shown on the works plans within which the Project may be carried out.
The Planning Inspectorate	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Preliminary Environmental Information Report (PEIR)	The PEIR was written in the style of a draft Environmental Statement (ES) and provided information to support and inform the statutory consultation process during the pre-application phase.
The Applicant	GTR4 Limited (a joint venture between Corio Generation (and its affiliates), TotalEnergies and Gulf Energy Development), trading as Outer Dowsing Offshore Wind.
The Project	Outer Dowsing Offshore Wind, an offshore wind generating station together with associated onshore and offshore infrastructure.
Regular Operator	A commercial operator associated with one or more vessels that transit an area on a regular basis.

Term	Definition
Safety Zone	An area around a structure associated with an Offshore Renewable Energy Installation where entry is prohibited under the Energy Act 2004.

Abbreviations Table

Abbreviation	Definition
ABP	Associated British Ports
AC	Alternating Current
AfL	Agreement for Lease
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ALB	All-Weather Lifeboats
ANS	Artificial Nesting Structure
ARPA	Automatic Radar Plotting Aid
AoS	Area of Search
AtoN	Aid to Navigation
ATBA	Area to be Avoided
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
BBC	British Broadcasting Corporation
BEIS	Department for Business, Energy & Industrial Strategy
BWEA	British Wind Energy Association
CA	Cruising Association
CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CCTV	Closed Circuit Television
CD	Chart Datum
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CHIRP	Confidential Human Factors Incident Reporting Programme
CoS	Chamber of Shipping

Abbreviation	Definition
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CRO	Coastguard Rescue Officers
CRT	Coastguard Rescue Teams
CTV	Crew Transfer Vessel
DC	Direct Current
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DESNZ	Department for Energy Security and Net Zero
DF	Direction Finding
DfT	Department for Transport
dML	Deemed Marine Licence
DSC	Digital Selective Calling
DWR	Deep Water Route
DWT	Deadweight Tonnage
ECC	Export Cable Corridor
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
ERCoP	Emergency Response Cooperation Plan
ES	Environmental Statement
ESRI	Environmental Systems Research Institute
EU	European Union
FRB	Fast Rescue Boat
FSA	Formal Safety Assessment
GIS	Geographic Information System
GLA	General Lighthouse Authorities
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
GRP	Glass Reinforced Plastic

Abbreviation	Definition
GT	Gross Tonnage
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HM	His Majesty's
HMCG	His Majesty's Coastguard
HVAC	High Voltage Alternating Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IHO	International Hydrographic Organisation
ILB	Inshore Lifeboats
IMCA	International Marine Contractors Association
ITOPF	International Tanker Owners Pollution Federation
IMO	International Maritime Organisation
JRCC	Joint Rescue Coordination Centre
JUV	Jack-up Vessel
kHz	Kilohertz
km	Kilometre
km^2	Kilometre Squared
kt	Knot
LAT	Lowest Astronomical Tide
LOA	Length Overall
LPG	Liquid Petroleum Gas
m	Metre
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MetOcean	Meteorological and Oceanographic
MGN	Marine Guidance Note
MMO	Marine Management Organisation

Abbreviation	Definition
MRCC	Maritime Rescue Coordination Centre
MSC	Maritime Safety Committee
MSI	Maritime Safety Information
MW	Megawatt
NAVTEX	Navigational Telex
NFFO	National Federation of Fishermen's Organisations
nm	Nautical Mile
nm^2	Nautical Mile Squared
NNG	Neart na Gaoithe
NPS	National Policy Statement
NRA	Navigational Risk Assessment
NSIP	Nationally Significant Infrastructure Projects
NUC	Not Under Command
ODOW	Outer Dowsing Offshore Windfarm
O&M	Operation and Maintenance
ORBA	Offshore Restricted Build Area
ORCP	Offshore Reactive Compensation Platform
OREIs	Offshore Renewable Energy Installations
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Windfarm
PEIR	Preliminary Environmental Information Report
PEXA	Practice and Exercise Area
PLL	Potential Loss of Life
PNT	Positioning, Navigation and Timing
POB	People on Board
QHSE	Quality, Health, Safety and Environment
OSS	Offshore Substation
Racon	Radar Beacon
Radar	Radio Detecting and Ranging

Abbreviation	Definition
RCS	Reactive Compensation Substation
REZ	Renewable Energy Zone
RIB	Rigid-hulled Inflatable Boat
RLB	Red Line Boundary
RNLI	Royal National Lifeboat Institution
RoPax	Roll-On/Roll-Off Passenger
Ro-Ro	Roll-On/Roll-Off Cargo
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SAR	Search and Rescue
SCADA	Supervisory Control and Data Acquisition
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea (SOLAS), 1974
SONAR	Sound Navigation Ranging
SOV	Service Operation Vessel
SPS	Significant Peripheral Structure
TCE	The Crown Estate
TSS	Traffic Separation Scheme
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
VHF	Very High Frequency
VTS	Vessel Traffic Service
WGS84	World Geodetic System 1984
WTG	Wind Turbine Generator

Reference Documentation

Document Number	Title
6.1.3	Project Description
6.1.14	Commercial Fisheries
6.1.13	Marine and Intertidal Archaeology
6.1.15	Shipping and Navigation
6.1.18	Marine Infrastructure and Other Users
6.3.5.1	Cumulative Impact Assessment Methodology
6.3.18.2	Access and Allision Report Appendix 18.2
6.3.18.2	Vessel Access Assessment

1 Introduction

1.1 Background

1. This annex to Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) of the Environmental Statement (ES) presents the Navigation Risk Assessment (NRA) for the Outer Dowsing Offshore Wind ("the Project").

2. GTR4 Limited (trading as Outer Dowsing Offshore Wind) hereafter referred to as the 'Applicant', is proposing to develop the Project. The Project will be located approximately 54 kilometres (km) from the Lincolnshire coastline in the southern North Sea. The Project will include both offshore and onshore infrastructure including an offshore generating station (windfarm), export cables to landfall, Offshore Reactive Compensation Platforms (ORCP) and connection to the electricity transmission network (see Volume 1, Chapter 3: Project Description (document reference 6.1.3) for full details).

3. The NRA has been undertaken with respect to the offshore components of the Project comprising the array area, offshore Export Cable Corridor (ECC), and ORCPs. Consideration has also been made of the Artificial Nesting Structure (ANS) areas. Updates have been made to the Project since submission of the DCO application, including the addition of an Offshore Restricted Build Area (ORBA), and removal of the northern offshore ECC route (resulting in the ORCP area within the northern offshore ECC route no longer being considered). The parameters of the ORBA are discussed further in Section 6.2, with the impacts of the ORBA on shipping and navigation addressed in detail in Annex F.

4. As the addition of the ORBA and removal of the northern ORCP area are considered to be positive for shipping and navigation based on stakeholder feedback, the existing assessment of the NRA undertaken pre introduction of the updates is considered a worst case. The risk significance of hazards with the ORBA and without the northern ECC option / ORCP area are therefore within the parameters already assessed in this NRA.

1.2 Navigational Risk Assessment

5. An Environmental Impact Assessment (EIA) is a process which identifies the environmental effects of a project, both negative and positive. An important requirement of the EIA for offshore projects is the NRA. Following the Maritime and Coastguard Agency (MCA) Marine Guidance Note (MGN) 654 (MCA, 2021) including the Methodology (Annex 1 to MGN 654), this NRA includes the following:

- Outline of methodology applied in the NRA;
- Summary of consultation undertaken with shipping and navigation stakeholders to date;
- Lessons learnt from previous offshore windfarm (OWF) developments;

- Summary of the project description relevant to shipping and navigation;
- Baseline characterisation of the existing environment;
- Discussion of potential impacts on navigation, communication and position fixing equipment;
- Cumulative and transboundary overview;
- Vessel to vessel collision modelling;
- Assessment of navigational risk (following the Formal Safety Assessment (FSA) process);
- Outline of embedded mitigation measures; and
- Completion of MGN 654 Checklist.

6. Potential hazards are considered for each phase of development as follows:

- Construction;
- Operation and maintenance (O&M); and
- Decommissioning.

7. The assessment of the Project is based on a parameter-based design envelope approach, which is recognised in:

- Overarching National Policy Statement (NPS) for Energy (EN-1) (Department for Energy Security and Net Zero (Department for Energy Security and Net Zero (DESNZ)), 2023;
- NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023a); and
- Planning Inspectorate Advice Note Nine: Rochdale Envelope (The Planning Inspectorate, 2018).

8. It is noted that the revised Overarching National Policy Statement for Energy (EN-1) and National Policy Statement for Renewable Energy (EN-3) (DESNZ, 2023a & 2023b) was published in November 2023 and became active in January 2024, following previous consultation on draft versions earlier in 2023.

9. The shipping and navigation baseline has been developed and risk assessment undertaken based upon the information available and responses received at the time of preparation, including the Maximum Design Scenario (MDS).

2 Guidance and Legislation

2.1 Legislation

10. Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIP) specific to shipping and navigation is contained in the NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023). Additionally, planning policy on NSIPs for ports is contained in the NPS for Ports (Department for Transport (DfT), 2012) and while not directly related to offshore windfarm development, is considered relevant for the purposes of this NRA. Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) summarises the relevant matters within NPS EN-3 and the NPS for Ports, and where they are considered in the ES.

2.2 Primary Guidance

11. The primary guidance documents used during the NRA process are the following:

- MGN 654 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Response (MCA, 2021) including its annexes; and
- Revised Guidelines for FSA for Use in the Rule-Making Process (International Maritime Organization (IMO), 2018).

12. MGN 654 highlights issues that shall be considered when assessing the effect on navigational safety from offshore renewable energy developments, proposed in UK internal waters, UK territorial sea, the UK Exclusive Economic Zone (EEZ) or Renewable Energy Zones (REZ).

13. The MCA require that their methodology (Annex 1 to MGN 654) is used as a template for preparing NRAs. It is centred on risk management and requires a submission that shows that sufficient controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with mitigation (see section 3.2). Across Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) and the NRA, both base and future case levels of risk have been identified and what measures are required to ensure the future case remains broadly acceptable or tolerable with mitigation.

2.3 Other Guidance

14. Other guidance documents used during the assessment are as follows:

- MGN 372 Amendment 1 (Merchant and Fishing) Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2022);
- International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA, 2021);

- IALA Guideline G1162 Guidance on the Marking of Offshore Man-Made Structures (IALA, 2021); and
- The Royal Yachting Association's (RYA) Position on Offshore Renewable Energy Developments: Paper 1 (of 4) – Wind Energy (RYA, 2019).

2.4 Lessons Learnt

15. There is considerable benefit for the Applicant in the sharing of lessons learnt within the offshore industry. The NRA, and in particular the risk assessment undertaken in Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15), includes general consideration for lessons learnt and expert opinion from previous OWF developments and other sea users, capitalising upon the UKs position as a leading generator of offshore wind power.

3 Navigational Risk Assessment Methodology

3.1 Formal Safety Assessment Methodology

16. A shipping and navigation user can only be exposed to a risk caused by a hazard if there is a pathway through which a risk can be transmitted between the source activity and the user. In cases where a user is exposed to a risk, the overall significance of risk to the user is determined. This process incorporates a degree of subjectivity. The assessments presented herein for shipping and navigation users have considered the following criteria:

- Baseline data and assessment;
- Expert opinion;
- Level of stakeholder concern including output of the Hazard Workshop;
- Time and/or distance of any deviation;
- Number of transits of specific vessels and/or vessel types; and
- Lessons learnt from existing offshore developments.

17. It is noted that, with regards to commercial fishing vessels, the methodology and assessment has been applied to hazards considering commercial fishing vessels in transit. A separate methodology and assessment have been applied in Volume 1, Chapter 14: Commercial Fisheries (document reference 6.1.14) to consider hazards on commercial fishing vessels including safety risks which are directly related to commercial fishing activity (rather than commercial fishing vessels in transit).

3.2 Formal Safety Assessment Process

18. The IMO FSA process (IMO, 2018) as approved by the IMO in 2018 under Maritime Safety Committee (MSC) – Marine Environment Protection Committee (MEPC).2/circ. 12/Rev.2 will be applied to the risk assessment within this NRA, and informs Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15).

19. The FSA process is a structured and systematic methodology based upon risk analysis and Cost Benefit Analysis (CBA) (if applicable) to reduce impacts to As Low as Reasonably Practicable (ALARP). There are five basic steps within this process as illustrated by Figure 3.1 and summarised in the following list:

- Step 1 – Identification of hazards (a list is produced of hazards prioritised by risk level specific to the problem under review);
- Step 2 – Risk assessment (investigation of the causes and initiating events and risks of the more important hazards identified in step 1);
- Step 3 – Risk control options (identification of measures to control and reduce the identified risks);
- Step 4 – CBA (identification and comparison of the benefits and costs associated with the risk control options identified in step 3); and

- Step 5 – Recommendations for decision-making (defining of recommendations based upon the outputs of steps 1 to 4).

Figure 3.1 Flow Chart of the FSA methodology

3.2.1 Hazard Workshop Methodology

20. A key tool used in the NRA process is the Hazard Workshop which ensures that all hazards are identified, and the corresponding risks qualified in discussion with relevant consultees. Due to array area updates post-PEIR (see section 6.1), there have been two Hazard Workshops held for the Project (further details are presented in section 4.2.5). Table 3-1 and Table 3-2 define the severity of consequence and the frequency of occurrence rankings that have been used to assess risks within the hazard log, respectively, completed based on the outputs of the Hazard Workshops.

Table 3-1 Severity of consequence ranking definitions

Rank	Description	Definition			
		People	Property[1]	Environment	Business
1	Negligible	No perceptible impact	No perceptible impact	No perceptible impact	No perceptible impact

[1] Note numerical cost values were shown at the Hazard Workshop for property definition. These were amended post workshop to textual definitions based on general user feedback and to allow for scale based on size of operation.

Rank	Description	Definition			
		People	Property[1]	Environment	Business
2	Minor	Slight injury(s)	Minor damage to property i.e., superficial damage	Tier 1 local assistance required	Minor reputational risks – limited to users
3	Moderate	Multiple minor or single serious injury	Damage not critical to operations	Tier 2 limited external assistance required	Local reputational risks
4	Serious	Multiple serious injuries or single fatality	Damage resulting in critical impact on operations	Tier 2 regional assistance required	National reputational risks
5	Major	More than one fatality	Total loss of property	Tier 3 national assistance required	International reputational risks

Table 3-2 Frequency of occurrence ranking definitions

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably probable	1 per 1 to 10 years
5	Frequent	Yearly

21. The severity of consequence and frequency of occurrence are then used to define the significance of risk via a tolerability matrix approach as shown in Table 3-3. The significance of risk is defined as Broadly Acceptable (low risk), Tolerable (intermediate risk) or Unacceptable (high risk).

Table 3-3 Tolerable matrix and risk ranking

Severity of Consequence						
	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Frequency of Occurrence				

	Unacceptable (high risk)
	Tolerable (intermediate risk)
	Broadly Acceptable (low risk)

22. Once identified the significance of risk will be assessed to ensure it is ALARP. Further risk control measures may be required to further mitigate a hazard in accordance with the ALARP principles. Unacceptable risks are not considered to be ALARP.

3.3 Methodology for Cumulative Risk Assessment

23. The hazards identified in the FSA are also assessed for cumulative risks with the inclusion of other projects and proposed developments. Given the varying type, status and location of developments, a tiered approach to cumulative risk assessment has been undertaken, which splits developments into tiers depending upon project status, proximity to the Project, and the level to which they are anticipated to cumulatively impact relevant users. It also considers data confidence, most notably in terms of the level of certainty over the location and timescales for a development.

24. The tiers are summarised in Table 3-4, with the level of assessment undertaken for each tier included. It is noted that an aggregate of the criterion is used to determine the tier of each development. For example, if a development is located within 50 nautical miles (nm) of the array area and may impact a main commercial route within 1nm of the array area but the development is only scoped, it may still be allocated to Tier 1.

Table 3-4 Cumulative development screening summary

Tier	Minimum Development Status	Criterion	Minimum Data Confidence Level	Level of Cumulative Risk Assessment
1	Under Determination	▪ May impact a main route identified as passing within the study area (see section 11.2) ▪ Offshore windfarm within 50nm of the array area. ▪ Subsea cable within 2nm of the offshore ECC.	Medium	Qualitative cumulative re-routeing assumptions made for main routes

Tier	Minimum Development Status	Criterion	Minimum Data Confidence Level	Level of Cumulative Risk Assessment
2	Scoped	▪ Unlikely to impact upon a main route identified as passing within the study area (see section 11.2) ▪ Offshore windfarm within 50nm of the array area. ▪ Subsea cable within 2nm.	Low	General qualitative assumptions.
3	Any	▪ Offshore wind farm further than 50nm from array area. ▪ Subsea cable further than 2nm from the offshore ECC.	Low	Screened Out

25. OWF developments are screened out if over 50nm from the array area. This distance is considered to represent a conservative threshold, noting that this is a typical approach undertaken for the cumulative risk assessment in NRAs.

26. It is noted that constructing or operational projects are considered as part of the baseline and therefore are not scoped into the cumulative risk assessment. This includes baseline oil and gas developments.

3.4 Shipping and Navigation Study Area

27. The shipping and navigation study area used within the NRA has been defined as a minimum[2] 10nm buffer of the array area as shown in Figure 3.2. The study area has been defined in order to provide local context to the analysis of risks by capturing the relevant routes, vessel traffic movements and historical incident data within and in proximity to the Project.

28. Navigational features wholly or partially outside the study area are considered where appropriate. A 10nm study area has been used in the majority of UK OWF NRAs with recent examples including Hornsea Three, Hornsea Four, Norfolk Vanguard and Norfolk Boreas, all of which were successfully consented.

29. The Offshore ECC study area has been defined as a 2nm buffer of the offshore ECC as shown in Figure 3.2, with the ORCP area study area being a minimum[3] 10nm buffer of the ORCP areas.

30. It is noted that study areas for the ANS have also been defined for the purposes of the NRA, as detailed in section 13.

[2] Study area based on the pre PEIR array area, which has been reduced post PEIR.
[3] Study area based on the pre PEIR ORCP area, which has been reduced post PEIR.

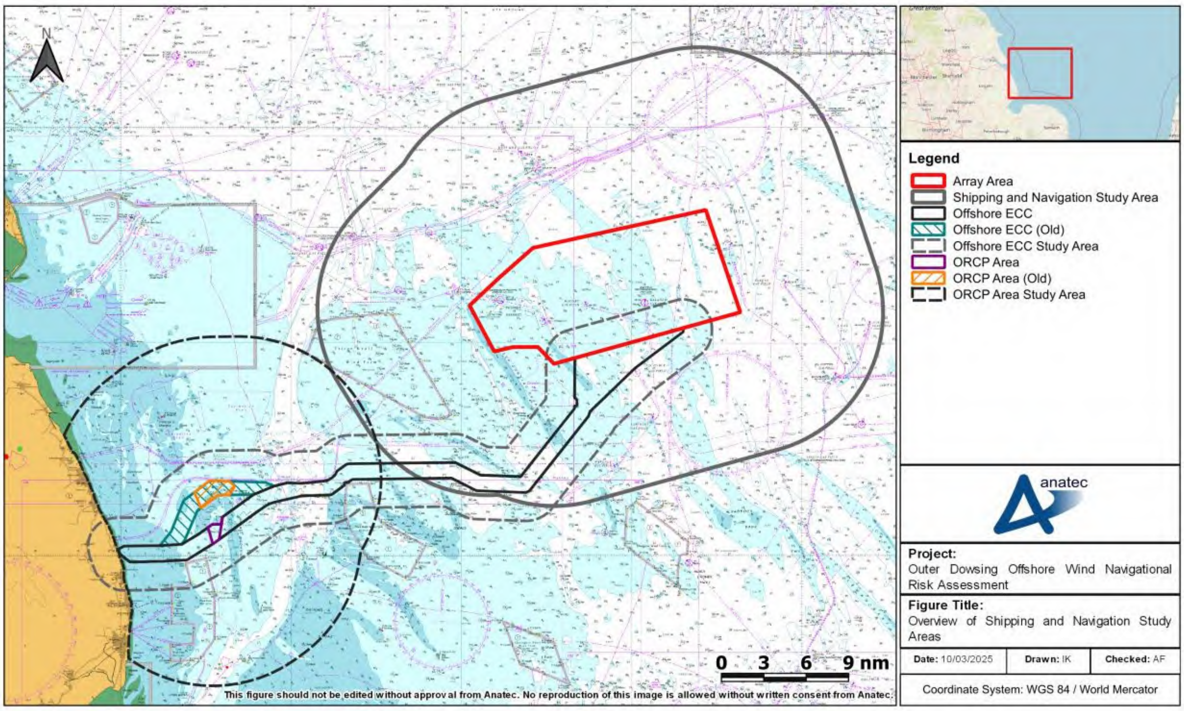

Figure 3.2 Study Areas for Shipping and Navigation

4 Consultation

4.1 Stakeholders Consulted in the Navigational Risk Assessment Process

31. Key shipping and navigation stakeholders have been consulted in the NRA process. The following stakeholders have been consulted via dedicated meetings:

- MCA;
- Trinity House;
- UK Chamber of Shipping (CoS); and
- DFDS.

32. As well as consulting with the organisations outlined above, 32 Regular Operators identified from the vessel traffic surveys/long-term annex were provided with an overview of the Project and offered the opportunity to provide comment (the full Regular Operator letter is presented in Annex C). The full list of Regular Operators identified is provided below:

- A2B;
- AMASUS;
- Anthony Veder;
- Arklow Shipping;
- BBC Chartering;
- Boomsma Shipping;
- Bore Ltd;
- Boskalis;
- Boston Putford;
- Britannia Aggregates Ltd.;
- Chemgas;
- CLdN;
- DS Norden;
- Deme;
- Den Herder Seaworks;
- DFDS;
- EemsWerken;
- Evergas Shipping;
- Gaschem;
- GEFO;
- Hanson Aggregates;
- James Fisher;
- P&O Ferries;
- Royal Wagenbord;
- Samskip;
- Scheepswerf Bijlsma;
- Sea Tank Chartering AS;
- Smyril Line;
- StenaLine;
- Unigas International;
- Wijnne Barends; and
- Wilson

4.2 Consultation Response

33. Responses have been received from stakeholders during consultation undertaken in the NRA process, either during conference calls, via email correspondence or through the Scoping Opinion and Section 42 feedback. The key points and where they have been addressed in the NRA or Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) are summarised in this section.

4.2.1 Scoping

34. The Applicant submitted a Scoping Report to the Planning Inspectorate in July 2022. The key points of relevance to shipping and navigation arising from the resultant Scoping Opinion are summarised in Table 4-1, which includes where they have been addressed in the NRA.

Table 4-1 Summary of Key Points Raised During Consultation from the Scoping Opinion

Stakeholder(s)	Date of correspondence	Point Raised	Response and where addressed in the NRA
MCA	26 August 2022	The Environmental Impact Report should supply detail on the possible impact on navigational issues for both commercial and recreational craft, specifically: ▪ Collision Risk ▪ Navigational Safety ▪ Visual intrusion and noise ▪ Risk Management and Emergency response ▪ Marking and lighting of site and information to mariners ▪ Effect on small craft navigational and communication equipment ▪ The risk to drifting recreational craft in adverse weather or tidal conditions ▪ The likely squeeze of small craft into the routes of larger commercial vessels.	The listed items and risks are assessed where appropriate in section 19.
MCA	26 August 2022	The development area carries a moderate amount of traffic with several important commercial shipping routes to/from UK ports, particularly passenger vessels, oil and gas support vessels and cargo ships including tankers. Attention needs to be paid to routing, particularly in heavy weather routeing so that vessels can continue to make safe passage without large-scale deviations. The likely cumulative and in combination effects on shipping routes should be considered which will be an important issue going forward. It	Vessel routeing included during adverse weather is assessed in section 12. Cumulative risk assessment is provided in section 20.

Stakeholder(s)	Date of correspondence	Point Raised	Response and where addressed in the NRA
		should consider the proximity to other windfarm developments, particularly with the construction of Hornsea Project 2 and 3 and proposed extension to Dudgeon OWF, other infrastructure, and the impact on safe navigable sea room.	
MCA	26 August 2022	It is noted that a Navigational Risk Assessment will be submitted in accordance with MGN 654. This should be accompanied by a detailed MGN 654 Checklist.	MGN 654 checklist is detailed in Annex A.
MCA	26 August 2022	A vessel traffic survey must be undertaken to the standard of MGN 654 which will consist of a minimum of 28 days of seasonal data (two x 14-day surveys) collected from a vessel-based survey using Automatic Identification System (AIS), Radio Detection and Ranging (Radar) and visual observations to capture all vessels navigating in the study area. We would expect the details of these consultations to be included within the NRA. Kindly note for all OREI developments, subject to the planning process, the traffic survey must be undertaken within 24 months prior to submission of the Development Consent Order (DCO) application. If the EIA Report is not submitted within 24 months an additional 14-day continuation survey data may be required for each subsequent 12- month period. Should there be a break in the continuation surveys, a new full traffic survey may be required, and the time period starts from the completion of the initial 28-day survey period.	Vessel traffic survey approach has been agreed with the MCA and Trinity House.
MCA	26 August 2022	The proximity to other OWFs will need to be fully considered, with an appropriate assessment of the distances between OREI boundaries and shipping routes as per MGN 654. The cumulative impacts of other windfarms in close proximity, in particular the Hornsea 3 and Dudgeon Extension developments will change routing, particularly those that transect the western and northern sections of the site. Attention must be paid for ensuring the established shipping routes within the area can continue safely without unacceptable deviations. Particular attention should also be given to the oil and gas activity within the area.	Cumulative risk assessment is provided in section 20. Hornsea Three and the Dudgeon Extension have been screened in as Tier 1 projects. Full consideration has been given to oil and gas activity.

Stakeholder(s)	Date of correspondence	Point Raised	Response and where addressed in the NRA
MCA	26 August 2022	The Wind Turbine Generator (WTG) layout design will require MCA approval prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue (SAR) aircraft operating within the site. Any additional navigation safety and/or Search and Rescue requirements, as per MGN 654 Annex 5, will be agreed at the approval stage.	Embedded mitigations include compliance with MGN 654 and layout approval by the MCA and Trinity House (see section 17.2.2.4).
MCA	26 August 2022	Attention should be paid to cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and subject to the traffic volumes, an anchor penetration study may be necessary. If cable protection measures are required e.g. rock bags or concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum (CD). This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase, such as at the HDD location.	As per section 17.2.2.4, a cable burial risk assessment process will be undertaken to determine cable protection requirements, and there will be full MGN 654 compliance including provisions associated with changes to water depths.
MCA	26 August 2022	Particular consideration will need to be given to the implications of the site size and location on SAR resources and Emergency Response Co-operation Plans (ERCoP). The report must recognise the level of radar surveillance, AIS and shore-based Very High Frequency (VHF) radio coverage and give due consideration for appropriate mitigation such as radar, AIS receivers and in-field, Marine Band VHF radio communications aerial(s) (VHF voice with Digital Selective Calling (DSC)) that can cover the entire windfarm sites and their surrounding areas. A SAR checklist will also need to be completed in consultation with MCA, as per MGN 654 Annex 5 SAR requirements.	As per section 17.2.2.4, there will be full MGN 654 compliance including provisions associated with the ERCoP, layout, and the SAR Checklist.
MCA	26 August 2022	MGN 654 Annex 4 requires that hydrographic surveys should fulfil the requirements of the International Hydrographic Organisation (IHO) Order 1a standard, with the final data supplied as a digital full density data set, and survey report to the MCA Hydrography Manager. Failure to report the survey or conduct it to Order 1a might invalidate the Navigational Risk Assessment if it was deemed not fit for purpose.	As per section 17.2.2.4, there will be full MGN 654 compliance including in relation to hydrographic surveys.
Trinity House	26 August 2022	NRA should include:	▪ Vessel traffic survey approach has been

Stakeholder(s)	Date of correspondence	Point Raised	Response and where addressed in the NRA
		▪ Comprehensive vessel traffic analysis in accordance with MGN 654. ▪ The possible cumulative and in-combination effects on shipping routes and patterns should be adequately assessed. ▪ The potential "corridor" between the project and Triton Knoll OWF, including future traffic patterns should be considered and assessed.	agreed with MCA and Trinity House and is MGN 654 compliant. ▪ Cumulative risk assessment is provided in section 20. ▪ Post windfarm routeing in section 15 includes appropriate assumptions around Triton Knoll OWF.
Trinity House	26 August 2022	We consider that this development will need to be marked with marine aids to navigation (AtoNs) by the developer/operator in accordance with the general principles outlined in IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) Guideline G1162 - The Marking of Offshore Man-Made Structures as a risk mitigation measure. In addition to the marking of the structures themselves, it should be borne in mind that additional AtoNs such as buoys may be necessary to mitigate the risk posed to the mariner, particularly during the construction phase. All marine navigational marking, which will be required to be provided and thereafter maintained by the developer, will need to be addressed and agreed with Trinity House. This will include the necessity for the AtoN to meet the internationally recognised standards of availability and the reporting thereof.	As per section 17.2.2.4, lighting and marking will be agreed with Trinity House and will be IALA G1162 compliant. Lighting and marking is secured by the generation and transmission deemed Marine Licences (dMLs) at condition 8.
Trinity House	26 August 2022	Assessment of impact on existing AtoNs, to include both offshore and shore based (where any cabling reaches landfall) AtoNs.	AtoN are considered in section 7.5.
Trinity House	26 August 2022	A decommissioning plan, which includes a scenario where on decommissioning and on completion of removal operations an obstruction is left on site (attributable to the windfarm) which is considered to be a danger to navigation and which it has not proved possible to remove, should be considered. Such an obstruction may require to be marked until such time as it is either removed or no longer considered a danger to navigation, the	The Applicant will produce a decommissioning plan as detailed in section 22.

Stakeholder(s)	Date of correspondence	Point Raised	Response and where addressed in the NRA
		continuing cost of which would need to be met by the developer/operator.	
Trinity House	26 August 2022	The possible requirement for navigational marking of the export cables and the vessels laying them. If it is necessary for the cables to be protected by rock armour, concrete mattresses or similar protection which lies clear of the surrounding seabed, the impact on navigation and the requirement for appropriate risk mitigation measures needs to be assessed.	A cable burial risk assessment process will be undertaken to determine cable protection requirements, and there will be full MGN 654 compliance including provisions associated with changes to water depths. Lighting and marking will be agreed with Trinity House.
Secretary of State	9 September 2022	A study area of 10nm has been proposed for the shipping and navigation assessment, with a likely final study area within the NRA of 10nm proposed for the array and any Offshore Reactive Platforms (ORPs), and 2nm for the offshore ECC. The ES should explain the rationale behind the choice of study areas and, where possible, the approach should be agreed with the relevant consultation bodies	Details of these study areas are provided in section 3.4. These were presented and agreed with the MCA, Trinity House and CoS during consultation.
Secretary of State	9 September 2022	The Scoping Report states that a preliminary assessment of navigational features within the AoS for the offshore ECC has been undertaken; however, no baseline information for the offshore ECC AoS has been included within the Scoping Report. The ES should describe the shipping and navigational baseline conditions for the entire AoS, accompanied by clear figures.	Section 10.2 provides full baseline details of the offshore ECC including in terms of vessel traffic, section 7 for navigational features and section 8 for marine incidents. Associated risk assessment is provided in section 19.
Secretary of State	9 September 2022	The Scoping Report proposes to determine significance as either broadly acceptable, tolerable, or unacceptable. The ES should clearly set out how the risk assessment approach leads to an assessment of significance of effect consistent/compatible with the terminology used in the ES, for which the intended approach is set out in Chapter 5 (paragraphs 5.7.12 to 5.7.13) of the Scoping Report.	The assessment methodology is described in section 3, which includes details around how the FSA translates into EIA terminology in terms of significance.
Secretary of State	9 September 2022	Noting the Scoping Report states that it will include changes to baseline routeing associated with submitted or consented OWF projects, notably Hornsea 3 and Hornsea 4, the ES should clearly state any assumptions made with regards to the baseline.	Baseline routeing is summarised in section 11. Projects screened in on a cumulative basis area shown in section 16.

Stakeholder(s)	Date of correspondence	Point Raised	Response and where addressed in the NRA
Secretary of State	9 September 2022	The ES should identify a future baseline for vessel movements and explain how this has been established, taking into account the existing sea users and the numerous proposed OWF projects in the vicinity.	Post windfarm routeing has been established in section 15, and future case scenarios of 10 and 20% have been modelled.

4.2.2 Section 42

35. The relevant responses received as part of the statutory consultation on the PEIR and as part of the autumn consultation, both under Section 42 of the Planning Act 2008 are summarised in Table 4-2.

Table 4-2 Section 42 Responses

Stakeholder(s)	Key Points Raised	Response and where addressed in the NRA
The Marine Management Organisation (MMO) (PEIR and Autumn Consultation)	The MMO defers to the Maritime and Coastguard Agency and Trinity House and relevant Harbour Authorities regarding the potential impacts on shipping and navigation that may occur because of the refinements. The MMO will maintain a watching brief on anything that may fall within the MMO's remit – such as dML conditions.	Acknowledged. Consultation has been undertaken with the MCA and Trinity House and other relevant shipping and navigation stakeholders.
MCA (PEIR)	A full marine traffic survey of 28 days duration has been undertaken as per MGN 654 requirements for winter and summer 2022 for the shipping and navigation study area. We note regarding the Offshore Reactive Compensation Platform (ORCP) area that a 14 day winter survey has been completed. Table 5.1 states a second 14-day vessel traffic survey of the ORCP area is planned post PEIR to bring the total up to 28 days, and this is stated again in paragraph 285. It is also noted that the Export Cable Corridor (ECC) traffic survey is based on AIS data only. We expect the NRA to be updated with the additional summer traffic data regarding the ORCP. The MCA will provide further comments once this is completed. The addition of 12 months AIS data (April 2021 – March 2022) and Anatec's ship route database is noted and will be useful in further informing the traffic analysis. The MCA also welcome the inclusion of commercial route identification and predicted displacements of these routes post windfarm in sections 10 and 13. It is noted however that the future traffic case will be incorporated into the NRA post PEIR. As stated in paragraph 385: "The final NRA will additionally consider future case traffic growth scenarios within the modelling processes. The scenarios considered will include cases of 10% and 20% commercial traffic increases.	The NRA has been updated with the additional ORCP survey, bringing the total up to 28 days of MGN 654 compliant data for both the array and ORCP (section 10.3). Consultation has continued post PEIR, including a second hazard workshop, and direct meetings with MCA, Trinity House, CoS and DFDS. Future case modelling has been undertaken in line with what was detailed at PEIR (see section 15).

Stakeholder(s)	Key Points Raised	Response and where addressed in the NRA
	The level of engagement with stakeholders to date is encouraging and the MCA expects this to continue. Navigation safety concerns raised during stakeholder consultations as summarised in chapter 4, will require continued comprehensive consultation as the project progresses.	
	We appreciate that the layout as presented currently is indicative of a 'worst case' as described in table 6.5 of the NRA. The turbine layout design will require MCA agreement prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue aircraft operating within the site. As such, MCA will seek to ensure all structures are aligned in straight rows and columns, including any platforms. Any additional navigation safety and/or Search and Rescue requirements, as per MGN 654 Annex 5, will be agreed at the approval stage.	The final layout will be agreed with the MCA and Trinity House post consent. Necessary SAR mitigations will be agreed with the MCA via the SAR Checklist process (see section 18).
	Section 14 gives a cumulative overview with the inclusion of 6 developments in addition to the baseline case as presented in table 14.1. Section 18 expands on this and presents a Cumulative Risk Assessment. 5 scenarios are considered covering the main identified Hazards. The MCA welcome this approach and note that under keel clearance and subsea cable interaction have been screened out of the cumulative assessment "given they are localised to the area around individual cables." We would expect that these localised hazards are also risk assessed in due course. "Various stakeholders have raised concerns with other project interactions in the area. Of note are Hornsea Three due its potential impact with the Immingham to Cuxhaven route (Route 7, Figure 10.2) the loss of the optional shallow track post construction with current boundaries (Route 9, Figure 10.2) east of the Outer Dowsing Shoal and the Dudgeon North extension with its protentional 'line up' with the western extent of the current Outer Dowsing array area as presented.	The final NRA includes full cumulative risk assessment of screened in hazards (section 20). Subsea interaction has been assessed within the in isolation risk assessment (see section 19).
	PEIR Chapter 1 paragraph 1.1.32, Chapter 15 Paragraph 15.5.2, and Paragraph 587 of the NRA state it is intended that a reduction of the array boundary from 500km2 to 300km2 will be presented for DCO Application. We understand that the cumulative impacts will be re-assessed post PEIR, where we will provide further comments following an additional assessment of the updated NRA. Considering the intended array boundary change, Para 588 asks: "Do you have any feedback on the array area boundaries from a shipping and navigation perspective?" An initial preference would be for a reduction to the western boundary to the extent that the optional shallow route (route 9, Figure 10.2) would remain viable and the lining up of the potential western edge of Dudgeon North Extension and the Outer Dowsing array area is avoided. A reduction to this western boundary would also increase the safety clearance of the traffic using the Outer Dowsing Channel.	The western boundary has been reduced post PEIR (as has the northern boundary). The MCA confirmed during the second hazard workshop they were generally content with the refinements.
	MGN 654 requires that hydrographic surveys should fulfil the requirements of the International Hydrographic Organisation (IHO) Order 1a standard, with the final data supplied as a digital full	There will be full MGN 654 compliance including in relation to

Stakeholder(s)	Key Points Raised	Response and where addressed in the NRA
	density data set, and survey report to the MCA Hydrography Manager and the UKHO. Further information can be found in MGN 654 Annex 4 supporting document titled 'Hydrographic Guidelines for Offshore Developers', available on our website: https://www.gov.uk/guidance/offshorerenewable-energy-installations-impact-on-shipping.This includes surveys during the pre-construction, post-construction and post-decommissioning stages.	hydrographic surveys (see section 18).
	Safety zones during the construction, maintenance and decommissioning phases as described in para 15.7.32 in the Shipping and Navigation chapter and paragraph 419 of the NRA (summarised with in embedded mitigation, Table 16.1) are supported. However, it should be noted that operational safety zones may have a maximum 50m radius from the individual turbines. A detailed justification would be required for a 50m operational safety zone, with significant evidence from the construction phase in addition to the baseline NRA required supporting the case.	Safety zones to be applied for as outlined within the Safety Zone Statement (document 9.3) will be discussed with key consultees including the MCA post consent at the time of the safety zone application (see section 18).
	An Emergency Response Cooperation Plan (ERCoP) is required to meet the requirements of MGN 654 Annex 5 and will need to be in place prior to construction. The ERCoP is an active operational document and must remain current at all stages of the project including during construction, operations & maintenance and decommissioning. A SAR checklist will be discussed as the project progresses to track all requirements detailed in MGN 654 Annex 5.	There will be full MGN 654 compliance including in relation to the ERCoP and SAR checklist (see section 18).
	Chapter 21.8, paragraph 586 lists next steps identified in order to present the final NRA to which the MCA agree. To reiterate we expect continued, comprehensive engagement with stakeholders as the project progresses as concerns on cumulative effects on established routes and proximately to active oil and gas/aggregate operations have been raised. In this regard, we look forward to the promulgation of information on the intended reduced array area boundary for further comment. We believe this response addresses the questions relevant to the MCA in paragraph 588. The comments detailed above are considered appropriate and necessary for the safety of navigation and Search and Rescue purposes. We hope you find them useful at this stage and MCA are happy to discuss further as the project progresses. We are content at this stage with regards to the process you have undertaken to comply with MGN 654 and its annexes, and we welcome the work undertaken for addressing the guidance and recommendations so far.	Consultation has continued post PEIR, including a second hazard workshop, and direct meetings with MCA, Trinity House, CoS and DFDS. The MCA have confirmed they are generally content with site boundary refinement.
CoS (PEIR)	The Chamber had a meeting on 16 August 2022 where it requested that PEIR included an idea of scale, possibly through the use of a grid to understand what the size of a certain development in the area will resemble. The response notes that this has been addressed in section 3.4 of the NRA. This is incorrect and it is disappointing that this request has not been fulfilled.	Site boundary refinement has been discussed with CoS post PEIR via both a dedicated meeting and in the hazard workshop.

Stakeholder(s)	Key Points Raised	Response and where addressed in the NRA
	The Chamber notes the reference to Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) (Department for Energy, Security & Net Zero (DESNZ), 2023) within Chapter 6.1.15. Given the statements referenced are in draft format and not formally approved and may be subject to change, they should not be given undue precedence, with the 2011 Department of Energy and Climate Change (DECC) NPS statements being the correct policies to follow at this time.	Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) references the latest active NPS, which have become active post PEIR.
	With regards to the specifics of the site, referring to Array Area Boundary Key Coordinates included within the NRA, the Chamber recommends two areas for reductions in the ORDER LIMITS. Firstly, the A-B northernly extent has the most interaction to high density traffic routes and the most impact upon navigational squeeze and accordingly safety. The Chamber also suggests that B and the resulting right angle creates a sharp turn and collision hot spot as identified in Figure 15.2 of the NRA, with the result being that a drawing in of the boundary at B be recommended to reduce the direct nature of vessel interaction. Secondly, the G-H westerly extent of the development as it abuts into the Outer Dowsing Channel. The Chamber acknowledges the 10m contour as being the defining depth for the majority of traffic using the Outer Dowsing Channel but does not agree that building to the edge of 10m contour is in the best interest of navigational safety given the recommended sailing distance of 2nm from the edge of a windfarm development.	The northern and western boundaries have both been reduced post PEIR to reduce impacts to shipping and navigation users. These changes were presented to key stakeholders including the CoS in dedicated meetings and the second hazard workshop.
	The Chamber welcomes the inclusion of MAIB accident data from 2000-2009 as greater historical data but would like to see a visual representation of it post PEIR. The Chamber also questions why 2020-2022 data is not shown given its availability.	21 years of MAIB data (up to 2022) has been analysed and presented visually in section 9.5.
	The Chamber has reviewed Chapter 15 and the NRA but found no detail regarding the decommissioning plan. The Chamber strongly advocates for the full removal of all infrastructure above and below the seabed, acknowledging Best Available Techniques Not Entailing Excessive Costs (BATNEEC) when it comes to turbine foundations which penetrate deep into the seabed. The Chamber is aware that various developments have a preference for cabling to remain in situ. The Chamber objects to this for a number of reasons as detailed below. Firstly, the Chamber has concerns that buried cables left in situ may become exposed and therefore pose a hazard to anchoring activity, especially in an emergency when such activity is most likely to take place. This has been highlighted by the International Hydrographic Organization (IHO) who at their Assembly meeting held at Monaco in April 2017 highlighted: "Mariners are also warned that the seafloor where cables were originally buried may have changed and cables become exposed; therefore particular caution should be taken when operating vessels in areas where submarine cables exist especially where the depth of water means that there is a limited under-keel clearance" Such risk is minimised during the economic life of the windfarm, as navigational traffic through the development will	At the end of the operational life of ODOW, the infrastructure will be decommissioned, in line with TCE AfL requirements and in line with the Energy Act (2004), a decommissioning programme will be secured through the DCO, which will be submitted prior to the start of construction. As such, the scope of the decommissioning works would be determined by the relevant legislation

Stakeholder(s)	Key Points Raised	Response and where addressed in the NRA
	be reduced and it is expected that regular monitoring of the cabling and its protection will be carried out with any necessary remedial works. However once decommissioned, the site will be open to a greater extent to surface navigation and other activity. The Chamber is not aware of commitments by developers post commissioning to regularly monitor and rebury or remove cabling which has become exposed. Secondly, it is widely recognised that ships' anchors pose a significant hazard to submarine cables as they are designed to penetrate the seabed. The depth of penetration will depend on the size and type of anchor and the nature of the seabed. Hence, the Chamber is concerned that cable burial at typical depths does not fully safeguard against anchor fouling and entanglement. This was exemplified through the incident of the Stema Barge II incident in the English Channel when emergency anchoring led to the IFA interconnector being fouled and cut though. Passing the cost of potential fouling and disentanglement to the shipping company, authorities, insurers and any Search and Rescue (SAR) services required is not desirable. Thirdly, through the leaving of cabling in situ, future seabed activity in the area is significantly constrained, either rendered unfeasible, or costly for the next seabed user to remove or work around such cabling.	and guidance at the time.
	The Chamber recognises the necessity for large scale deployment of offshore wind as part of the UK energy mix to reach net zero and therefore calls upon the developer to be frugal in its usage of the seabed and reduce the footprint of the OWF or not build out to the full red line boundary (RLB). The UK EEZ is finite and unnecessary use of the seabed squanders the valuable wind resource the UK has. Through reducing the seabed area developed by Outer Dowsing, it means there is available sea-room set aside for other activities, including commercial navigation, along with the potential for more build out of offshore wind in later rounds.	The northern and western boundaries have both been reduced post PEIR to reduce impacts to shipping and navigation users. These changes were presented to key stakeholders including the CoS via dedicated meetings and at the second hazard workshop.
Trinity House (PEIR)	I can confirm that Trinity House has the following comments/requests to make at this stage: • I have attached our most recent standard navigation conditions, which we would expect to be provided for within your DCO/DML. • We would welcome your earliest possible consultation regarding proposed turbine layouts, as well as the locations of any other infrastructure.	Appropriate condition wording will be agreed with Trinity House via the Statement of Common Ground process, noting that the DCO and dMLs is considered to contain conditions covering the points raised by Trinity House. The final layout will be agreed with the MCA

Stakeholder(s)	Key Points Raised	Response and where addressed in the NRA
		and Trinity House post consent.
Trinity House (autumn consultation)	"With reference to the below and the Hazard Workshop Meeting yesterday, I can confirm that Trinity House has no further comments to add to those previously made (attached for ease of reference) on 14/07/23, which remain valid."	Noted.

4.2.3 Dedicated Meetings

36. Key points raised at dedicated stakeholder meetings of relevance to shipping and navigation are summarised in Table 4-3.

Table 4-3 Key Stakeholder Meetings

Stakeholder(s)	Date and form of correspondence	Key Points Raised	Response and where addressed in the NRA
DFDS and CoS	02 June 2021 Initial Meeting	CoS raised cumulative concerns with the Dudgeon and Sheringham Extensions to the south.	See section 16 and section 20.
DFDS and CoS	02 June 2021 Initial Meeting	DFDS noted concern over traffic passing inshore of the Outer Dowsing bank, in particular whether the Project may increase traffic levels in this area or reduce navigable width.	Post windfarm routeing is considered in section 15.5. Associated impacts are assessed in section 19.
DFDS and CoS	02 June 2021 Initial Meeting	DFDS stated limited concern with their Newcastle to Ijmuiden Route. However the Immingham-Cuxhaven routeing will be affected. Adverse weather routeing between Immingham and Esbjerg may also be impacted.	Post windfarm routeing is considered in section 15.5, and adverse weather routeing in section 12. Associated impacts are assessed in section 19.
Trinity House	10 January 2022 Pre-Scoping Consultation Meeting	Trinity house has a key interest in where traffic passing north of the Project will route. North / south traffic passing west of the Hornsea sites is also of interest. Tanker traffic from Humber should be considered given the size of the vessels.	Vessel displacement and full details of potential route deviations including on a cumulative basis are provided has been considered in section 19.
Trinity House	10 January 2022 Pre-Scoping Consultation Meeting	Trinity House prefers straight line edges for the Project with no isolated structures.	As per section 17.2.2.4, the layout will be agreed with the MCA and Trinity House.
Trinity House	10 January 2022 Pre-Scoping Consultation Meeting	Construction buoyage will need to be thoroughly considered regarding the presence of Triton Knoll OWF and the shallow banks.	As per section 17.2.2.4, lighting and marking including the buoyed

Stakeholder(s)	Date and form of correspondence	Key Points Raised	Response and where addressed in the NRA
			construction area will be agreed with Trinity House.
MCA	14 January 2022 Pre-Scoping Consultation Meeting	Proposed seaweed farms and Dutch windfarms to the north of the East Anglia projects are unlikely to cause any impact but interested in knowing if there is any effect.	Cumulative risk assessment is provided in section 20. Cumulative development screening has been undertaken in section 16.1.
MCA	14 January 2022 Pre-Scoping Consultation Meeting	The larger structures and rotor diameters can create challenges for SAR helicopters.	As per section 17.2.2.4, the layout will be agreed with the MCA and Trinity House. These discussions will include SAR considerations, noting the Project will be MGN 654 compliant.
CoS	16 August 2022 Consultation Meeting	CoS stated that general trends in vessel traffic will remain similar but cautious over the passenger cruising growth that was present pre-Covid-19 and how that growth may continue but routeing is currently vague.	The potential future case traffic increases are detailed in section 15.
CoS	16 August 2022 Consultation Meeting	Consideration should be taken in regard to the study area and the location the existing Dudgeon/Sheringham sites and the planned extension projects. CoS requested that PEIR included an idea of scale, possibly through the use of a grid to understand what the size of a certain development in the area will resemble.	Details of the study area are provided in section 3.4.
DFDS	8th September 2022 Consultation Meeting	Although King & Princess Seaways intersected or passed in proximity to the site on adverse weather routes, there is limited concern with the associated routeing. Key DFDS concern is the Immingham to Cuxhaven routes.	DFDS routeing has been identified and assessed and the risk assessment is provided in section 19.
CoS	7th September 2023 Consultation Meeting	The array area reduction was welcome and positive, however the importance of an angled northern boundary was highlighted. The updated western boundary was viewed as a “positive change”.	Additional array area reduction has been presented in section 6.1. This includes an angled northern boundary.
		With regard to the draft National Policy Statements, CoS stance is that these should not be given undue precedence, given that the statements remained in draft.	Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) references the latest active NPS, which have become active post PEIR.

Stakeholder(s)	Date and form of correspondence	Key Points Raised	Response and where addressed in the NRA
DFDS	7th September 2023 Consultation Meeting	Estimated a 2nm increase in journey distance as a combined result of the array area and Hornsea Three.	Cumulative deviations to the associated DFDS route have been assessed in section 16.2.1.1.
		Noted that 'dog leg' routes and increased way points increases the risk to DFDS vessels	The array area reduction has been presented in section 6.1. This includes an angled northern boundary to minimise the need to 'dog leg'.
MCA	13th of September 2023 Consultation Meeting	The northern boundary reductions were "welcome", however MCA indicated they would want to understand DFDS view.	DFDS have confirmed broadly content with the array area changes (see section 6.1).
		The western boundary changes were "positive", MCA noted routeing passing between the Outer Dowsing Bank and Pickerill.	The associated vessel operator was included in the regular operator outreach and invited to both hazard workshops.
		MCA confirmed that 12 months of historical AIS was sufficient to assess the ANS areas.	See section 13.
Trinity House	15th of September 2023 Consultation Meeting	East / west traffic cargo vessel traffic through the site should be considered within the NRA including on a cumulative basis (in particular with Hornsea Three)	Baseline cargo vessel routeing has been assessed in section 10.1.2.1. Associated deviations are assessed in sections 15.5 and 16.2
		The site reduction is a positive, and it makes sense to pull back to the other side of the Outer Dowsing bank	The array area reduction has been presented in section 6.1.
		Trinity House would likely look to mark ANS and ORCPs as isolated structures (e.g., longer range lights than the 5nm ranges used for the windfarm).	Lighting and marking for isolated structures has been considered in section 18. Lighting and marking of the ANSs and ORCPs is a requirement of the relevant dMLs.

4.2.4 Regular Operators

40. The key points raised as part of the Regular Operators outreach (see section 4.1) are summarised in Table 4-4, including where each point raised has been addressed within the NRA.

Table 4-4 Summary of Regular Operators Outreach

Regular Operator(s)	Data and form of correspondence	Point Raised	Response and where addressed in the NRA
StenaLine	8th September 2022 Email correspondence	Presence of the Project will impact vessel routeing and extend current transit lengths as will require re-routeing as well as creating additional safety concerns. Vessels will never transit through the array area but will continue to pass in close proximity.	Likely Post-windfarm routeing has been established in section 15 and the associated risks assessed in section 19.
Bore Ltd.	15th September 2022 Email correspondence	As long as baseline space remains between Outer Dowsing Shoal and Triton Knoll OWF, Bore suggested there would be limited concern. The optional shallow track to the east of Outer Dowsing Bank cannot be used post windfarm so vessels will route between Outer Dowsing Bank and Triton Knoll OWF. Therefore important that the width between Outer Dowsing Bank and Triton Knoll OWF is not reduced as above. Noted on a cumulative basis if vessels rerouted inshore of Triton Knoll OWF they would need to account for the Humber anchorage areas.	Likely Post-windfarm routeing has been established in section 15. This includes consideration of adverse weather transits and the associated risks assessed in section 19.
P&O Ferries	30 September 2022 Email correspondence	Vessels will only be affected by Project vessels crossing transit routes. Stated general experience that UK project vessel movements are “well managed and promulgated”.	Impacts associated with project vessels are assessed in section 19.

4.2.5 Hazard Workshops

41. A key element of the consultation phase were the Hazard Workshops, meetings of local and national marine stakeholders to identify and discuss potential shipping and navigation hazards. Using the information gathered from the Hazard Workshops, a Hazard Log was produced for use as input into the risk assessment undertaken in Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15). This

ensured that expert opinion and local knowledge was incorporated into the hazard identification process and that the Hazard Log was site-specific.

4.2.5.1 Hazard Workshop Attendance

42. Two Hazard Workshops have been undertaken – one prior to the PEIR stage, and one following project design changes made for the ES stage.

43. Both Hazard Workshops were held virtually via Microsoft Teams, with the first on 10 November 2022 and the second on 23 November 2023. The following organisations attended at least one of the Hazard Workshops:

- MCA;
- Trinity House;
- CoS;
- NFFO (National Federation of Fishermen's Organisations);
- Shell UK,
- Perenco;
- Cruising Association (CA);
- StenaLine;
- CLdN;
- DFDS;
- Boskalis Aggregate;
- Boston Putford;
- Associated British Ports (ABP) Humber; and
- Poseidon.

44. It is noted that all regular operators contacted (see section 4.1) were given the opportunity to attend the Hazard Workshops.

4.2.6 Hazard Workshop Process and Hazard Log

45. During the Hazard Workshops, key maritime hazards associated with the construction, O&M and decommissioning of the Project were identified and discussed. Where appropriate, hazards were considered by vessel type to ensure risk control options could be identified on a type-specific basis.

46. Following the first Hazard Workshop, the risks associated with the identified hazards were ranked in the Hazard Log based upon the discussions held during the workshop, with appropriate embedded mitigation measures identified, including any additional measures required to reduce the risks to ALARP. The Hazard Log was then provided to the Hazard Workshop attendees for comment on 25 November 2022, with final versions then issued on 9 January 2023.

47. Following the second Hazard Workshop, the hazard log was reviewed and updated based upon the discussions held during the Workshop and again provided to attendees to comment.

48. The associated feedback has been incorporated into the NRA. The final hazard log has been used to inform the risk assessment from section 19 and is provided in full in Annex B.

49. Key points raised during the first Hazard Workshop deemed of relevance to the NRA are provided in Table 4-5. Following this, key points raised during the second Hazard Workshop deemed of relevance to the NRA are provided in Table 4-6.

Table 4-5 First Hazard Workshop Summary

Comment Originator	Point raised	Response and where addressed in the NRA
MCA	Many factors need to be considered when regarding vessel displacement in this specific area including navigational features and water depts etc. and as a whole will be hard to generalise.	Vessel deviation has been considered in section 15.5. This has accounted for water depths and navigational features.
Boskalis Aggregate	Aggregate activity will continue to become more intense in the area in coming years but will be limited to the boundary of the already assigned dredging areas so minimal impact will occur, but an increase of vessels will be attending areas from the southeast and will avoid the array area.	Marine aggregate dredgers have been considered in the Risk Assessment in section 19.
NFFO	AIS for the array area is likely to be representative of fishing activity. Although fisheries in the area are seasonal, whelk, crab and lobster potting are common in the area and static gear vessels will likely continue to fish within the array depending on final layout resulting in gear modifications. Vessels may leave and not fish in area if WTGs are not positioned favourably to the tides. Displacement of commercial vessels will impact static fishing gear in new areas. Displacement of commercial vessels will impact static fishing gear in new areas.	Fishing vessels in transit have been considered in the Risk Assessment in section 19.

Comment Originator	Point raised	Response and where addressed in the NRA
CA	Recreational vessels will avoid main commercial routes and so will move to due to areas of higher activity or displacement as a result of the Project placement. Sail vessels will be more reluctant to transit through the array when compared with motor vessels.	Recreational vessels have been considered in the Risk Assessment in section 19.
ABP Humber	Impact on Humber Ports will depend on the levels of construction traffic mobilising from the Humber region.	Construction traffic has been assessed in the Risk Assessment in section 19.

Table 4-6 Second Hazard Workshop Summary

Comment Originator	Point raised	Response and where addressed in the NRA
CoS	The changes made to the array are positive and welcome from a shipping and navigation perspective	The site reduction has been presented in section 6.1.
Boskalis	There may be concerns over the proximity of the construction buoyage or safety zones of the array area to extraction area 515/2 during the construction phase.	Trinity House and Boskalis will be liaised with to ensure that construction impact is minimised. Associated assessment is provided in section 19.
Cruising Association	From a recreational viewpoint, it is helpful that the Outer Dowsing shoal is now clear of the red line boundary, as recreational vessels could now more easily utilise this searoom when avoiding the busy Outer Dowsing channel	Impact of the Outer Dowsing shoal on recreational vessel collision and alision risk has been assessed in the Risk Assessment in section 19
CLdN	The refinement to the western extent is a welcome update	The site reduction has been presented in section 6.1.
CoS	The selected areas for the worst-case ORCP are suitable.	The worst case ORCP locations are presented in section 6.
MCA	The location of tanker tracks in proximity to the OCRP should be included within the NRA, to ensure limited impact.	Tankers in proximity to the ORCP area have been assessed in section 10.3.2.2.

It is noted that the CoS confirmed via email response on 12 January 2024 that feedback collected from DFDS was "broadly positive" regarding navigational safety and the array area updates.

5 Data Sources

50. This section summarises the main data sources used to characterise the shipping and navigation baseline relative to the Project.

5.1 Summary of Data Sources

51. The main data sources used to characterise the shipping and navigation baseline relative to the Project are outlined in Table 5-1.

Table 5-1 Data sources used to inform shipping and navigation baseline

Data	Source(s)	Purpose
Vessel Traffic	Summer vessel traffic survey data consisting of AIS, Radar and visual observations for the shipping and navigation study area (14-days, 2 - 15 August 2022) recorded from a dedicated on-site survey vessel.	Characterising vessel traffic movements within and in proximity to the Project in line with MGN 654 (MCA, 2021) requirements.
	Winter vessel traffic survey data consisting of AIS, Radar, and visual observations for the shipping and navigation study area (14-days, 15–29 November 2022) recorded from a dedicated on-site survey vessel.	
	Winter vessel traffic survey data consisting of AIS, Radar, and visual observations for the ORCP area study area (14-days, 9 - 23 January 2023) recorded from a dedicated on-site survey vessel.	
	Summer vessel traffic survey data consisting of AIS, Radar, and visual observations for the ORCP area study area (14 days, 14 – 28 June 2023) recorded from a dedicated on-site survey vessel.	
	AIS data for the offshore ECC study area covers same period as the summer vessel traffic survey for the shipping and navigation study area (28-days, 2 – 15 August 2022 and 15-29 November 2022).	

Data	Source(s)	Purpose
	AIS data for the shipping and navigation study area (12-months April 2021 to March 2022) (hereafter the 'long-term vessel traffic data') recorded from coastal receivers.	Validation of the vessel traffic surveys and characterising seasonal variations.
	Anatec's ShipRoutes database (2023).	Secondary source for characterising vessel traffic movements including cumulatively within and in proximity to the Project.
	RYA Coastal Atlas of Recreational Boating 2.1 (RYA, 2019).	Secondary source for characterising recreational vessel traffic movements.
	12 Months AIS (2023) within 5nm of the ANS areas.	Used to assess vessel traffic patterns within the vicinity of the ANS areas.
Maritime incidents	Maritime Accident Investigation Branch (MAIB) marine accidents database (2002 to 2022).	Review of maritime incidents within and in proximity to the Project.
	Royal National Lifeboat Institution (RNLI) incident data (2003 to 2022).	
	DfT UK civilian SAR helicopter taskings (2015 to 2023).	
Marine aggregate dredging	Marine aggregate dredging areas (licenced and active) (The Crown Estate (TCE), 2023).	Characterising marine aggregate dredging areas within and in proximity to the Project.
Other navigational features	Admiralty Charts, 1187, 1503 and 1190 (United Kingdom Hydrographic Office (UKHO), 2023).	Characterising other navigational features in proximity to the Project.
	Admiralty Sailing Directions NP54 (UKHO, 2021).	
Weather	Met Office UK weather station data (12-months, April 2021 to March 2022)	Identify periods of adverse weather in proximity to the Project.

5.2 Vessel Traffic Surveys

52. The vessel traffic surveys were undertaken by the guard vessel *Karima* (IMO number 7,427,403) and in agreement with the MCA and Trinity House. For the shipping and navigation study area, surrounding the array area, the summer survey was carried out

from 00:00 Universal Time Coordinated (UTC) on 2 August 2022 and concluded at 00:00 UTC on 16 August 2022, giving 14 full days of survey data. The winter survey was carried out from 01:00 UTC on 15 November 2022 and concluded at 01:00 UTC on 29 November 2022, giving 14 full days of survey data. Combined with the summer survey, a full 28 days of data was gathered for the array area and shipping and navigation study area.

53. The winter vessel traffic survey carried out for the ORCP area study area was carried out from 20:00 UTC on 9 January 2023 and concluded at 20:00 UTC on 23 January 2023, giving 14 full days of survey data. The summer vessel traffic survey for the ORCP area study area commenced at 21:30 UTC on 14 June 2023, and was concluded at 21:30 UTC on 28 June 2023, providing an additional 14 full days of survey data. Combined with the winter survey, a full 28 days of data was gathered for the ORCP area study area.

54. A number of vessel tracks recorded during the survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel and tracks of vessels associated with windfarm support at the Hornsea Project Two, which at the time of the summer survey was still under construction, as well as the Reactive Compensation Substation (RCS) and were therefore excluded from the characterisation of the vessel traffic baseline. Careful consideration was taken to keep any vessels involved in the operation of Hornsea Project One, which lies directly east to Hornsea Project Two, as this site was fully commissioned by the start of the survey period. Vessel traffic associated with this site is assumed to be routine, and so maintained within the dataset along with vessels associated with the operational Triton Knoll OWF within the shipping and navigation study area.

55. The dataset is assessed in full in section 10.

5.3 Long -Term Vessel Traffic Data

56. The long-term vessel traffic data consisting of Automatic Identification System (AIS) covering 12-months from 1 April 2021 to 31 March 2022 was collected from both coastal receivers and the survey vessel *Guard Celena,* from which data was available from the 20th August 2021 to the 2nd January 2022. The assessment of this dataset allowed seasonal variations to be captured in addition to low use or adverse weather routeing.

57. As for the vessel traffic survey data (see section 5.2) any traffic deemed to be temporary in nature has been excluded from the dataset.

58. The dataset is assessed in full in Annex E.

5.4 Data Limitations

5.4.1 AIS Data

59. The carriage of AIS is required on board all vessels of greater than 300 Gross Tonnage (GT) engaged on international voyages, cargo vessels of more than 500GT not engaged on international voyages, passenger vessels irrespective of size built on or after 1 July 2002, and fishing vessels over 15 metres (m) Length Overall (LOA).

60. Therefore, for the vessel traffic surveys larger vessels were recorded on AIS, while smaller vessels without AIS installed (including fishing vessels under 15m LOA and recreational craft) were recorded, where possible, on the Automatic Radar Plotting Aid (ARPA) Radio Detecting and Ranging (Radar) on board the *Karima*. A proportion of smaller vessels also carry AIS voluntarily, typically utilising a Class B AIS device. Throughout the summer and winter surveys of the array area, approximately 99% and 98% of vessel tracks respectively within the shipping and navigation study area were recorded via AIS with the remainder recorded via Radar and visual observation. For both the winter and summer vessel traffic surveys covering the ORCP area study area, over 99% of vessel tracks were recorded via AIS.

61. The long-term vessel traffic data and offshore ECC vessel traffic datasets – AIS only datasets – assume that vessels under a legal obligation to broadcast via AIS will do so. Vessels not on AIS are likely to be unrepresented (noting that it was indicated at the first Hazard Workshop that AIS was likely to be representative of overall traffic as per section 4.2.5).

62. Both the long-term vessel traffic data and the AIS component of the vessel traffic survey data assume that the details broadcast via AIS is accurate (such as vessel type and dimensions) unless there is clear evidence to the contrary.

5.4.2 Historical Incident Data

63. Although all UK commercial vessels are required to report accidents to the Maritime Accident Investigation Branch (MAIB), non-UK vessels do not have to report unless they are within a UK port or within 12nm territorial waters (noting that the shipping and navigation study area is not located within 12nm territorial waters) or carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report accidents to the MAIB.

64. The Royal National Lifeboat Institution (RNLI) incident data cannot be considered comprehensive of all incidents in the shipping and navigation study area. Although hoaxes and false alarms are excluded, any incident to which an RNLI resource was not mobilised has not been accounted for in this dataset.

5.4.3 United Kingdom Hydrographic Office Admiralty Charts

65. The UKHO admiralty charts are updated periodically and therefore the information shown may not reflect the real time features within the region with total accuracy. However, during consultation input has been sought from relevant stakeholders regarding the navigational features baseline.

66. Navigational features are based upon the most recently available UKHO Admiralty Charts and Sailing Directions at the time of writing.

6 Project Description

67. The NRA reflects the design envelope, which is detailed in full in Volume 1, Chapter 3: Project Description (document reference 6.1.3). The following subsections outline the maximum extent of the Project for which any shipping and navigation hazards are assessed.

6.1 Project Order Limits

68. The array area is located within the southern North Sea approximately 29nm (or 54km) from the Lincolnshire coast of the UK. The total area covered by the array area is approximately 127 square nautical miles (nm^2) with charted water depths ranging between 5 and 46m below Chart Datum (CD). The ORCP area covers a total area of approximately 0.9nm^2, and whereas at DCO submission was split into two sites across the offshore ECC, now lies solely within the retained southern offshore ECC option. Charted water depths for the ORCP area range between 11m and 13m and encompasses the shallow waters and banks of the Inner Dowsing area. The total area covered by the offshore ECC is approximately 57nm^2 with charted water depths ranging between 0m (at landfall) and 32m below CD. The WTGs and substations will be located entirely within the section of the array area excluding the ORBA, inclusive of blade overfly. It is noted that the current envelope also includes the potential for ANSs (section 6.6).

69. The key coordinates defining the order limits of the array area of the Project are illustrated in Figure 6.1 and provided in Table 6-1 using World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) Zone 31N. The ORBA has also been included within Figure 6.1 for reference.

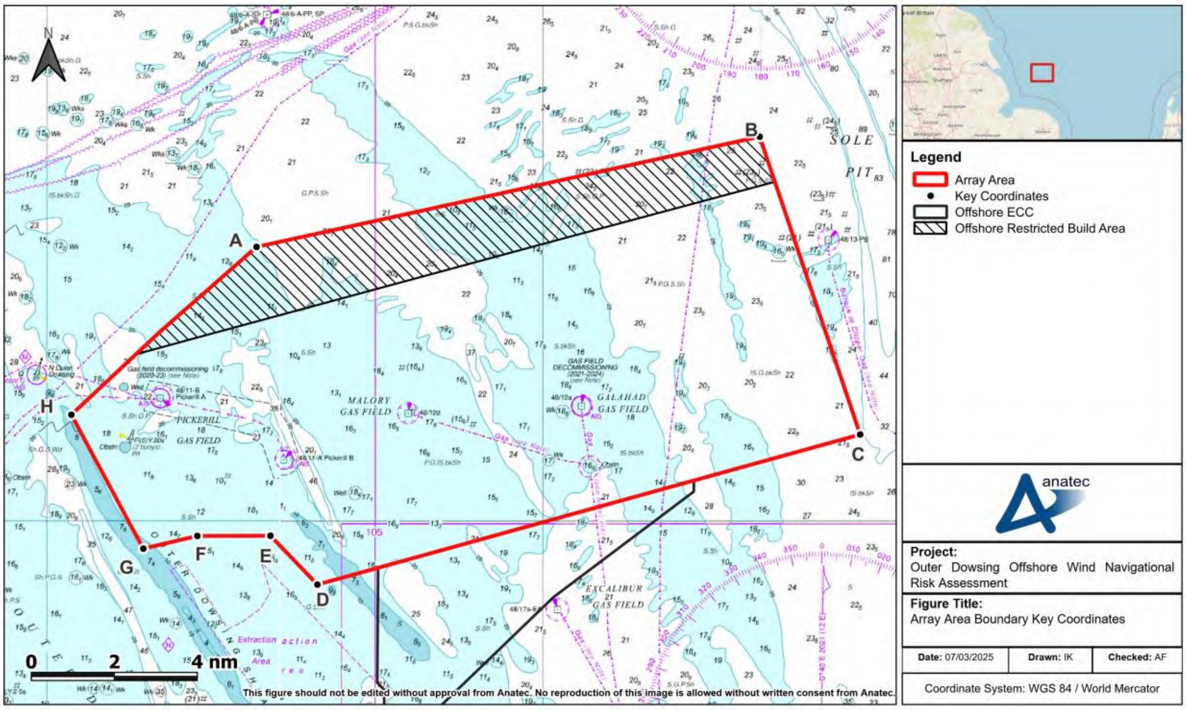

Figure 6.1 Key Coordinates for the Array Area

Table 6-1 Key Coordinates for the Array Area

Point	Latitude (WGS84)	Longitude (WGS84)
A	53° 36′ 34.08″ N	001° 08′ 26.92″ E
B	53° 39′ 12.69″ N	001° 28′ 43.59″ E
C	53° 32′ 03.76″ N	001° 32′ 46.68″ E
D	53° 28′ 27.09″ N	001° 10′ 54.11″ E
E	53° 29′ 37.65″ N	001° 09′ 00.49″ E
F	53° 29′ 37.33″ N	001° 06′ 03.73″ E
G	53° 29′ 19.04″ N	001° 03′ 53.18″ E
H	53° 32′ 32.23″ N	001° 00′ 59.09″ E

70. It is noted that the array area represents a change from that considered at PEIR (the Area for Lease (AfL) array area), with the changes made following stakeholder feedback (see section 4.2). The array area changes are presented in Figure 6.2.

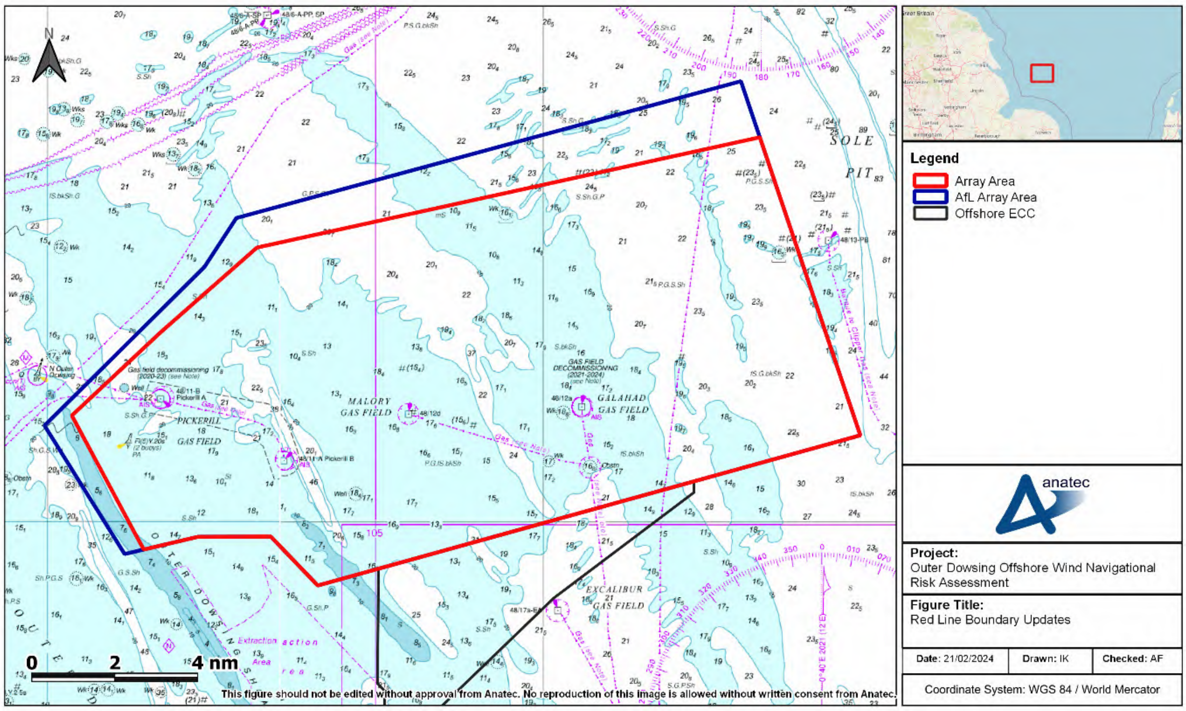

Figure 6.2 Order Limit Updates

71. The key change relates to the western and northern extents of the AfL array area and important Roll-on/Roll-off cargo (Ro-Ro) and Roll-on/Roll-off passenger (RoPax) routes (see section 11.2.1) with which stakeholders raised concerns. The changes were presented to stakeholders post PEIR at the second hazard workshop. The agreed minutes state that:

"*The key outputs of the initial Hazard Log were that vessel displacement, collision risk, and adverse weather routeing were deemed to be tolerable with the need for further consultation and array area refinement, both of which have now been actioned.* ***General consensus by attendees was that concerns have been generally addressed****, noting that feedback from DFDS was needed and still pending*."

72. DFDS subsequently confirmed via the CoS that they were "*broadly positive regarding navigational safety and the RLB* [Red Line Boundary] *change*".

6.2 Offshore Restricted Build Area

73. As described in Section 1, this document has been revised and updated to reflect the inclusion of the ORBA. The updated information ensures that all relevant considerations related to the ORBA are addressed and are in line with the current environmental, regulatory, and operational requirements. The updates are designed to support the ongoing efforts to minimise environmental impacts.

74. The ORBA is proposed to cover the northern part of the array area, comprising an area that is approximately 2km wide at the north-east corner and approximately

3.5km at the north-west corner. In total, the ORBA covers an area of 71.3km^2, which represents 16.4% of the array area. No WTGs or OPs will be installed in the ORBA, however, the area may be used for cable installation and ancillary operations during construction (and decommissioning) and operations and maintenance works.

75. As such, no change is being proposed to the extent of the array area, as defined within the draft Development Consent Order (DCO).

76. In total, the ORBA comprises an area of 20.8nm^2 – comprising approximately 16.4% of the total array area. As the NRA predates the ORBA, much of the relevant consultation and analysis does not account for its presence. Based on consultation post-submission, the ORBA is viewed as a largely positive addition from a shipping and navigation perspective; therefore, the analysis within the NRA that does not include the ORBA (in addition to the inclusion of the northern ORCP option) is considered highly conservative. Route deviation calculations and collision modelling undertaken to highlight the benefits of the ORBA are provided in Annex F.

77. The ORBA is located in the northern extent of the array area, as presented alongside the array area and AfL array area in Figure 6.3.

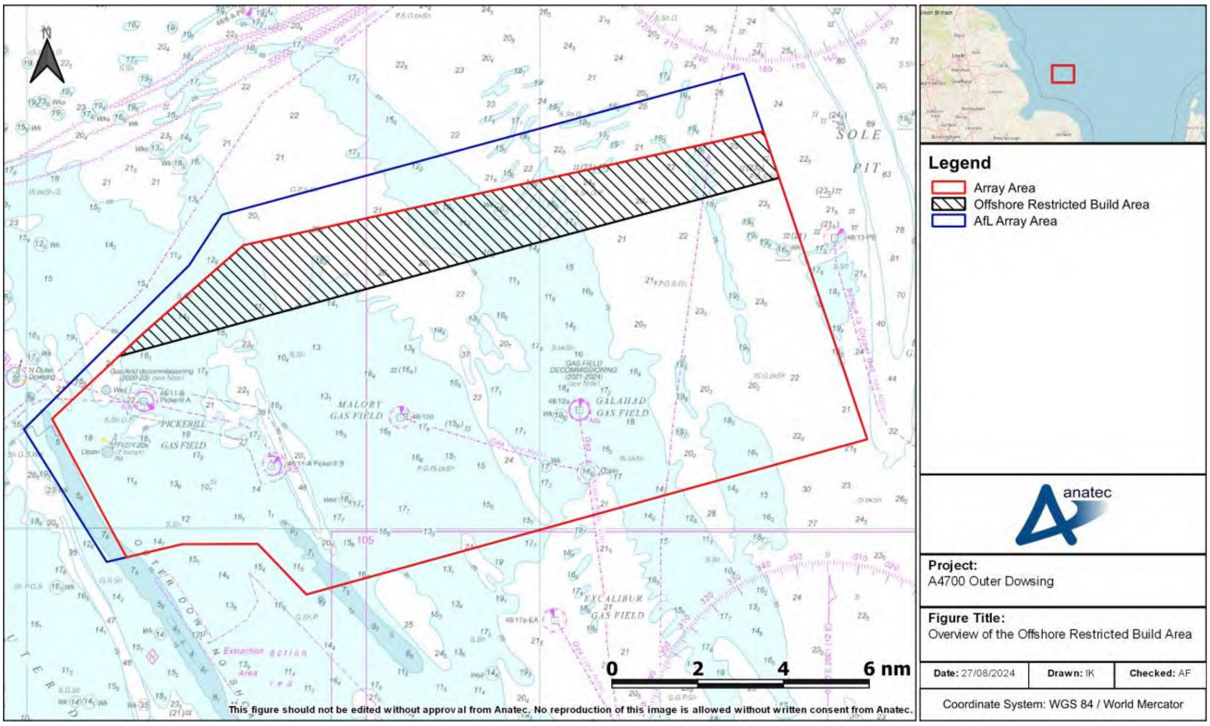

Figure 6.3 Overview of the ORBA

6.3 Surface Infrastructure

6.3.1 Wind Turbine Generators (WTGs)

78. WTG capacity (size) will range between 15MW and 30MW and the size of WTGs used will dictate final structure numbers.

79. Regardless of the WTG size used, there will be a minimum rotor blade clearance (air draft above MSL) of 40m, ensuring compliance with MGN 654 (2021).

80. Four-legged jacket foundations on suction buckets have been considered as the MDS for shipping and navigation as this foundation type provides the maximum structure dimension at the sea surface.

81. The MDS WTG measurements assuming use of suction bucket jacket foundations are provided in Table 6-2.

Table 6-2 WTGs MDS for shipping and navigation

Parameter	MDS for shipping and navigation
Number	100
Foundation type	Suction bucket jacket
Dimensions at sea surface	30 x 30 m
Minimum blade tip height (above MSL/Mean High Water Springs (MHWS))	40m/38m
Maximum rotor diameter	Up to 340m

82. Although the final locations of array infrastructure have not yet been defined, two indicative array layout options are considered in this NRA – one incorporating a full build out of the array area, and another which demonstrates the minimum spacing. It is noted that both layouts pre-date the introduction of the ORBA (see Section 6.2). Given the ORBA is considered to be a positive for shipping and navigation (see Section F.2.1), any future layout designs that incorporate the ORBA will be within the parameters already assessed within the NRA.

83. The full build out and minimum spacing array layouts are presented in Figure 6.4 and Figure 6.5 respectively.

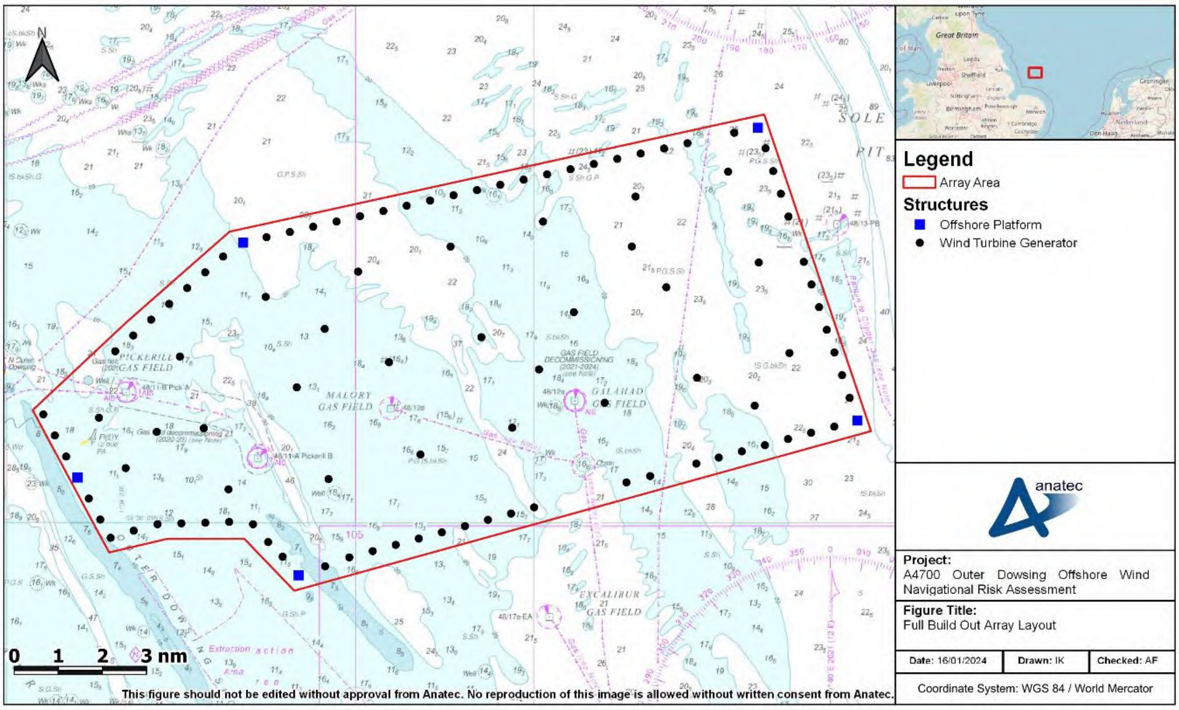

Figure 6.4 Full Build Out Array Layout (assessment layout that pre-dates ORBA)

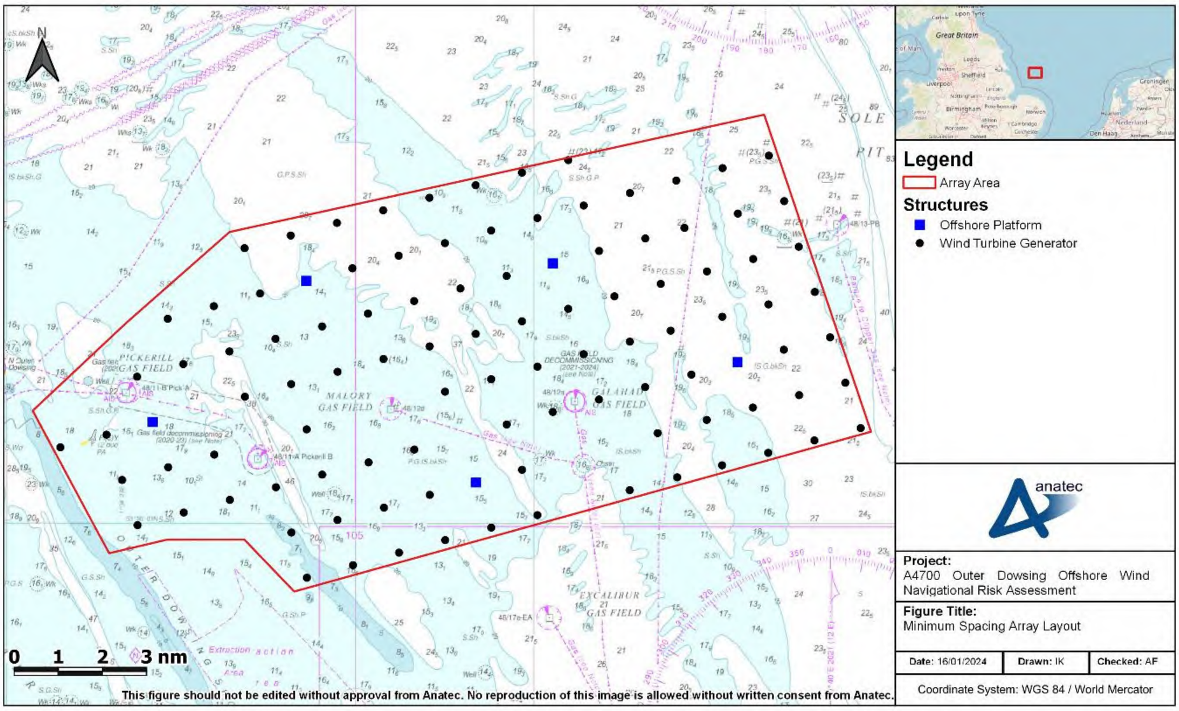

Figure 6.5 Minimum Spacing Array Layout (layout that pre-dates ORBA)

84. As well as jackets with suction buckets, the other foundation types under consideration include gravity based foundations, monopiles, and jackets with pin piles.

Descriptions of each foundation type under consideration are provided in Volume 1, Chapter 3: Project Description (document reference 6.1.3).

6.3.2 Offshore Substations and Other Auxiliary Structures in the Array Area

85. Up to four offshore transformer substations and one accommodation platform may be installed in the array area, with topside dimensions of 90x90m assuming the maximum number are constructed. A lower number of larger platforms may also be used (topside dimensions of 110x160m). The substations may be installed on either four-legged jackets with pin pile, gravity based foundations, monopiles and four-legged jackets with suction buckets.

6.3.3 ORCPs

86. Up to two ORCPs may be installed within the ORCP area, within the offshore ECC. The topside dimensions would be a maximum of 90m (height) x90m (width) when constructed.

87. The areas within which the ORCP could be sited have undergone refinement both pre and post submission. These processes are summarised below.

6.3.3.1 Refinement

88. Post-PEIR, the northern ORCP area was refined at the northeast extent in order to allow for additional searoom for routeing vessels in proximity, including high-use Ro-Ro and RoPax routes between Humber ports and Dutch ports (see section 11.2.2), with a section also removed from the southern ORCP area. The updates to the ORCP areas and offshore ECC are highlighted in Figure 6.6.

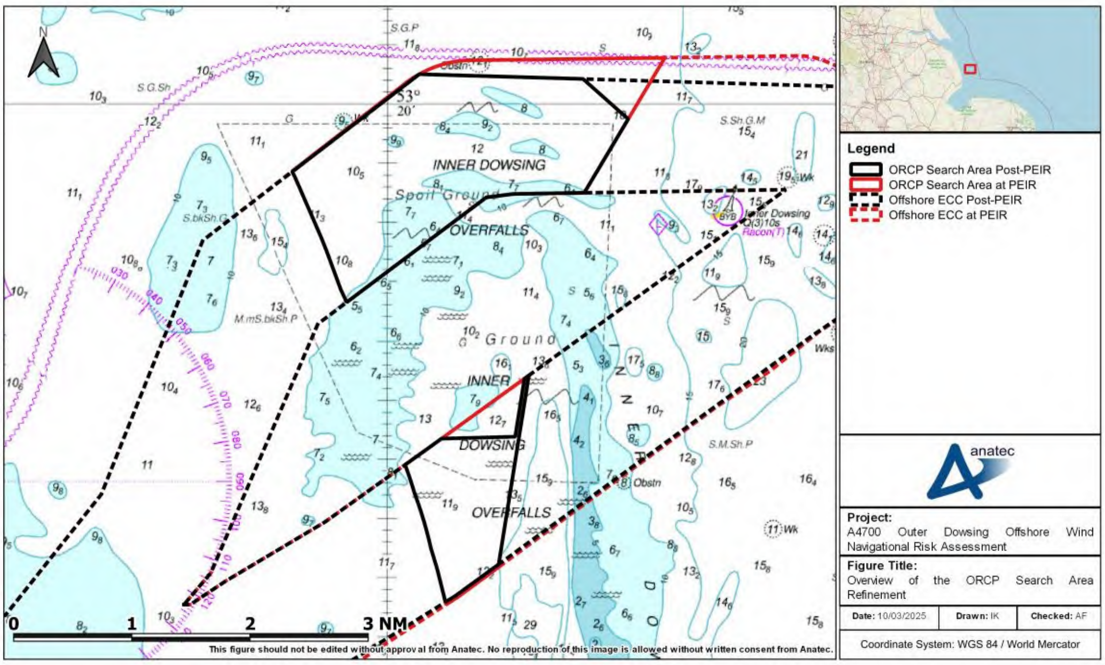

Figure 6.6 Overview of the ORCP Area Refinement (Post-PEIR)

89. Post submission, the northern option of the offshore ECC was removed from consideration, which in turn resulted in the removal of the northern ORCP area. In addition, the northern boundary of the southern ORCP area (now the sole ORCP area) was also refined. These site updates are presented in Figure 6.7. Consultation has confirmed that these changes are positive for shipping and navigation.

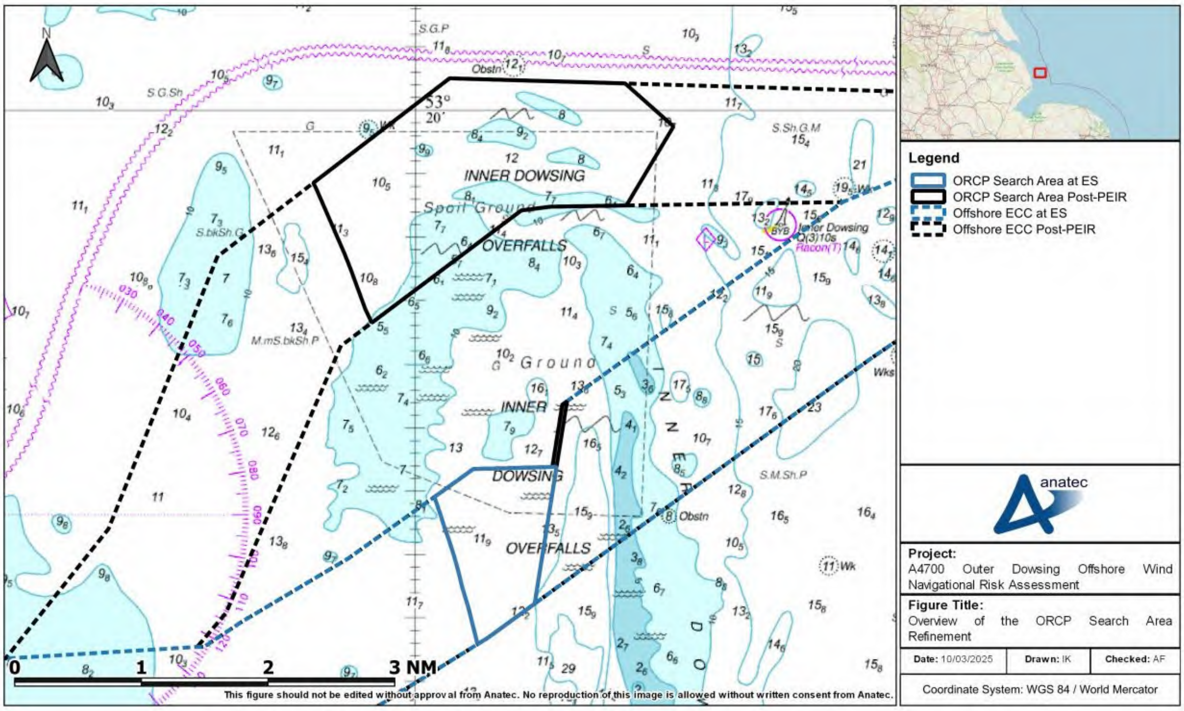

Figure 6.7 Overview of the ORCP Area Refinement (ES)

6.3.3.2 Worst Case Locations

90. As the northern ORCP area was retained for allision/collision modelling purposes (as per section 1.1), an ORCP position was included here as a worst case. This position, along with the worst-case location for an ORCP in the southern ORCP area, is illustrated in Figure 6.8**Error! Reference source not found.**. These locations were presented to stakeholders in the second hazard workshop (see section 4).

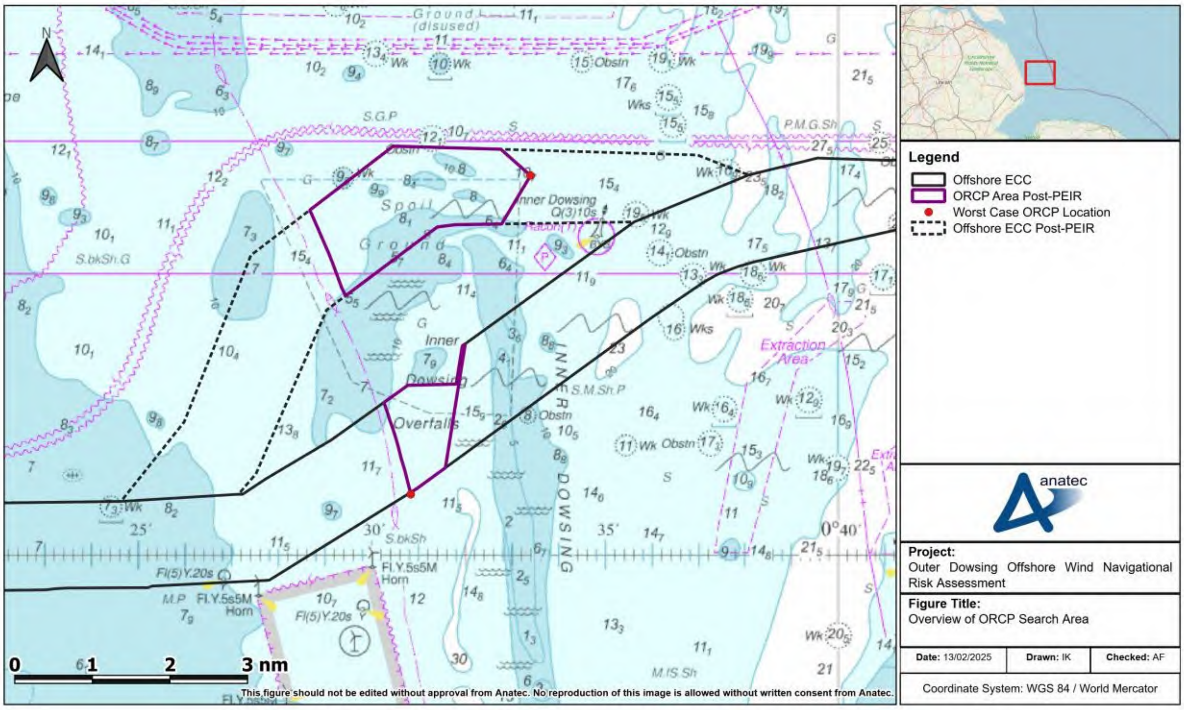

Figure 6.8 Overview of the ORCP Area within the Offshore ECC

91. Given the removal of the northern ORCP is considered a benefit for shipping navigation as it means any ORCPs will be further from the proximal routeing, any risk of the final location(s) will be within the parameters already assessed in the NRA through these worst case locations.

6.4 Subsea Infrastructure

92. Three types of subsea cables will be installed: inter-array cables, interlink cables and offshore export cables. Each category of subsea cables is summarised in the following subsections.

6.4.1 Inter-Array Cables

93. The inter-array cables will connect individual WTGs to each other and the substations. Up to 204nm (or 377.42km) of inter-array cables will be required with the final length dependent on the final array layout. All inter-array cables will be installed within the array area. The extent of burial and need for any external protection will be determined via a cable burial risk assessment process (see section 6.4.4).

6.4.2 Interlink Cables

94. The interlink cables will provide interlink connections between the substations (and accommodation platform) within the array area. A maximum of six interlink cables will be required with a total length of up to 67nm (or 123.75km). The final length will be dependent on the final array layout. The extent of burial and need for any external

protection will be determined via a cable burial risk assessment process (see section 6.4.4).

6.4.3 Export Cables

95. The export cables will carry the energy generated by the WTGs from the array area to shore. A maximum of four export cables will be required with a combined total length of up to 238nm (or 440km) which will be installed within the offshore ECC. The export cables will make a proposed landfall south of Anderby Creek on the Lincolnshire coast. The extent of burial and need for any external protection will be determined via a cable burial risk assessment process (see section 6.4.4).

96. As noted within section 6.3.3, initially two offshore ECC routes were proposed. However, the northern of these routes will no longer be considered. An overview of the offshore ECC and proposed export cable landfall is illustrated in Figure 6.9, with the previous route also highlighted.

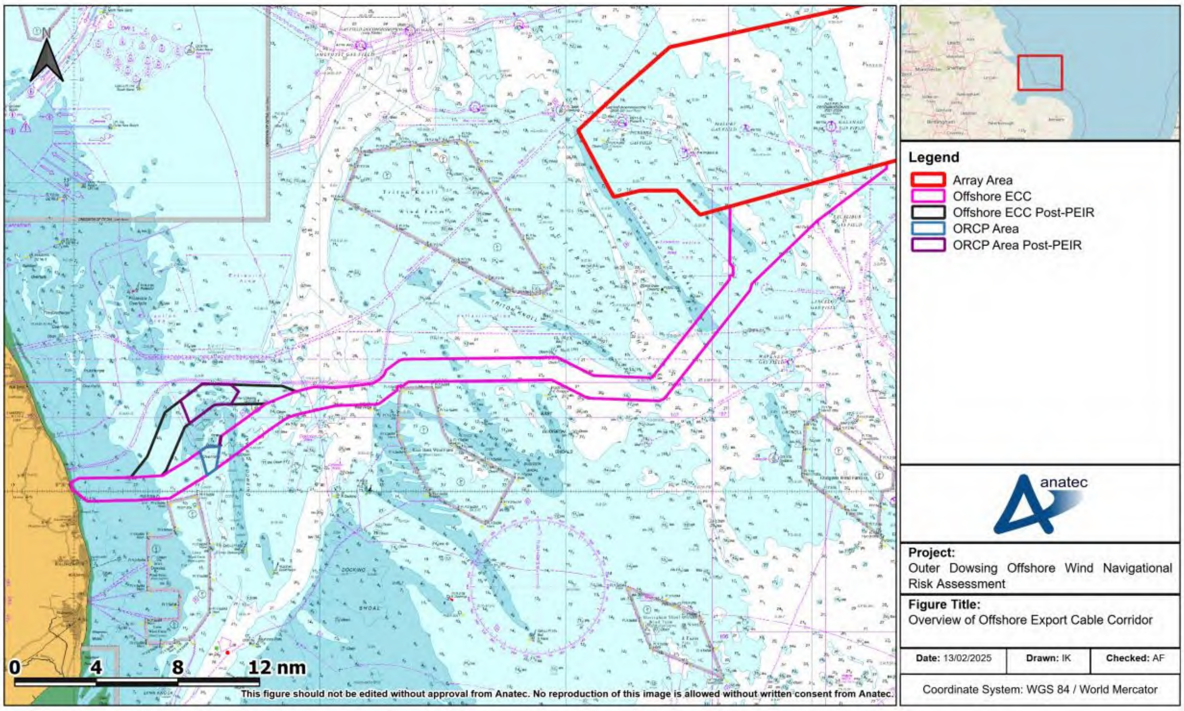

Figure 6.9 Overview of the Offshore Export Cable Corridor

6.4.4 Cable Burial and Protection

97. Where available, the primary means of cable protection will be by seabed burial. The extent and method by which the subsea cables will be buried will depend on the results of a detailed seabed survey of the final cable routes and associated cable burial risk assessment process, with an indicative maximum depth of 3m (when using vertical injection) anticipated. Where cable burial is not possible, alternative cable protection measures may be used all which will be determined within the cable burial risk

assessment process. In addition, cable protection will be used where cables cross existing seabed assets, such as existing cables and pipelines. It is anticipated that there will be cable crossings associated with all cable types.

6.5 Vessel Numbers

6.5.1 Construction Phase

98. Up to 5,128 return trips by construction vessels may be made throughout the construction phase, breaking down as summarised in Table 6-3 (noting that numbers are indicative and assumed to be an MDS for shipping and navigation).

Table 6-3 Maximum vessel numbers per construction activity

Activity	Vessel Type	Number of Vessels	Round Trips
WTGs installation	Installation vessels (Jack-up Vessel (JUV) or anchored)	2	50
WTGs installation	Support vessels	18	1480
WTGs installation	Transport vessels	10	150
WTG foundations installation	Installation vessels (JUV and anchored)	3	54
WTG foundations installation	Support vessels	10	67
WTG foundations installation	Transport / feeder vessels (incl. tugs)	8	400
WTG foundations installation	Anchored transport / feeder vessels	8	400
Offshore platforms installation	Installation vessels	2	24
Offshore platforms installation	Support vessels	12	96
Offshore platforms installation	Transport vessels (tugs and barges)	4	48
Offshore platform foundations installation	Installation vessels	2	16
Offshore platform foundations installation	Support vessels	12	48
Offshore platform foundations installation	Transport vessels (tugs and barges)	4	32
Inter-array cables installation	Main cable laying vessels	3	24
Inter-array cables installation	Main cable burial vessels	2	18

Activity	Vessel Type	Number of Vessels	Round Trips
Inter-array cables installation	Support vessels	14	1099
Offshore export cables installation	Main cable laying vessels	3	20
Offshore export cables installation	Main cable jointing vessels	3	16
Offshore export cables installation	Main cable burial vessels	3	16
Offshore export cables installation	Support vessels	16	1070
ANS foundation installation	Installation Vessel	2	8
ANS foundation installation	Support Vessel	12	32
ANS foundation installation	Transport Vessel	4	16
ANS topside installation	Installation Vessel	2	8
ANS topside installation	Support Vessel	12	16
ANS topside installation	Transport Vessel	4	12
Benthic compensation installation	Installation Vessel	1	10
Benthic compensation installation	Annual Monitoring Vessels	1	4
Total		**174**	**5234**

99. Up to 384 return trips by helicopters may be made throughout the construction phase, as summarised in Table 6-4.

Table 6-4 Maximum helicopter numbers per construction activity

Construction activity	Maximum number of return trips
WTG foundation installation	100
WTG installation	176
Offshore substation foundation installation (All OSSs, ORCPs and Accommodation Platform)	28
Offshore substation installation (All OSSs, ORCPs and Accommodation Platform)	40
Inter-array and interlink cable installation	24
Export cable installation	16
Total	**384**

6.5.2 Operation and Maintenance

100. An indicative 2,480 return trips per year is assumed to be a worst case for shipping and navigation over an anticipated maximum 35-year operational lifetime O&M phase.

6.5.3 Decommissioning Phase

101. The decommissioning sequence will generally be the reverse of the construction sequence and is likely to involve similar types and numbers of vessels.

6.6 ANS

102. The Project may construct a maximum of up to two ANS offshore to provide a nesting location for certain bird species. The ANS would be comprised of a topside nesting structure and will be supported by a foundation structure such as a monopile or jacket. Maximum topside dimensions are the ANS are 23x23m.

103. The ANS Areas are shown in Figure 6.10.

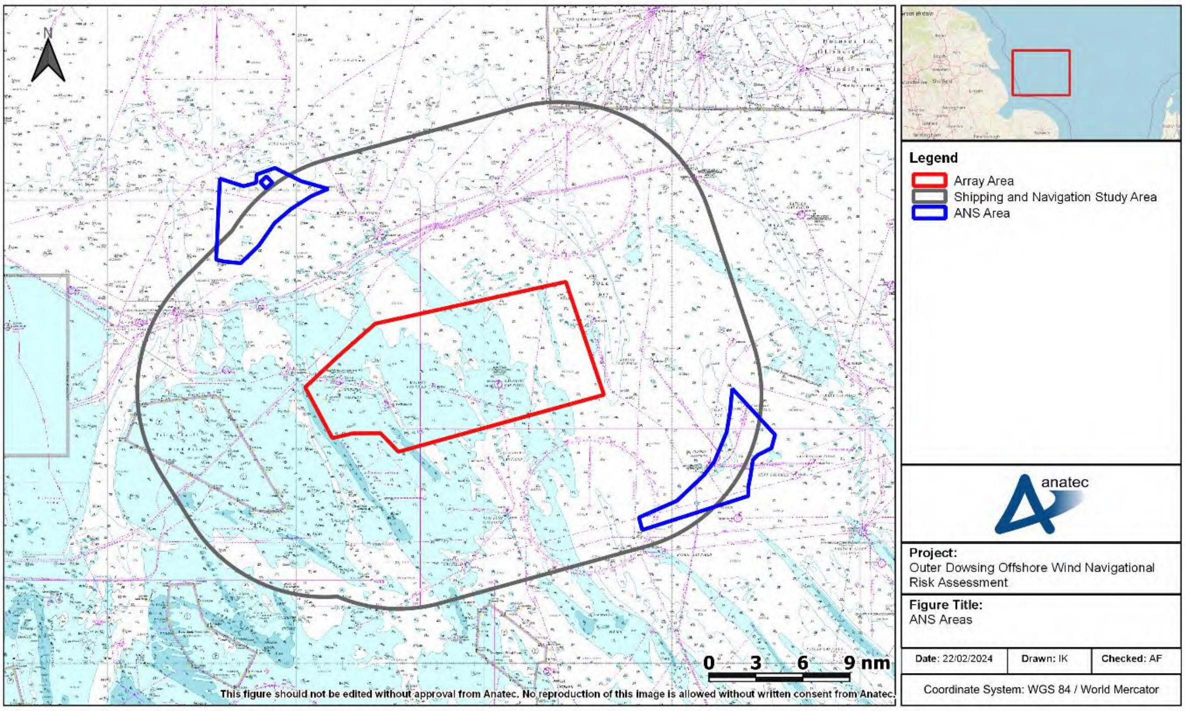

Figure 6.10 ANS Areas

104. The assessment approach to the ANS is detailed in section 13.

6.7 Maximum Design Scenario

105. The MDS for each shipping and navigation hazard is provided in Table 6-5 and is based on the parameters described in the previous subsections.

Table 6-5 MDS by Hazard for Shipping and Navigation

Potential Hazard	MDS for Shipping and Navigation	Justification
Construction		
Displacement of vessels leading to increased collision risk between third-party vessels.	▪ Maximum extent of buoyed construction area assuming full build out of array area; ▪ 100 WTGs and five substations (including accommodation platform) in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Construction phase up to 4 years; and ▪ 500m safety zones around structures where active construction is ongoing, 50m safety zones otherwise.	Largest area over maximum period will lead to maximum displacement.
Restriction of adverse weather routeing.	▪ Maximum extent of buoyed construction area assuming full build out of array area; ▪ 100 WTGs and five substations (including accommodation platform) in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Construction phase up to 4 years; and ▪ 500m safety zones around structures where active construction is ongoing, 50m safety zones otherwise.	Largest area over maximum period will lead to maximum potential for restriction of adverse weather routeing options.
Increased vessel-to-vessel collision risk between a third-party vessel and project vessel;	▪ Maximum extent of buoyed construction area assuming full build out of array area; ▪ 100 WTGs and five substations (including accommodation platform) in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Up to 377.42km of array cables; ▪ Up to 123.25km of interlink cables;	Maximum number of construction vessels will lead to maximum third party collision risk.

Potential Hazard	MDS for Shipping and Navigation	Justification
	▪ Up to 440km of export cables; ▪ Construction phase up to 4 years; and ▪ Up to 174 project vessels with a total of up to 5,234 return trips.	
Increased vessel to structure allision risk (powered, drifting, and internal navigation);	▪ Maximum extent of buoyed construction area assuming full build out of array area; ▪ 100 WTGs and five substations (including accommodation platform) in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Construction phase up to 4 years; and ▪ 500m safety zones around structures where active construction is ongoing, 50m safety zones otherwise.	Maximum number of structures will lead to maximum allision risk.
Reduction of emergency response provision including SAR capability.	▪ Maximum extent of buoyed construction area assuming full build out of array area; ▪ 100 WTGs and five substations (including accommodation platform) in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Up to 377.42km of array cables; ▪ Up to 123.75km of interlink cables; ▪ Up to 440km of export cables; ▪ Construction phase up to 4 years; and ▪ Up to 174 project vessels with a total of up to 5,234 return trips.	Maximum number of construction vessels will lead to largest potential for increased incident rates.
Operations and Maintenance		

Potential Hazard	MDS for Shipping and Navigation	Justification
Displacement of vessels leading to increased collision risk between third-party vessels.	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five substations in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Operational life up to 35 years; and ▪ 500m safety zones around structures where major maintenance is ongoing.	Largest area over maximum period will lead to maximum displacement.
Restriction of adverse weather routeing.	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five substations in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Operational life up to 35 years; and ▪ 500m safety zones around structures where major maintenance is ongoing.	Largest area over maximum period will lead to maximum potential for restriction of adverse weather routeing options.
Increased vessel-to-vessel collision risk between a third-party vessel and project vessel;	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five substations in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Up to 377km of array cables; ▪ Up to 124km of interlink cables; ▪ Up to 440km of export cables; ▪ Operational life up to 35 years; and ▪ Up to 2,480 return trips per year from project vessels.	Maximum number of project vessels will lead to maximum third party collision risk.
Increased vessel to structure allision risk (powered, drifting, and internal navigation);	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five substations in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Operational life up to 35 years; and ▪ 500m safety zones around structures where major maintenance is ongoing.	Maximum number of structures will lead to maximum allision risk.

Potential Hazard	MDS for Shipping and Navigation	Justification
Reduction of emergency response provision including SAR capability.	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five substations in the array area; ▪ ORCP locations as per **Error! Reference source not found.**; ▪ Up to 377.42km of array cables; ▪ Up to 123.75km of interlink cables; ▪ Up to 440km of export cables; ▪ Operational life up to 35 years; and ▪ Up to 2,480 return trips per year from project vessels.	Maximum number of project vessels will lead to largest potential for increased incident rates.
Reduction of Under Keel Clearance	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five offshore platforms in the array area; ▪ Up to 377.42km of array cables, maximum height of rock berm of 1.5m, up to 22.75% of array cables requiring external protection; ▪ Up to 123.75km of interlink cables, maximum height of rock berm of 1.5m, up to 18.75% of interlink cables requiring external protection; ▪ Up to 440km of export cables, maximum height of rock berm of 1.5m, up to 25% of export cable requiring external protection within offshore ECC (outside of SAC); and ▪ Operational life up to 35 years.	Maximum length of subsea cable and maximum extent of protection over longest period leading to maximum under keel interaction risk.
Increased anchor/gear interaction with subsea cables	▪ Maximum extent (i.e., full build out) of array area; ▪ 100 WTGs and five offshore platforms in the array area; ▪ Up to 377.42km of array cables, maximum height of rock berm of 1.5m, up to 22.75% of array cables requiring external protection; ▪ Up to 123.75km of interlink cables, maximum height of rock berm of 1.5m, up to 18.75% of interlink cables requiring external protection;	Maximum length of subsea cable over longest period leading to maximum anchor/gear interaction risk.

Potential Hazard	MDS for Shipping and Navigation	Justification
	▪ Up to 440km of export cables, maximum height of rock berm of 1.5m, up to 25% of export cable requiring external protection within offshore ECC (outside of SAC); ▪ Minimum target burial depth of 1m; and ▪ Operational life up to 35 years.	
Decommissioning		
Analogous to construction phase.		

7 Navigational Features

106. A plot of the navigational features within and in proximity to the Project have been identified using the relevant UKHO Admiralty Sailing Directions (UKHO, 2021) and the UKHO Admiralty Charts (UKHO, 2023) as is presented in Figure 7.1. Each feature of relevance illustrated is discussed in the following subsections.

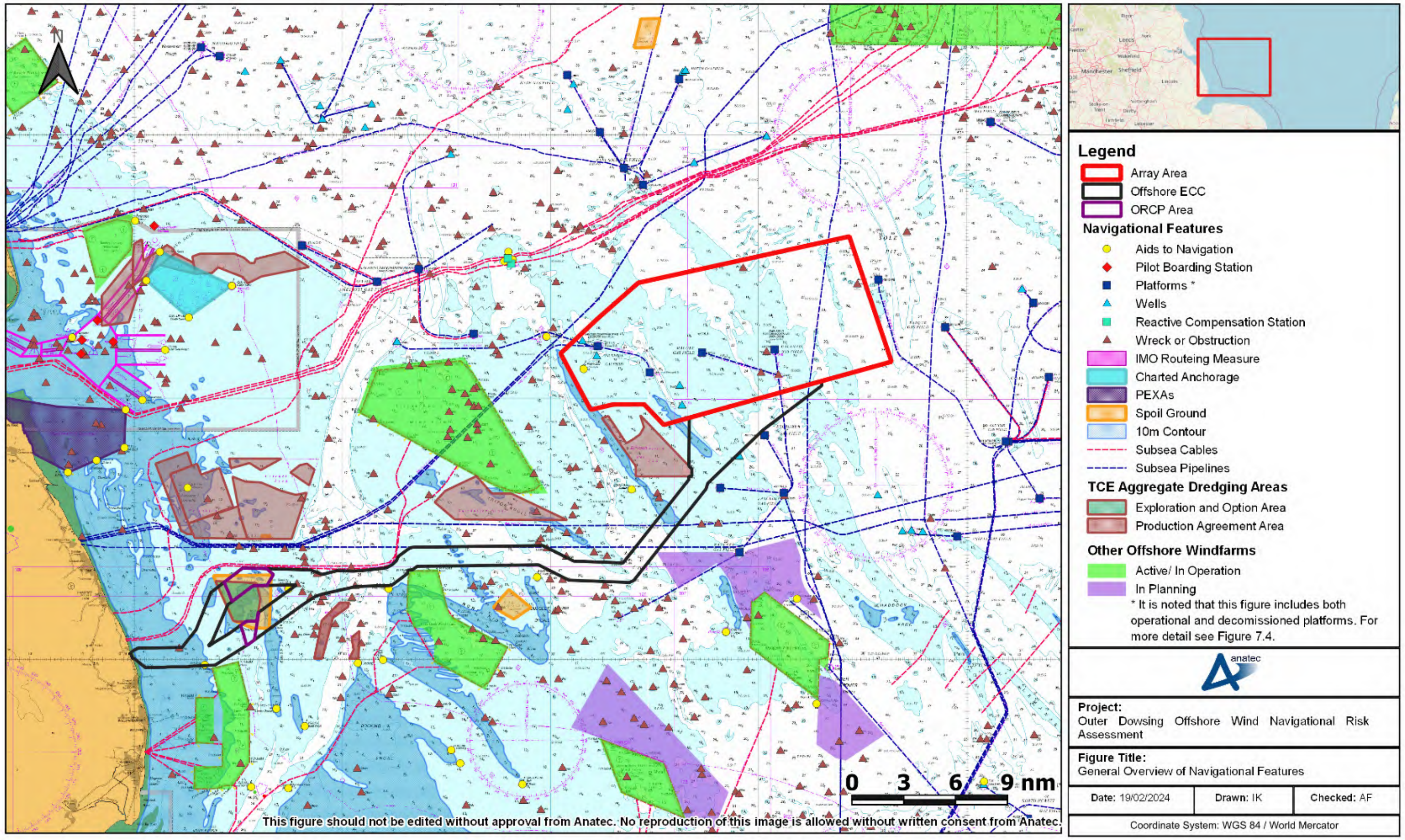

Figure 7.1 General Overview of Navigational Features Relevant to the Project

7.1 Other OWF Developments

107. Triton Knoll OWF is situated approximately 4nm to the west of the array area as illustrated in Figure 7.2. Triton Knoll was fully commissioned and operational in January 2022. Hornsea Project Two also intersects the shipping and navigation study area to the northeast and was fully commissioned and operational at the end of November 2022.

108. The operational Lincs OWF is situated less than 1nm southwest of the ORCP area and so immediately south of the offshore ECC. Racebank OWF lies 0.1nm south of the offshore ECC approximately 16nm offshore and is positioned approximately 7.4nm directly east of the ORCP area.

109. Other operational windfarms in proximity to the Project include Hornsea Project One approximately 10.6nm to the northeast of the array area, Dudgeon OWF approximately 10.7nm south of the array area, and Race Bank approximately 12.3nm to the southwest (and intersecting the offshore ECC)

110. Two RCSs are situated approximately 5nm to the northwest of the array area and are associated with the Hornsea projects.

111. It is noted that projects pre construction are not considered baseline and instead are captured within the cumulative assessment (see section 16).

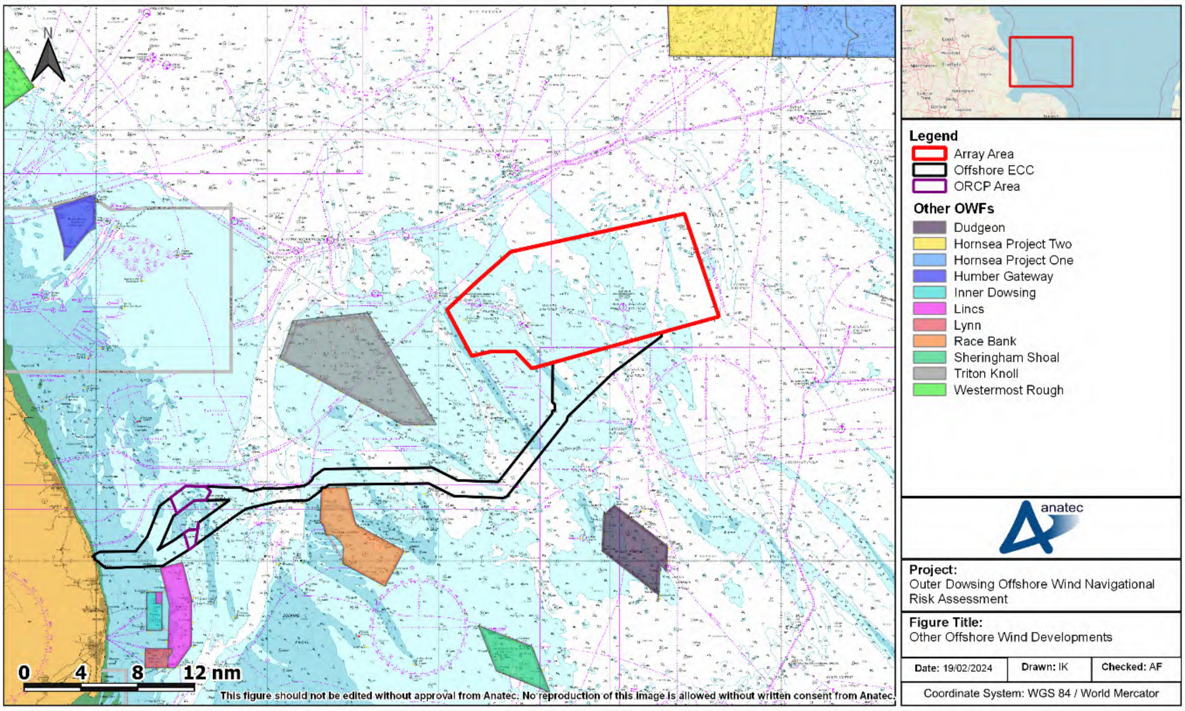

Figure 7.2 Other OWFs in proximity to the Project

7.2 Ports, Harbours, and Related Facilities

112. Several ports and harbours are located along the coast to the west of the Project as illustrated in Figure 7.3.

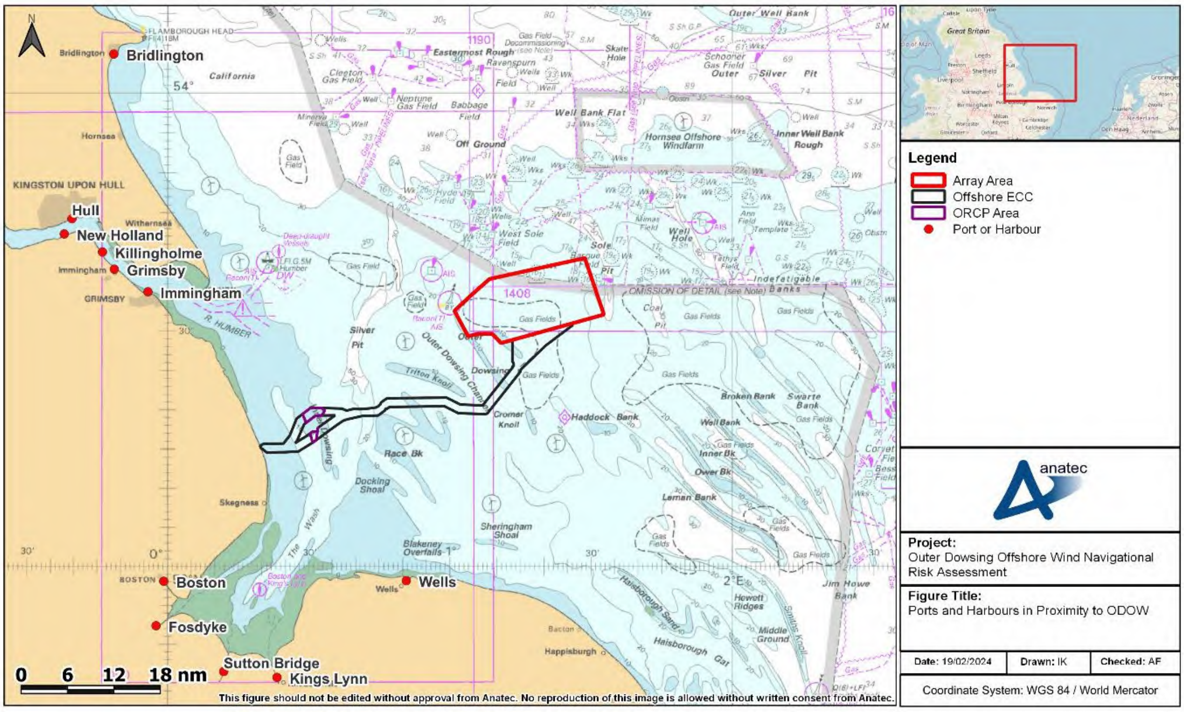

Figure 7.3 Ports and Harbours in Proximity to the Project

113. The closest port or harbour to the array area is Wells Harbour which is located approximately 32nm to the southwest on the Norfolk coast. The Admiralty Sailing Directions describe Wells as a "*small port for fishing and recreational craft*". Port of Immingham (38nm northwest), Port of Grimsby (42nm northwest), Port of Killingholme (44nm northwest), Port of Boston (49nm southwest), and Bridlington Harbour (53nm northwest) are also situated within the vicinity as well as many others along the River Humber and within The Wash estuary.

114. The following subsections provide further details on the main ports and harbours in proximity to the Project. Namely commercial ports and harbours within the Humber estuary and within The Wash Estuary.

7.2.1 Humber Ports

115. The Humber estuary is an extensive area for both industry and trade with commercial ports of significance including Immingham, Grimsby, Killingholme, Hull, and New Holland, with ports Goole and Flixborough further inland. The Humber estuary is known to be the largest port complex within the UK, handling 14% of all the country's international trade (Humber Nature Partnership, 2022).

116. A Vessel Traffic Service (VTS) is in operation for the control of shipping within port limits. Participation in the VTS Humber scheme is compulsory for all vessel over 50GT and any vessels carrying dangerous substances. Pilotage in the area is compulsory for vessels of 60m and over in length and for all vessels carrying dangerous substances in bulk when proceeding to and from inner anchorages with the purpose of anchoring. Anchorage within the area is detailed in section 7.4.

7.2.1.1 Port of Immingham

117. The Port of Immingham is classed as the UKs largest port in terms of tonnage with a handling of approximately 46 million tonnes of cargo each year and is the centre of the Humberside chemical and oil refining industries. The Immingham Oil Terminal will accept and handle vessels of lengths up to 336m and approximately 290,000 Deadweight Tonnage (DWT) partly laden. Between the other jetties and terminals at Immingham, there is collectively eight Ro-Ro berths, and as well as terminals specifically designed for the import and transport of coal, iron ore, and gas and being able to accommodate vessels up to 380,000 DWT.

7.2.1.2 Port of Grimsby

118. The Port of Grimsby is a leading UK port with both fishing and commercial properties and is a major car import terminal for the country importing more than 600,000 vehicles per year. The port specialises in short-sea trade to various locations in Europe and the Baltic while also assisting in O&M activities for the offshore wind industry. The two docks within the harbour will generally accept vessels up to a length of 145m, 20.5m beam, and 5.8m draught and have a combined total of 16 berths and four Ro-Ro berths.

7.2.2 The Wash Ports

119. The Wash estuary situated at the northwest corner of the Norfolk coast at the border of Norfolk and Lincolnshire provides a sheltered bay for many ports and harbours. Those of importance include the Port of Boston, Port of King's Lynn, Port of Sutton Bridge, Fosdyke Yacht Haven, and Wells Harbour.

120. Most of the ports and harbours in the area accommodate recreational craft and fishing vessels including Wells Harbour which is no longer in commercial use but has multiple pontoons in which is used by recreational craft and windfarm vessels in the area. Fosdyke Yacht Haven, previously serving as a commercial port for Boston, has now been converted into a private pleasure craft marina.

121. Commercial ports within the vicinity include Port of Boston and Port of King's Lynn.

122. The Port of Boston handles more than one million tonnes of cargo per year with a focus on importation of steel and timber. Exports of grain, fish, and recyclable

material is also common at the port. Pilotage is compulsory at the Port of Boston for vessels over 30m in length and all commercial vessels. The port offers seven berths and one Ro-Ro berth.

123. The Port of King's Lynn is a smaller commercial port importing steel, timber, fuel, and agricultural products and also exporting grain. Pilotage is compulsory for all vessels over 35m in length and any vessel over 100m in length must be considered by the harbour office regarding draught. All vessels entering the port must have sufficient under-keel clearance.

7.3 Marine Aggregate Dredging Areas

124. Several marine aggregate dredging areas defined by The Crown Estate (TCE) are present in proximity to the array area as seen in Figure 7.1. The extraction areas are Outer Dowsing areas 515/1 which lies approximately 6nm to the southwest of the array area, and 515/2 situated immediately southwest of the array area. Both sites are operated by Westminster Gravels Limited.

125. Intersecting both the north and south ORCP area sites, and so the offshore ECC also, is an exploration and options area, Inner Dowsing area 1805 operated by Hanson Aggregates Marine Ltd.

126. Other marine aggregate dredging areas are also located in close proximity to the ORCP area and the offshore ECC. Extraction area Van Oord Ltd area 481/1 is situated approximately 0.8nm south of the offshore ECC and 3.6nm to the east of the ORCP area. To the north, at approximately 1.5nm to both the ORCP area and the offshore ECC, is Humber Estuary extraction areas 400 and 106/3. Sharing boundaries with the Humber Estuary areas is Off Saltfleet area 197 to the north, and Humber Overfalls area 493 to the east.

7.4 Charted Anchorage Areas

127. The are no charted anchorage areas in proximity to the array area, ORCP area, or the offshore ECC.

128. The closest charted anchorage area to the Project is the Humber Deep Water Anchorage, north of the River Humber entrance, which is located approximately 15nm north of the ORCP area and Offshore ECC and approximately 19nm northwest of the array area.

7.5 Aids to Navigation

129. Various Aids to Navigations (AtoNs) are located within proximity to the array area as illustrated in Figure 7.1.

130. Within the array area, there is an AtoN situated to the west between the Outer Dowsing Shoal and Pickerill gas field. Other AtoNs in proximity to the array area include the three AtoNs at the RCS, associated with Hornsea Project Two, located 5nm to the northwest of the array area; the Northern Outer Dowsing Light Buoy, a north cardinal mark located approximately 1nm to the northwest of the array area above the Outer Dowsing Shoal; and the Mid Outer Dowsing Light Buoy, a lateral mark west of the Outer Dowsing Shoal approximately 4nm to the southwest or the array area.

131. AtoNs in proximity to the ORCP area include the Inner Dowsing east cardinal mark light buoy which is located approximately 1nm east of the ORCP area and is positioned on the northeast of the shallow inner dowsing shoal. This AtoN is also on the boundary of the offshore ECC.

132. In addition to the Inner Dowsing AtoN, other AtoNs bordering the offshore ECC include the West Ridge west cardinal mark light buoy, situated immediately south of the offshore ECC to the west of Race Bank OWF; the East Dudgeon east cardinal mark light buoy 0.7nm south of the offshore ECC on the east of the Dudgeon Shoal; and the Mid Outer Dowsing Light Buoy, a lateral mark west of the Outer Dowsing Shoal approximately 2nm north of the offshore ECC. The Dudgeon light buoy to the west of Dudgeon OWF as well as the AtoNs to the east and south are also located south of the offshore ECC.

133. It is noted that Trinity House stated within their Scoping Response (see section 4.2.1) that any impacts on existing AtoN should be considered. This has been assessed within the Risk Assessment in section 19.

7.6 Subsea Cables

134. There are a number of subsea cables in proximity to the Project including the export cables for Hornsea Project One and Two which make landfall on the Yorkshire Coast. These cables pass through the Hornsea RCSs and pass at approximately 2.4nm north of the array area in an east-west direction. These are the closest subsea cables in proximity to the array area.

135. Export cables for the Triton Knoll OWF pass immediately north of the offshore ECC. These cables make landfall approximately 0.5nm north of the offshore ECC landfall.

7.7 Oil and Gas Infrastructure

136. The oil and gas platforms and pipelines in proximity to the Project are presented in Figure 7.4, with a summary of details of relevance presented in Table 7-1.

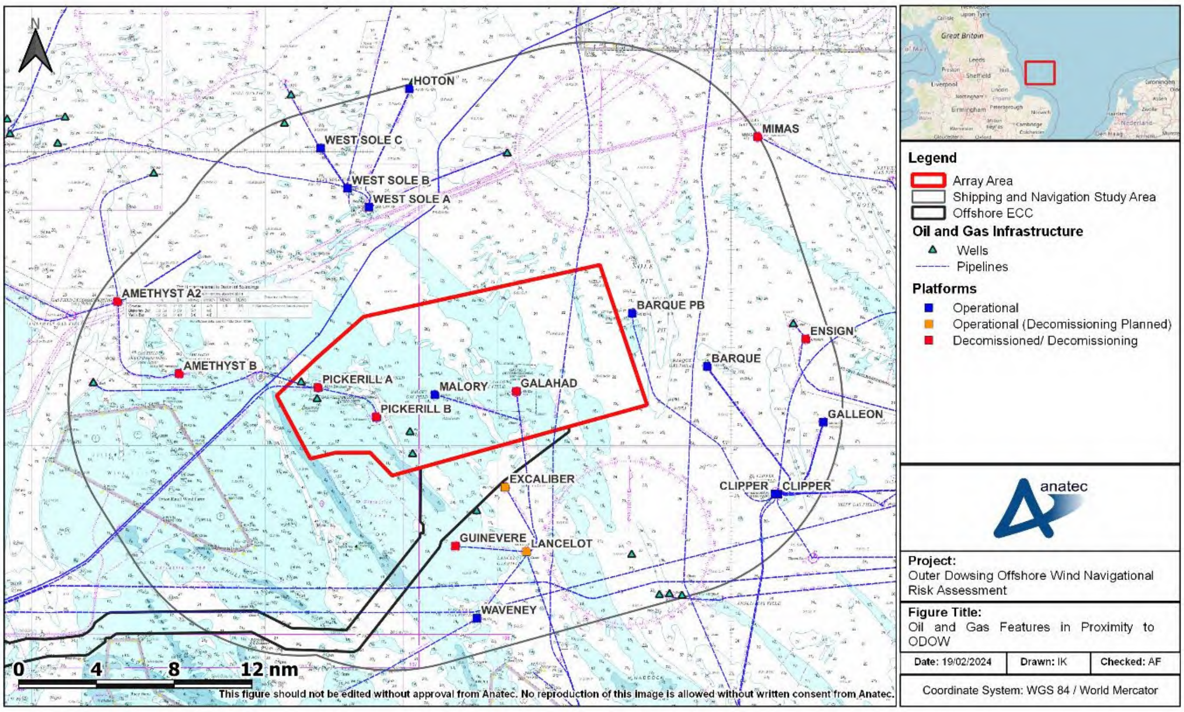

Figure 7.4 Oil and Gas Features in Proximity to the Project

137. A number of platforms and oil and gas fields are within the array area including the partially decommissioned Pickerill Gas Field and its two offshore platforms Pickerill A and B, the pending decommissioning Galahad gas field and its Galahad platform, and the operational Malory gas field and its Malory platform, equating to a total of four offshore platforms within the array area.

138. An additional 15 offshore platforms are within the surrounding shipping and navigation study area within gas fields Clipper, Barque, Audrey, Galleon, Waveney, Lancelot, Excalibur, Amethyst, West Sole, Hoton, and Mimas. The closest offshore platform out with the array area is the Barque PB platform, 0.8nm to the immediate east.

139. There are a total of six charted pipelines from offshore subsea assets to shore within proximity to the array area (including pipeline bundles), with pipelines between assets also present. It is noted that these include pipelines that are planned to be or undergoing decommissioning.

140. Two pipelines also intersect the offshore ECC at multiple locations, both former gas pipeline which connected the now decommissioned Theddlethorpe gas terminal to the North Valiant and Viking gas fields. These pipelines have been flushed, cleaned, and filled with seawater and disconnected and so now disused.

141. The cluster of disused pipelines connected to the decommissioned Theddlethorpe gas terminal are the closest pipelines to the ORCP area at

approximately 1nm north. No pipelines, or any other oil and gas infrastructure intersect the ORCP area.

142. A summary of details of the relevant oil and gas fields and their current status is provided in Table 7-1.

Table 7-1 Details of Oil and Gas Fields in Proximity to the Project

Name	Type	Distance from Array Area (nm)	Status
Galahad	Gas	0.0	Pending Decommissioning
Malory	Gas	0.0	Operational
Pickerill	Gas	0.0	Partially decommissioned – topsides removed
Barque	Gas	0.8	Operational
Excalibur	Gas	2.1	Operational (decommissioning planned)
Guinevere	Gas	4.3	Decommissioned – topsides and jackets removed
Amethyst	Gas	4.5	Pending decommissioning
West Sole	Gas	5.4	Operational
Lancelot	Gas	5.6	Operational (decommissioning planned)
Clipper	Gas	8.0	Operational
Waveney	Gas	8.2	Operational
Ensign	Gas	8.4	Pending decommissioning
Galleon	Gas	9.0	Operational
Mimas	Gas	9.9	Decommissioned
Hoton	Gas	10.7	Operational

7.8 Charted Wrecks or Obstructions

143. A total of 93 charted wrecks or obstructions are present within the shipping and navigation study area with a total of five of these being present within the array area. The shallowest wreck or obstruction within the array area is at a depth of 5m below CD located within the Outer Dowsing Shoal, approximately 4nm to the southwest of the array area.

144. There are eight charted wrecks within the offshore ECC, the shallowest at a depth of 7m below CD approximately 3nm offshore.

145. No charted wrecks were recorded within the ORCP area.

146. Non-charted wrecks (which are not considered a danger to safe navigation) are considered in Volume 1, Chapter 13: Marine and Intertidal Archaeology (document reference 6.1.13).

7.9 Spoil Grounds and Foul Areas

147. There are two areas of spoil ground in close proximity to the offshore ECC. One area of spoil ground intersects both ORCP area sites and subsequently the offshore ECC approximately 6nm from the coast, this area is a historic disposal site which is not used for waste disposal (Centre for Environment, Fisheries and Aquaculture Science (Cefas), 2023). Another area, although disused, is present 1.4nm south of the offshore ECC.

148. A spoil ground is also located 12nm north of the array area.

7.10 International Maritime Organisation Routeing Measures

149. There are no IMO routeing measures in the region. However, the Inner Approaches Traffic Separation Scheme (TSS) consisting of three outer TSSs from a northeast, east, and southeast direction leading into a single TSS into the Humber is located approximately 11nm north of the ORCP area and Offshore ECC and 22nm to the west of the array area.

7.11 Military Practice and Exercise Areas

150. The Donna Nook firing practice area is located north of the offshore ECC, approximately 10nm northwest of the ORCP area, at the south of the Humber entrance. There are no restrictions placed on the right to transit a military PEXA at any time although mariners are advised to exercise caution. Exercises and firing only occur when the area is considered to be clear of all shipping.

151. There are no military practice and exercise areas (PEXAs) in proximity to the array area.

8 Meteorological Ocean Data

152. This section presents meteorological and oceanographic (MetOcean) statistics local to the Project. The data presented in this section has been used as input to the collision and allision risk modelling (see section 17).

8.1 Wind

153. The proportion of the wind direction within each 30-degree interval for a location in the array area is presented in Figure 8.1 in the form of a wind rose, with similar data for the ORCP area presented in Figure 8.2. It can be seen from both sites that wind is predominately from the southwest.

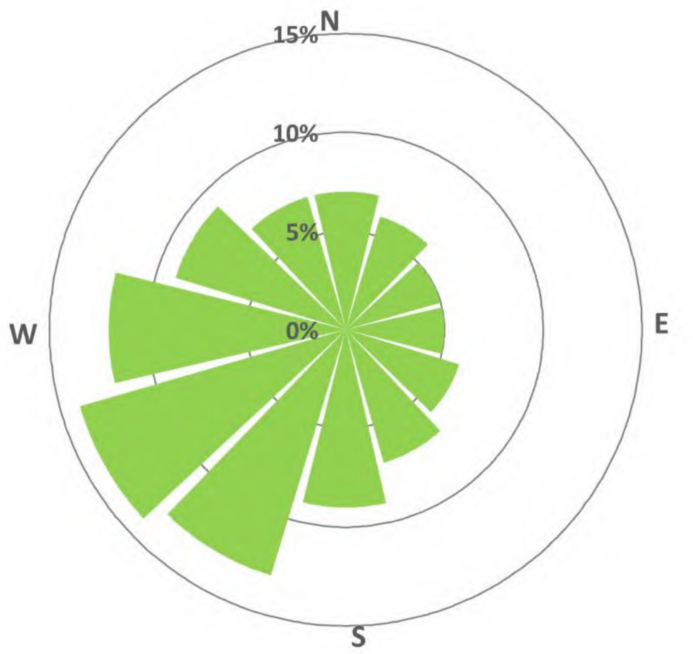

Figure 8.1 Wind Direction Distribution (Array Area)

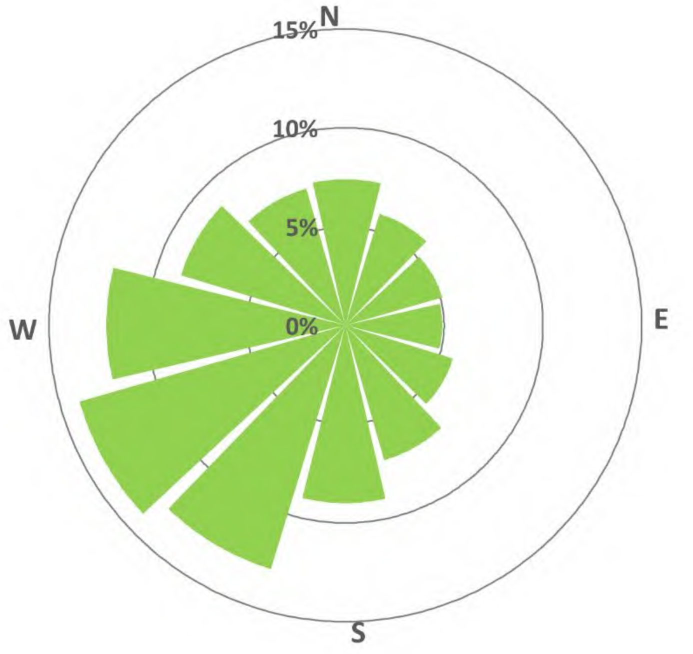

Figure 8.2 Wind Direction Distribution (ORCP Area)

8.2 Wave

154. The proportion of the sea state within each of the three defined ranges for each site is presented in Table 8-1.

Table 8-1 Sea State Data

Sea State (Significant Wave Height)	Array Area Proportion (%)	ORCP Area Proportion (%)
Calm (<1 m)	44.0	56.5
Moderate (1 to 5 m)	56.0	43.5
Severe (≥5 m)	0.0	0.0

8.3 Visibility

155. Based on information provided in the relevant Admiralty Sailing Directions (NP54 North Sea (West) Pilot), it is assumed that the proportion of poor visibility (defined as the proportion of a year where the visibility can be expected to be less than 1km) is 5% for both the array area and ORCP area.

8.4 Tide

156. From UKHO Admiralty Charts 105, 107, 1187, and 1190, currents within and in proximity to the array area and ORCP area are set in a generally north-west to south-west on the flood tide and the same on the ebb tide. The greatest flood peak tidal rate is 2.9 knots (kt) and the greatest peak ebb tidal rate is 3.4kt. The peak speed and corresponding direction data for the flood and ebb tides for the relevant tidal diamonds for the array area on UKHO Admiralty Charts 105, 107, 1187, and 1190 are presented in Table 8-2; and the relevant tidal diamonds for ORCP area on UKHO Admiralty Charts 107 and 1190 are presented in Table 8-3.

Table 8-2 Peak Flood and Ebb Tidal Data in Proximity to the Array Area

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (kt)	Direction (°)	Speed (kt)
105	A	331	1.7	142	1.6
	D	311	1.2	131	1.5
107	A	168	1.5	351	1.3
	C	159	2.3	342	1.9
	H	329	1.7	331	1.6
	K	324	2.2	325	2.2
1187	C	141	1.4	319	1.4
	D	145	1.2	323	1.2
	E	153	1.3	334	1.5
	F	136	2.0	307	1.7
1190	E	168	1.9	345	1.8
	Q	327	1.7	331	1.6

Table 8-3 Peak Flood and Ebb Tidal Data in Proximity to the ORCP Area

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (kt)	Direction (°)	Speed (kt)
107	H	331	1.6	331	1.6
	K	325	2.2	325	2.2

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (kt)	Direction (°)	Speed (kt)
1190	H	159	2.3	342	1.9
	K	163	2.9	348	2.6
	L	209	2.6	40	3.4
	P	185	1.8	9	1.5
	Q	331	1.6	331	1.6
	T	315	1.6	323	1.5

157. Based upon the available data, no hazards are expected at high water that would not also be expected at low water, and vice versa. The windfarm structures are not expected to result in any additional risk on the existing tidal streams in relation to their effect on existing shipping and navigation users.

9 Emergency Response and Incident Overview

158. This section summarises the existing emergency response resources (including Search and Rescue (SAR)) and reviews historical maritime incident data to assess baseline incident rates in proximity to the Project.

9.1 Search and Rescue Helicopters

159. In July 2022, the Bristow Group were awarded a new 10-year contract by the MCA (as an executive agency of the DfT) commencing in September 2024 to provide helicopter SAR operations in the UK. Bristow have been operating the service since April 2015.

160. There are currently ten base locations for the SAR helicopter service. The closest SAR helicopter base to the Project is located at Humberside Airport, approximately 40nm west of the closest point of the array area, as illustrated in Figure 9.1. This base operates two Sikorsky S-92 helicopters and was purpose built when the Bristow Group took over SAR operations in the UK and *"provides vital life-saving support to the fishing and other marine industries and the offshore energy sector, as well as to land-based incidents including missing persons and other medical emergencies"* (Bristow Group, 2017). The base is most likely to respond to any incident requiring SAR helicopter services based upon the SAR helicopter data for the region.

161. The DfT has produced data on civilian SAR helicopter activity in the UK by the Bristow Group on behalf of the MCA between April 2015 and March 2023. The SAR helicopter taskings undertaken between April 2015 and March 2023 in proximity to the Project are presented in the subsections below.

9.1.1 Array Area

162. The SAR helicopter tasking recorded within the shipping and navigation study area, surrounding the array area, over the 9-year period (2015-2023) are presented in Figure 5.1, colour-coded by tasking type.

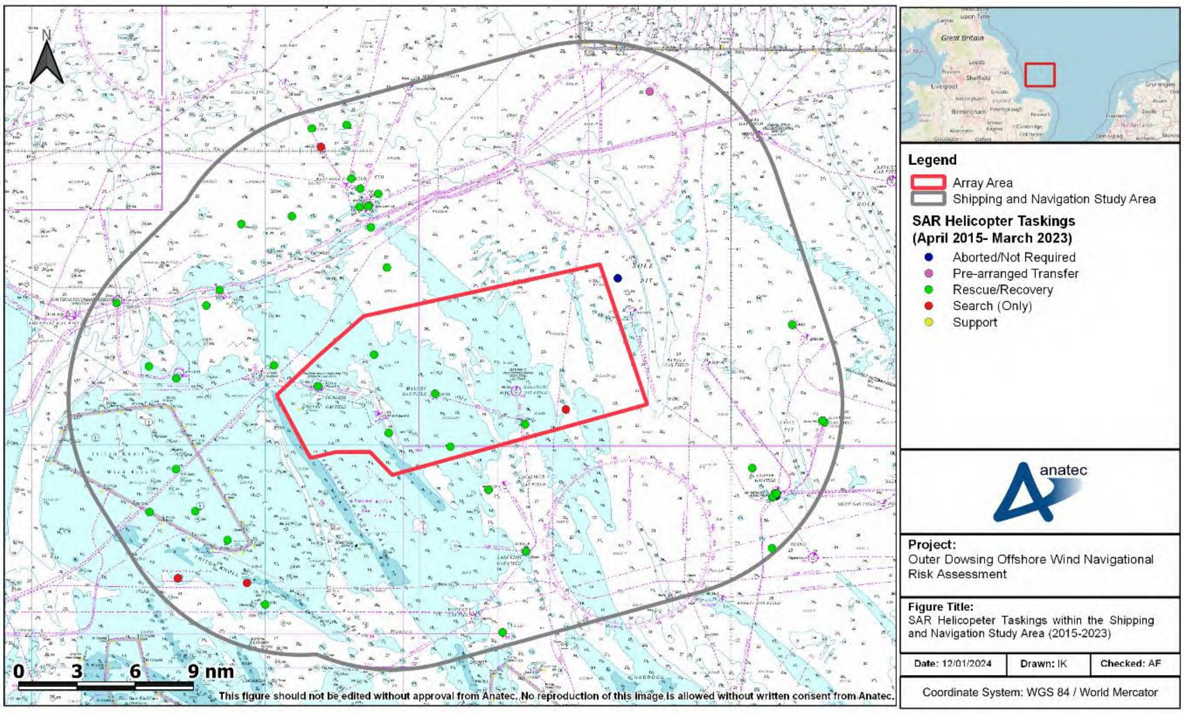

Figure 9.1 SAR Helicopter Taskings within the Shipping and Navigation Study Area (2015 to 2023)

163. A total of 55 unique SAR helicopter taskings were undertaken for incidents within the shipping and navigation study area between April 2015 and March 2023, corresponding to an average of six taskings per year. The majority of these taskings were "*rescue/recovery*" (85%). Seven SAR helicopter taskings were undertaken within the array area itself with six being "*rescue/recovery*" and one "*search*".

164. A number of these SAR helicopter taskings were attending oil and gas platforms within the area. Such platforms with more than one incident recorded were from gas fields Clipper, West Sole, Pickerill, and Galleon.

9.1.2 Offshore Export Cable Corridor

165. The SAR helicopter tasking recorded within the ECC study area over the 8-year period (2015-2022) are presented in Figure 9.2, colour-coded by tasking type.

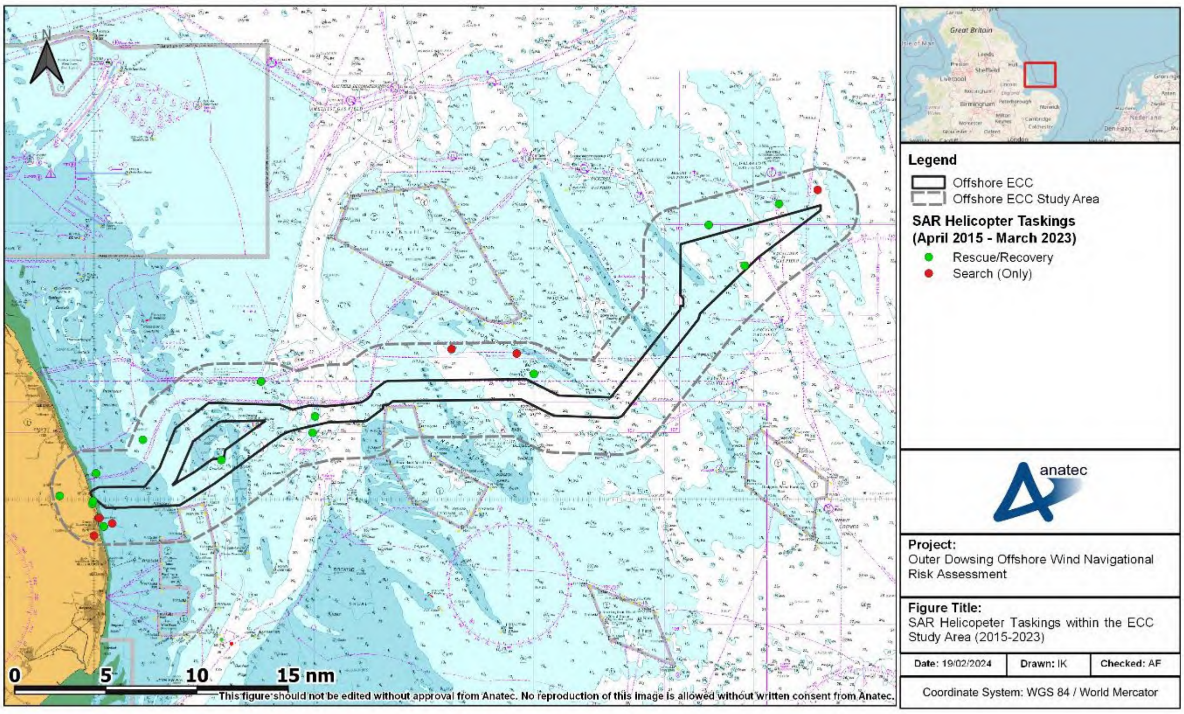

Figure 9.2 SAR Helicopter Bases and Taskings within the ECC Study Area (2015 to 2023)

166. A total of 24 unique SAR helicopter taskings were undertaken for incidents within the ECC study area between April 2015 and March 2023, corresponding to an average of three taskings per year. The majority of these taskings were "*rescue/recovery*" (63%). Three SAR helicopter taskings were undertaken within the offshore ECC itself, with all being "*rescue/recovery*".

9.1.3 Offshore Reactive Compensation Platform Area

167. The SAR helicopter tasking recorded within the ORCP area study area over the 8-year period are presented in Figure 9.3, colour-coded by tasking type.

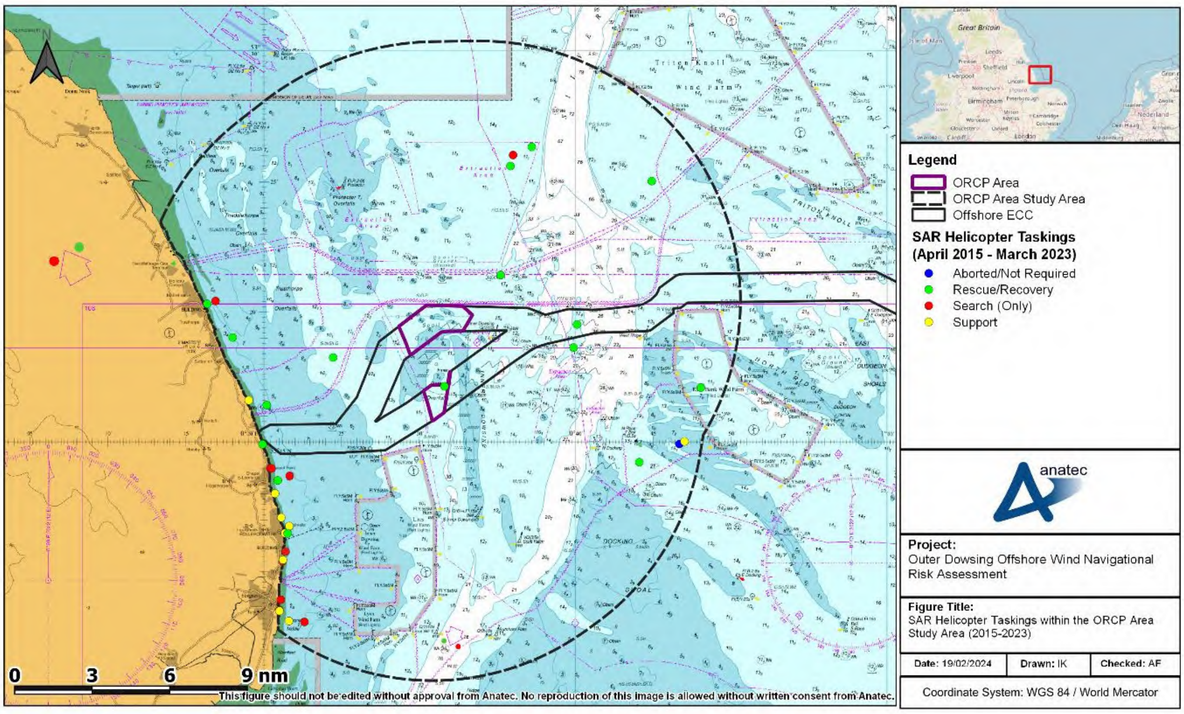

Figure 9.3 SAR Helicopter Bases and Taskings within the ORCP Area Study Area (2015 to 2023)

168. A total of 37 unique SAR helicopter taskings were undertaken for incidents within the ORCP area study area between April 2015 and March 2023, corresponding to an average of four taskings per year. The majority of these taskings were "*rescue/recovery*" (46%) and "search" (27%). One SAR helicopter tasking was undertaken within the ORCP area itself, a "*rescue/recovery*".

169. The majority of these taskings within the ORCP area study area were coastal with 65% of taskings occurring within 1nm of the coastline.

9.2 Royal National Lifeboat Institution

170. The RNLI is organised into six divisions, with the relevant region for the Project being the East division. Based out of more than 230 stations, there are over 400 active lifeboats across the RNLI fleet, including both All-Weather Lifeboats (ALB) and Inshore Lifeboats (ILB). RNLI lifeboats are available on a 24-hour basis throughout the year. Given that the RNLI have an operational limit of 100nm, it is anticipated that an incident occurring in proximity to the Project may result in a response from an RNLI asset.

171. RNLI stations in proximity to the Project are illustrated in Figure 9.4.

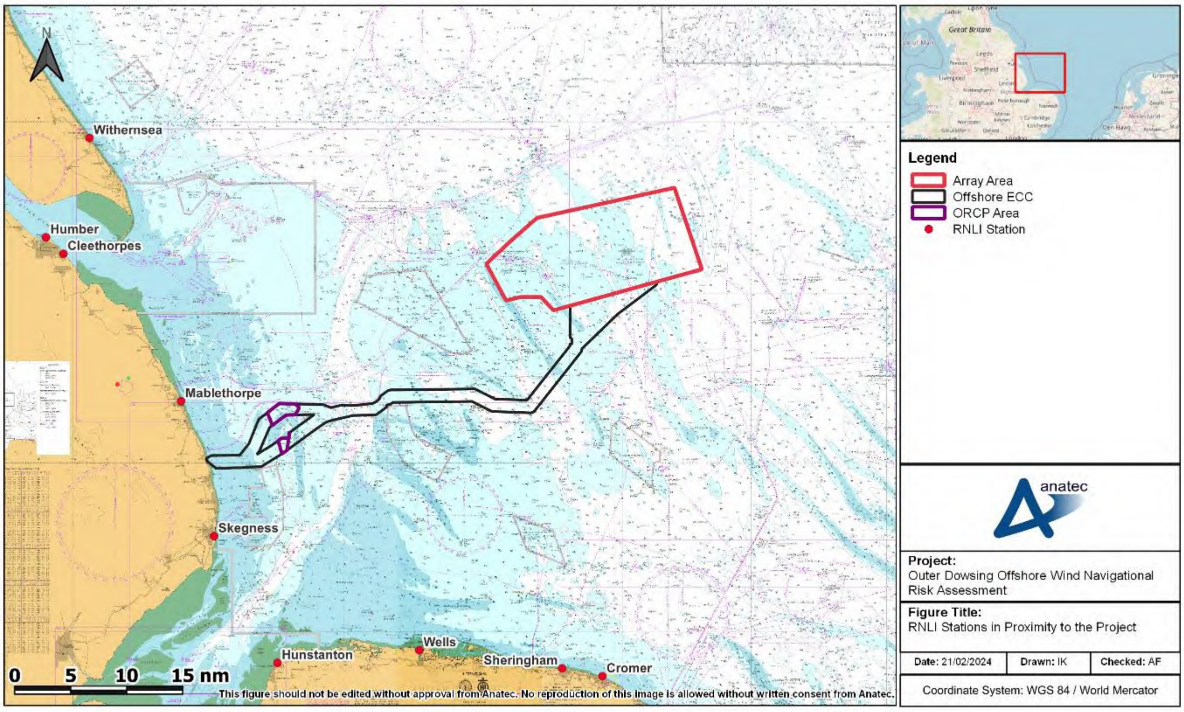

Figure 9.4 RNLI Stations in Proximity to the Project

172. RNLI stations Mablethorpe and Skegness are located approximately 5nm north and 6nm south of the offshore ECC, respectively. Mablethorpe RNLI station is also the closest to the array area at approximately 29nm.

173. RNLI incident data from 2013-2022 has been reviewed and is presented in in the following subsections. It is noted that hoaxes and false alarms have been excluded from the analysis.

9.2.1 Array Area

174. RNLI incidents recorded within the shipping and navigation study area, surrounding the array area, over the 10-year period are presented in Figure 9.5 colour-coded by incident type. Following this, the same data is presented, colour-coded by casualty type, in Figure 9.6.

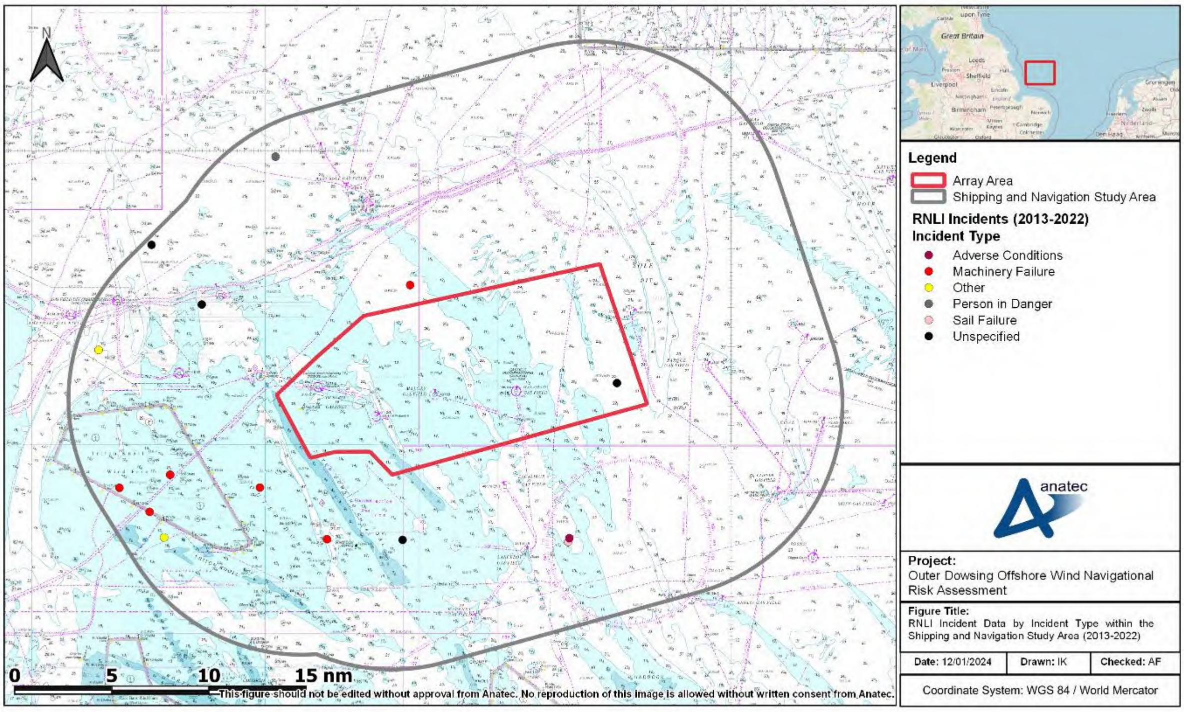

Figure 9.5 RNLI Incidents by Incident Type within the Shipping and Navigation Study Area (2013 to 2022)

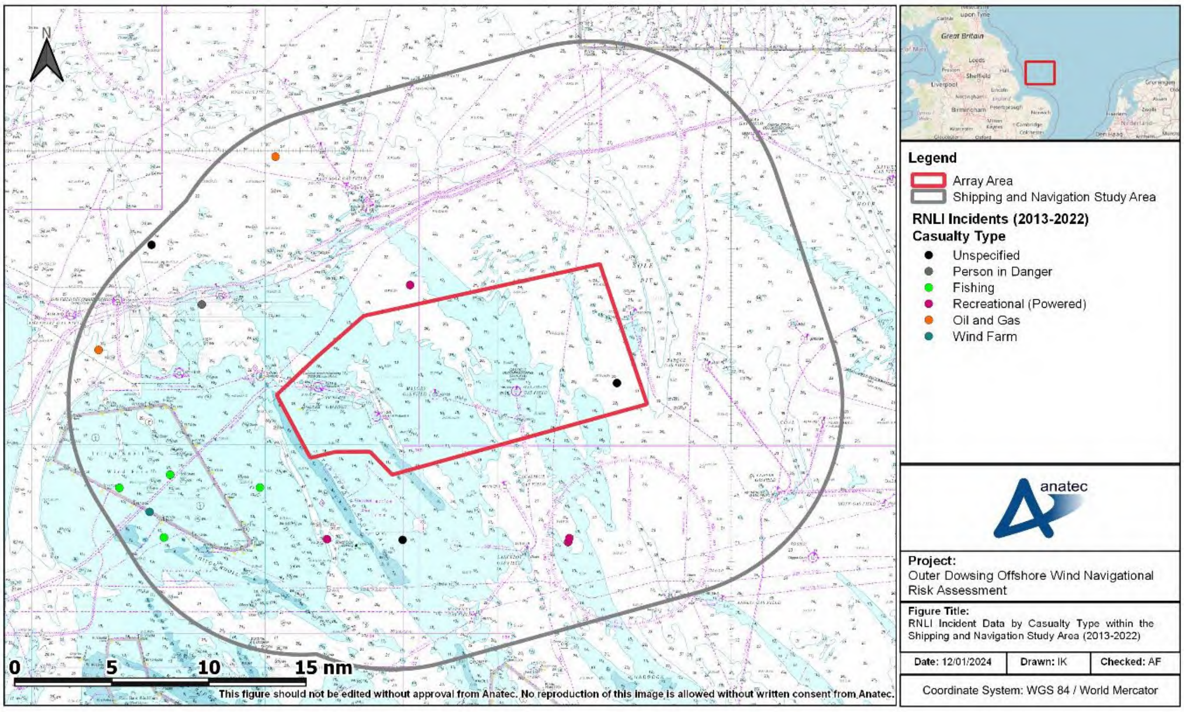

Figure 9.6 RNLI Incidents by Casualty Type within the Shipping and Navigation Study Area (2013 to 2022)

175. A total of 15 unique incidents were responded to by the RNLI within the shipping and navigation study area between 2013 and 2022, corresponding to an average of one to two incidents per year. Throughout the 10-year period, one incident occurred within the array area itself.

176. Of all the unique incidents recorded within the shipping and navigation study area, the most frequently recorded incident types were "*machinery failure*" (40%) , with 27% of incidents being unspecified. The most common casualty types were fishing (27%) and powered recreational (27%) vessels.

177. The most common RNLI base stations recorded for lifeboat launches for incidents in the shipping and navigation study area were Humber (80%) and Cromer (20%).

9.2.2 Offshore Export Cable Corridor

178. RNLI incidents recorded within the ECC study area over the 10-year period are presented in Figure 9.7, colour-coded by incident type. Following this, the same data is presented, colour-coded by casualty type, in Figure 9.8.

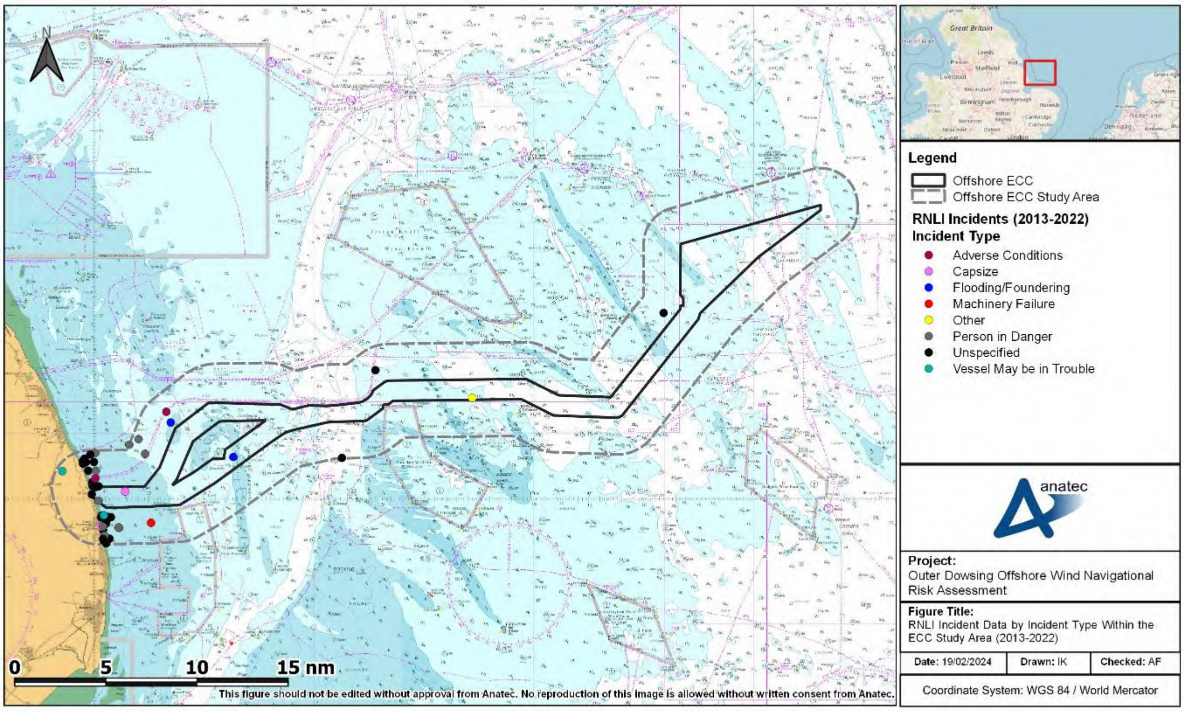

Figure 9.7 RNLI Incidents by Incident Type within the ECC Study Area (2013 to 2022)

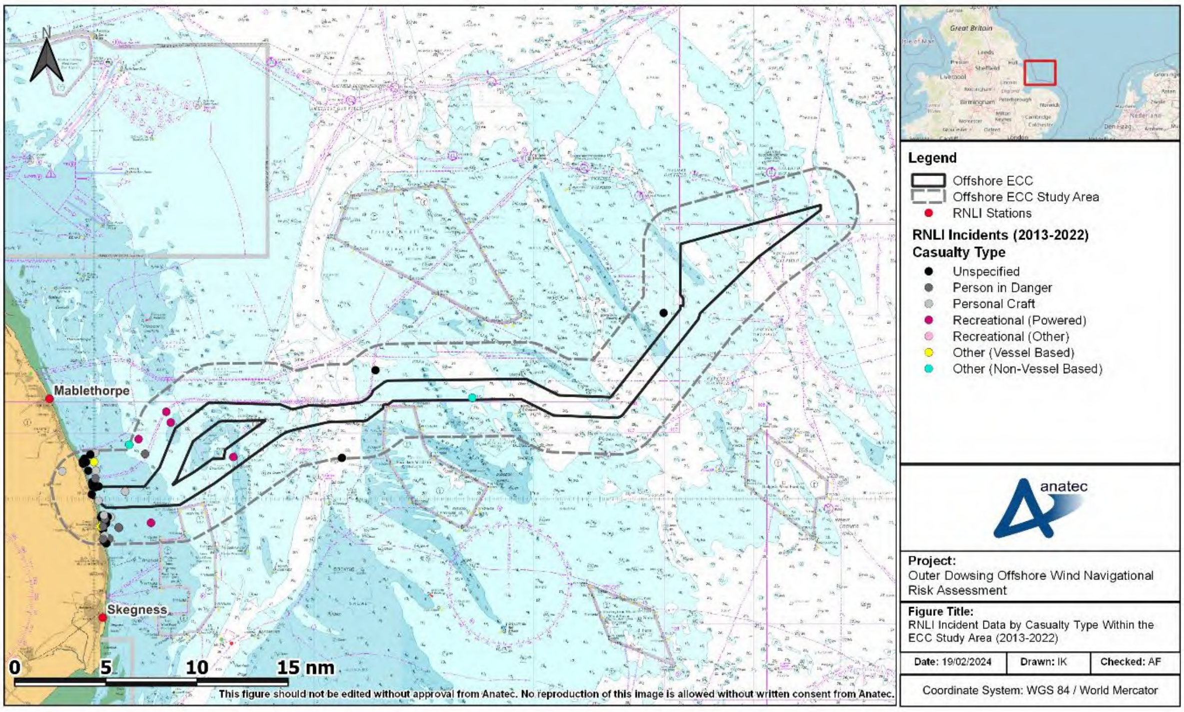

Figure 9.8 RNLI Incidents by Casualty Type Within the ECC Study Area (2013 to 2022)

179. A total of 65 unique incidents were responded to by the RNLI within the ECC study area between 2013 and 2022, corresponding to an average of six to seven incidents per year. Throughout the 10-year period, six incidents occurred within the offshore ECC itself. It is noted that of all the incidents recorded within the ECC study area, 82% occurred within 5nm of the coastline.

180. Of all the unique incidents recorded within the ECC study area, the most frequently recorded incident types were "*person in danger*" (17%) noting that 63% of incidents were unspecified within the dataset, although the majority were observed to be coastal. The most common casualty types were "*person in danger*" (15%) and powered recreational vessels (14%), with unspecified casualties comprising 54% of incidents, noting that these were again primarily coastal.

181. The most common RNLI base stations recorded for lifeboat launches for incidents in the ECC study area were Skegness (54%) and Mablethorpe (38%).

9.2.3 Offshore Reactive Compensation Platform Area

182. RNLI incidents recorded within the ORCP area study area over the 10-year period are presented in Figure 9.9 colour-coded by incident type. Following this, the same data is presented, colour-coded by casualty type, in Figure 9.10.

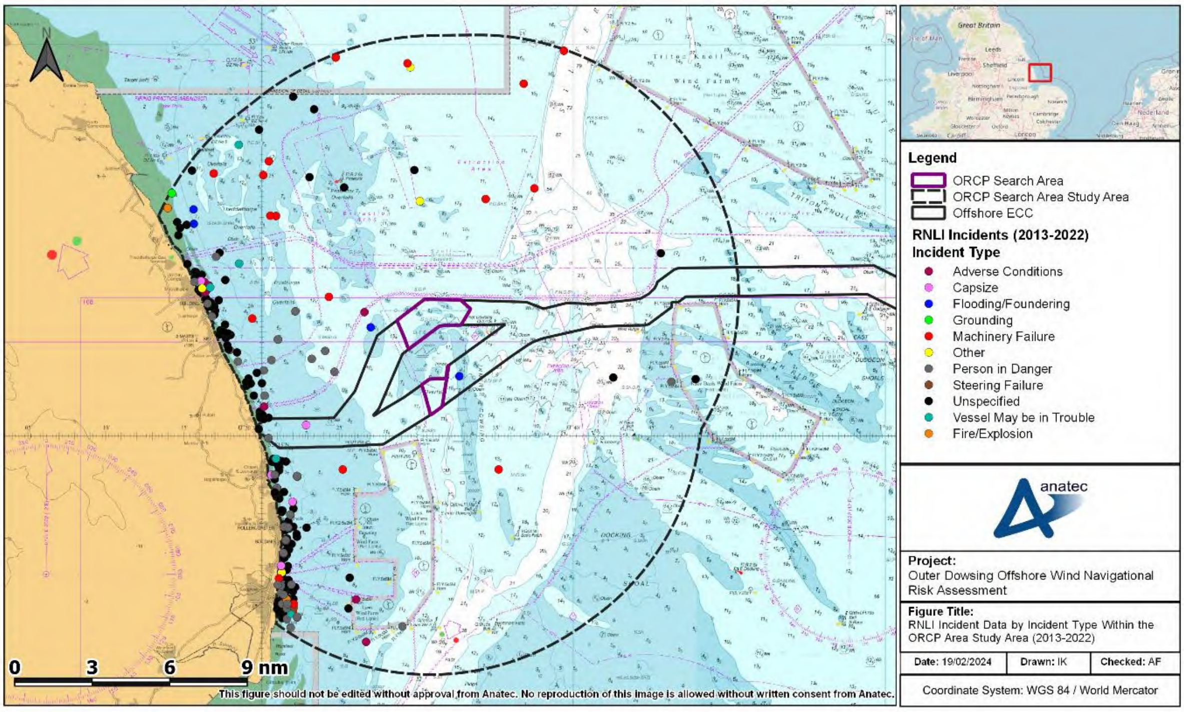

Figure 9.9 RNLI Incidents by Incident Type within the ORCP Area Study Area (2013 to 2022)

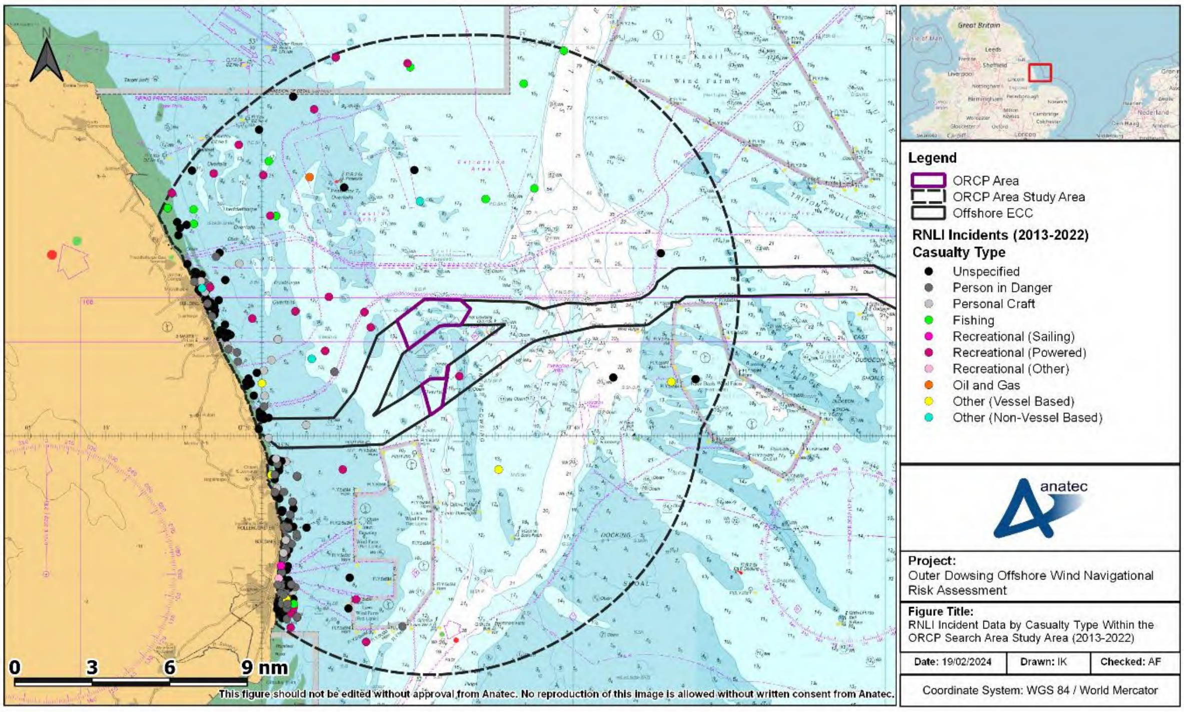

Figure 9.10 RNLI Incidents by Casualty Type within the ORCP Area Study Area (2013 to 2022)

183. A total of 317 unique incidents were responded to by the RNLI within the ORCP area study area between 2013 and 2022, corresponding to an average of 32 incidents per year. Throughout the 10-year period, no incidents occurred within the ORCP area itself. It is noted that of all the incidents recorded within the ORCP area study area, 83% occurred within 5nm of the coastline.

184. Of all the unique incidents recorded within the ORCP area study area, the most frequently recorded incident types were "*person in danger"* (25%) and "*machinery failure*" (7%), noting that 55% of incidents were unspecified within the dataset, although the majority were observed to be coastal. The most common casualty types were "*person in danger*" (28%) and powered recreational vessels (11%), with unspecified casualties comprising 45% of incidents, and again being primarily coastal.

185. The most common RNLI base stations recorded for lifeboat launches for incidents in the ORCP area study area were Skegness (58%) and Mablethorpe (34%)

9.3 Maritime Rescue Coordination Centres and Joint Rescue Coordination Centres

186. His Majesty's Coastguard (HMCG), a division of the MCA, is responsible for requesting and tasking SAR resources made available to other authorities and for coordinating the subsequent SAR operations (unless they fall within military jurisdiction).

187. The HMCG coordinates SAR operations through a network of 11 Maritime Rescue Coordination Centres (MRCC), including a Joint Rescue Coordination Centre (JRCC) based in Hampshire. A corps of over 3,500 volunteer Coastguard Rescue Officers (CRO) around the UK from 352 local Coastguard Rescue Teams (CRT) are involved in coastal rescue, searches and surveillance.

188. All of the MCA's operations, including SAR, are divided into 18 geographical regions. Area 6 – "*East Anglia*" – covers the south of the North Yorkshire and entire East Yorkshire and Lincolnshire coast of England, and therefore covers the area encompassing the Project. The Humber MRCC is located within Area 6 approximately 44nm northwest of the closest point of the array area boundary and coordinates the SAR response for maritime and coastal emergencies within the district boundary.

9.4 Global Maritime Distress and Safety System

189. The Global Maritime Distress and Safety System (GMDSS) is a maritime communications system used for emergency and distress messages, vessel to vessel routeing communications and vessel to shore routine communications. It is implemented globally, and vessels engaged in international voyages are obliged to carry GMDSS certified communication equipment.

190. There are four GMDSS sea areas, and in the UK, it is the responsibility of the MCA to ensure Very High Frequency (VHF) coverage from coastal stations within sea area A1. The Project is located close to the extent of the A1 Sea Area, as shown in Figure 9.11.

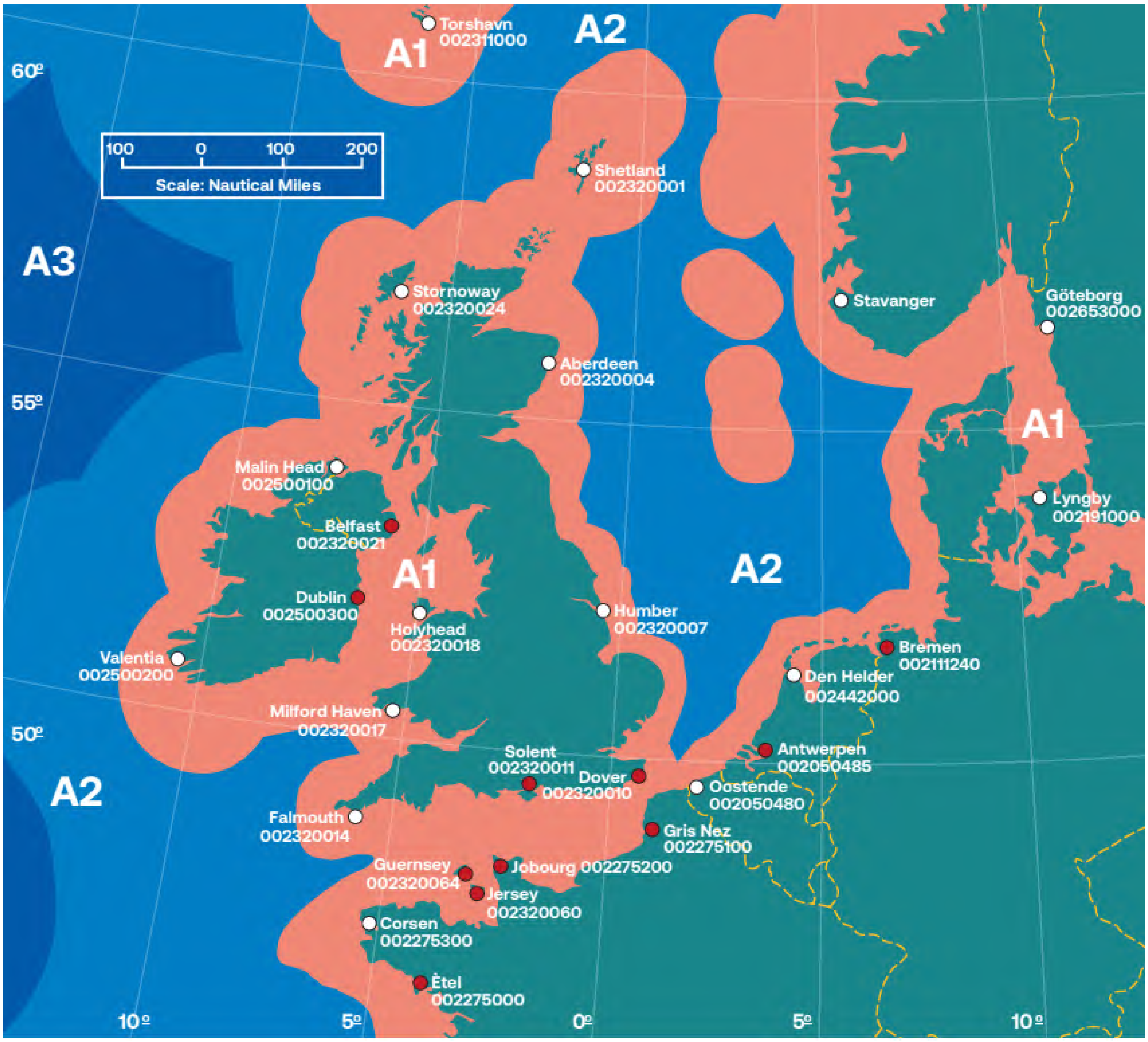

Figure 9.11 GMDSS Sea Areas (MCA, 2021)

9.5 Marine Accident Investigation Branch

191. All UK flagged vessels and non-UK flagged vessels in UK territorial waters (12nm), a UK port or carrying passengers to a UK port are required to report incidents to the MAIB. Between 1,000, and 1,300 incidents have generally been reported to the MAIB annually in recent years. A recent 11-year[4] of dataset (2012-2022) has formed

[4] CoS requested up to 2022 data was included in NRA, see section 4.

the primary assessment tool, with additional validation then undertaken based on the 2002 to 2011 data.

9.5.1 Array Area

192. The locations of accidents, injuries, and hazardous incidents reported to MAIB within the shipping and navigation study area between 2012 and 2022 are presented in Figure 9.12, colour-coded by incident type. Following this, Figure 9.13 shows the same data colour-coded by the type of vessels involved in each incident.

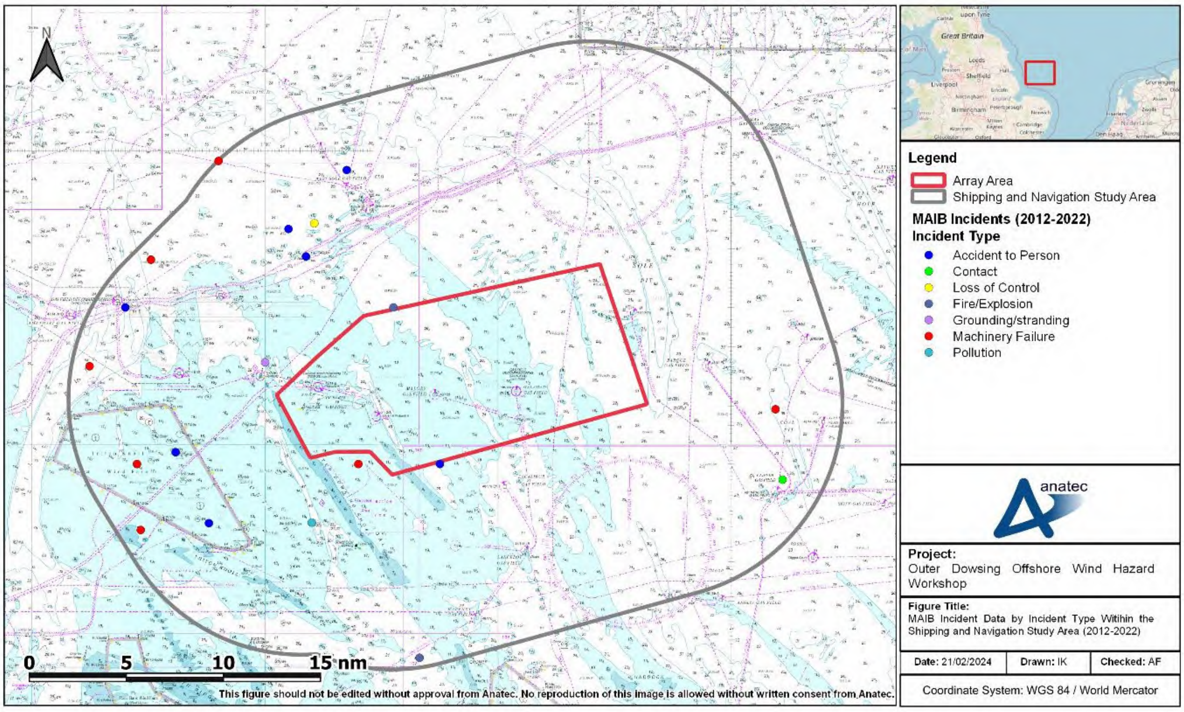

Figure 9.12 MAIB Incidents by Incident Type within the Shipping and Navigation Study Area (2012-2022)

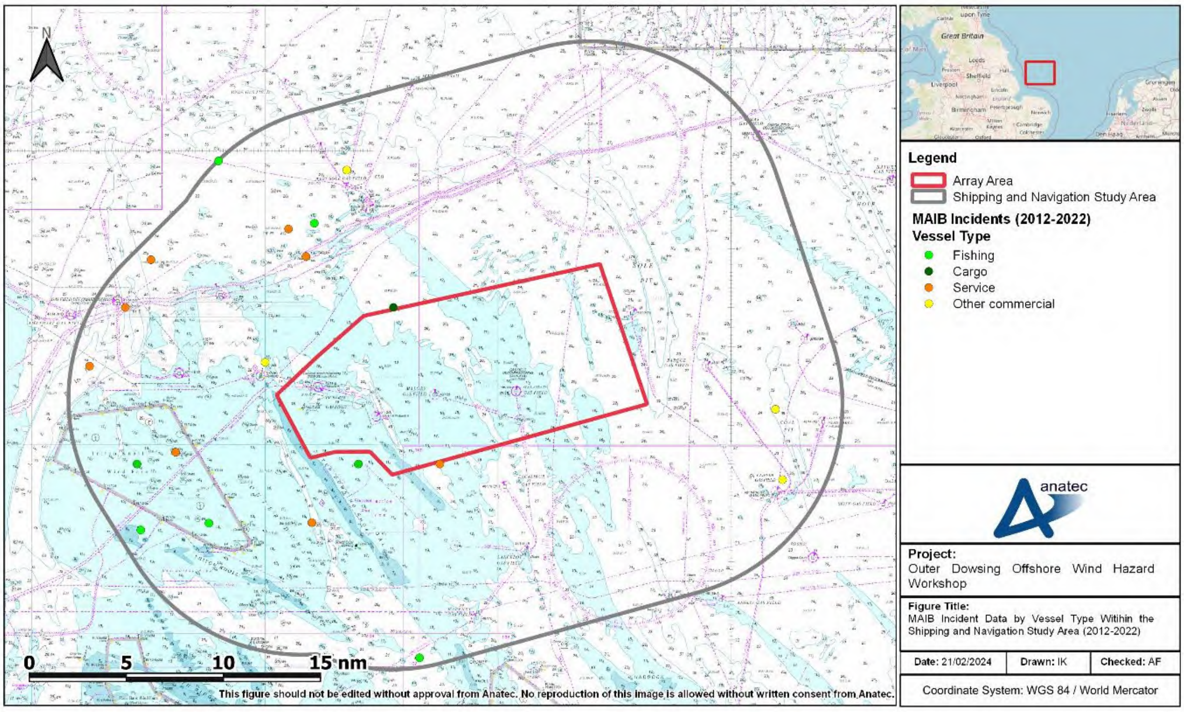

Figure 9.13 MAIB Incidents by Vessel Type within the Shipping and Navigation Study Area (2012-2022)

193. A total of 20 unique incidents were reported to the MAIB within the shipping and navigation study area between 2012 and 2021, which corresponds to an average of two incidents per year. Throughout the 10-year period, no incidents were reported within the array area itself.

194. The most common incident types recorded within the shipping and navigation study area were "*accident to person*" (35%) and "*machinery failure*" (35%), and the most frequently recorded vessel type involved in these incidents were service (40%) and fishing vessels (35%).

9.5.2 Offshore Export Cable Corridor

195. The locations of accidents, injuries, and hazardous incidents reported to MAIB within the ECC study area between 2012 and 2022 are presented in Figure 9.14, colour-coded by incident type. Following this, Figure 9.15 shows the same data colour-coded by the type of vessels involved in each incident.

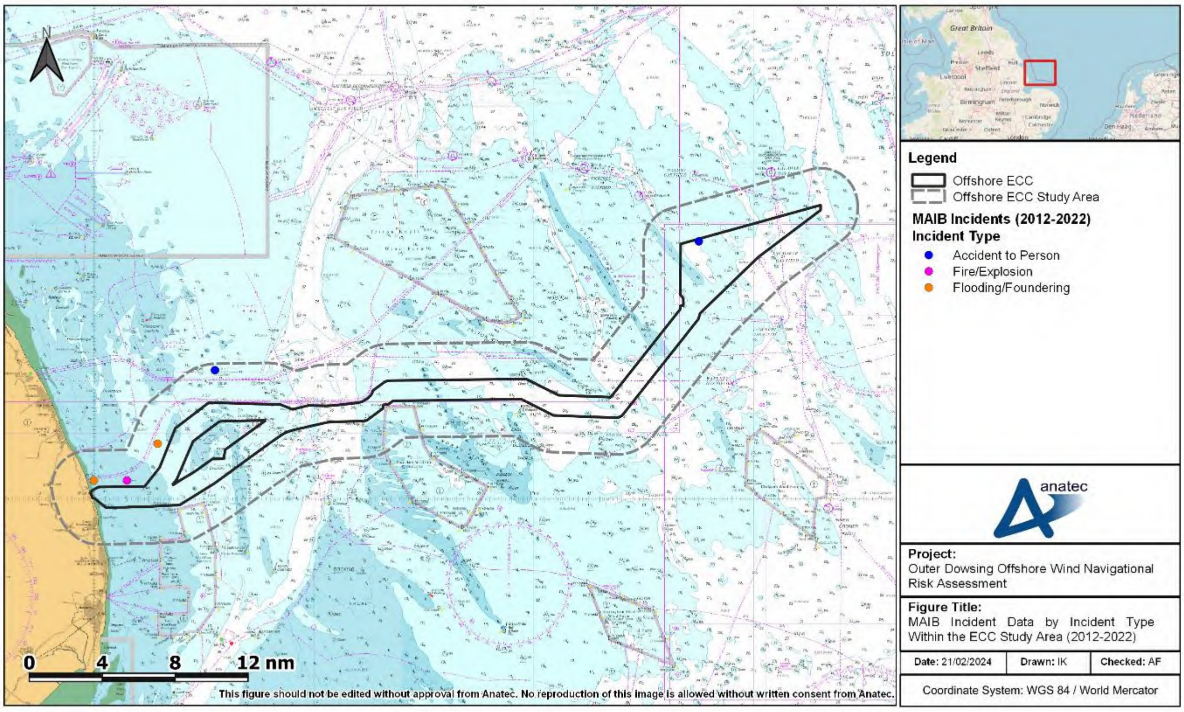

Figure 9.14 MAIB Incidents by Incident Type within the ECC Study Area (2012-2022)

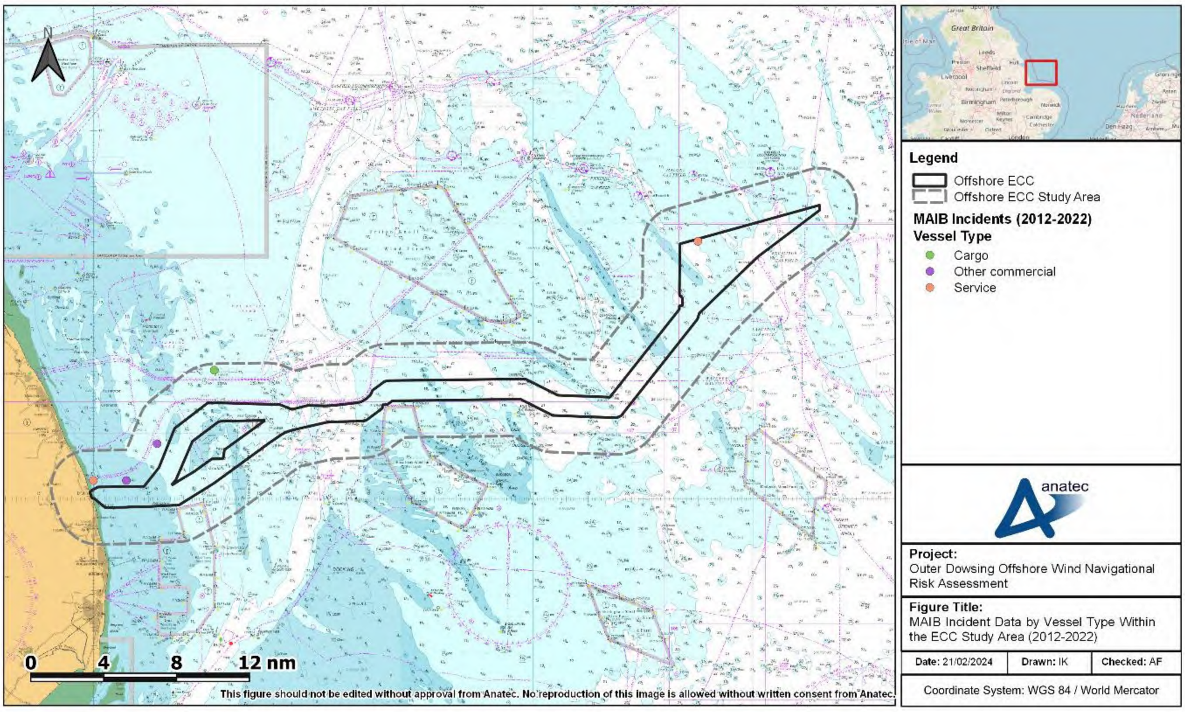

Figure 9.15 MAIB Incidents by Vessel Type within the ECC Study Area (2012-2022)

196. A total of five unique incidents were reported to the MAIB within the ECC study area between 2012 and 2022, which corresponds to an average of one incident every

two-years. Throughout the 11-year period, no incidents were reported within the offshore ECC itself.

197. The most common incident types recorded were "*accident to person*" (40%) and "*flooding/foundering*" (40%) with one "*fire/explosion*" incident recorded. The most frequently recorded vessel type involved in these incidents were other commercial (40%) and service vessels (40%), with one passenger vessel incident recorded.

9.5.3 Offshore Reactive Compensation Station

198. The locations of accidents, injuries, and hazardous incidents reported to MAIB within the ORCP area study area between 2012 and 2022 are presented in Figure 9.16, colour-coded by incident type. Following this, Figure 9.17 shows the same data colour-coded by the type of vessels involved in each incident.

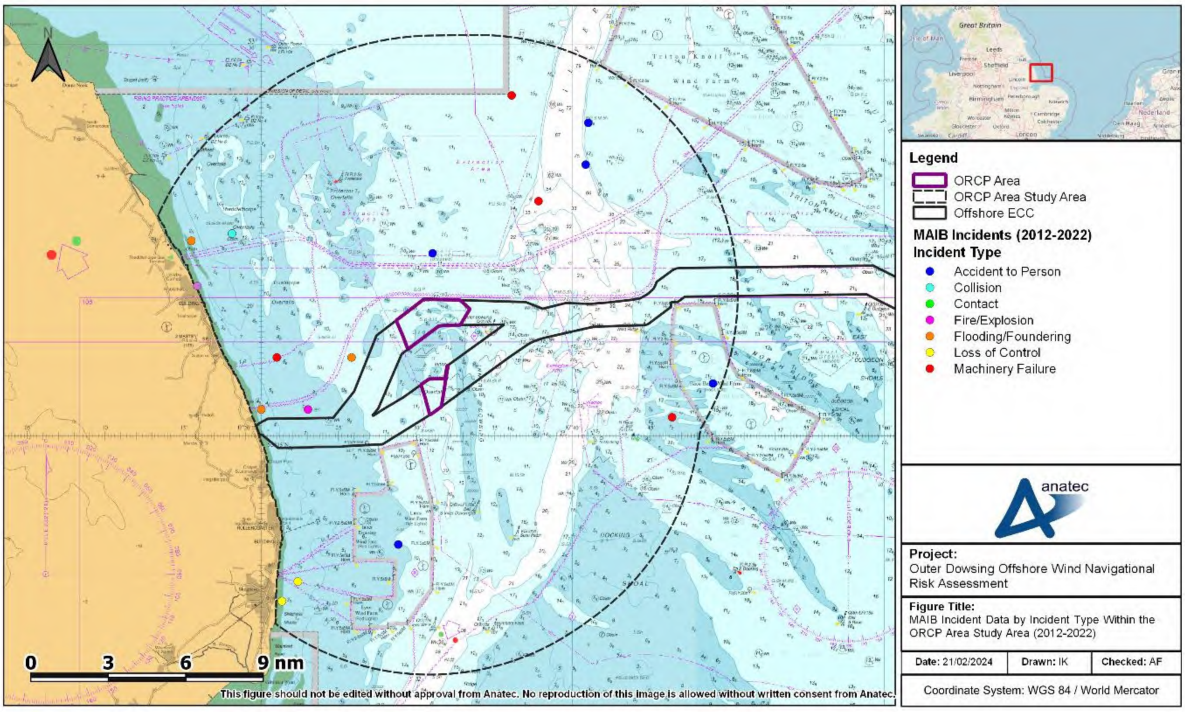

Figure 9.16 MAIB Incidents by Incident Type within the ORCP Area Study Area (2012-2022)

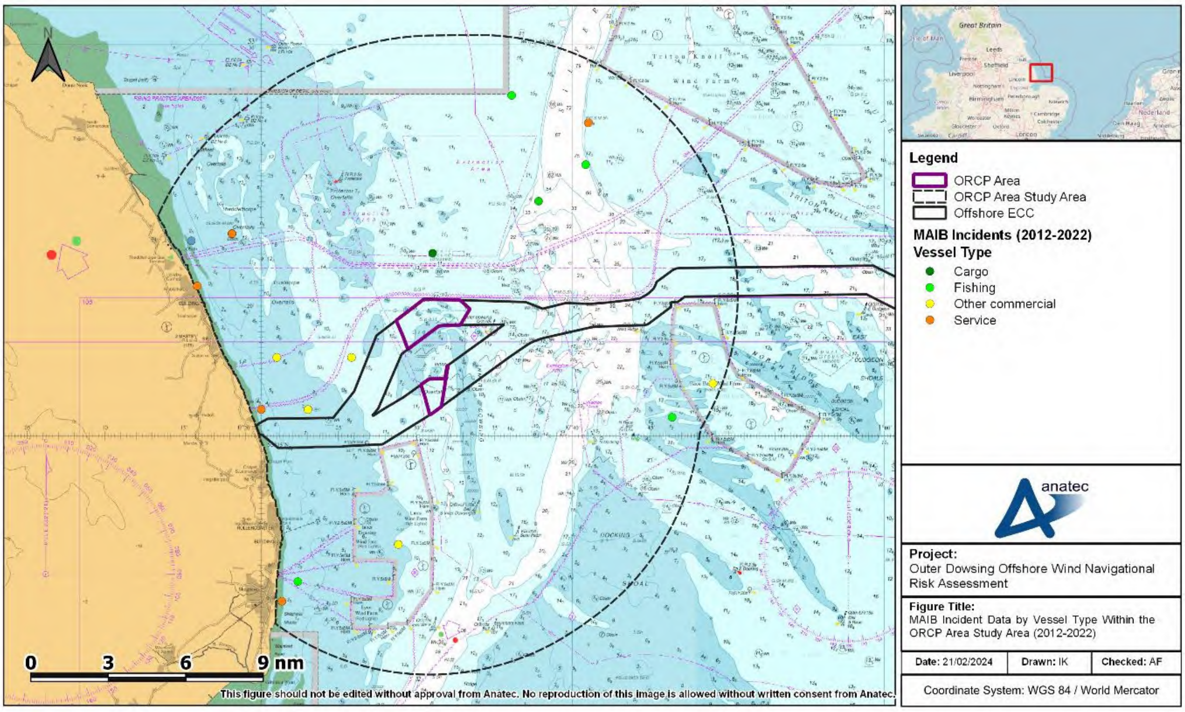

Figure 9.17 MAIB Incidents by Vessel Type within the ORCP Area Study Area (2012-2022)

199. A total of 21 unique incidents were reported to the MAIB within the ORCP area study area between 2012 and 2022, which corresponds to an average of two incidents per year. Throughout the 11-year period, no incidents were reported within the ORCP area itself.

200. The most common incident types recorded were "*accident to person*" (24%), *"collision"* (19%), and "*machinery failure*" (19%). The most frequently recorded vessel type involved in these incidents were other commercial (29%), service (29%), and fishing (25%), vessels.

9.5.4 2002-2011

201. A review of older MAIB incident data within the shipping and navigation study area between 2002 and 2011 indicates that the number of incidents has decreased over time within the shipping and navigation study area. The incidents recorded in this time frame are colour-coded by incident type and presented in Figure 9.18.

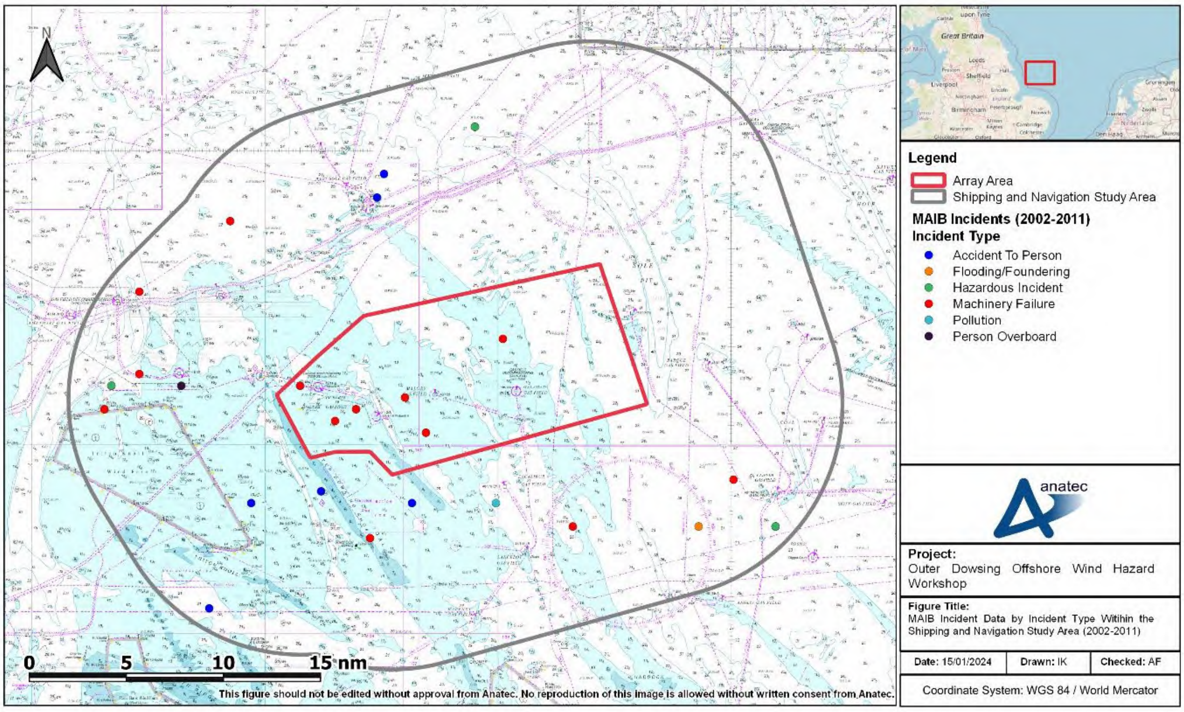

Figure 9.18 MAIB Incidents by Incident Type within the Shipping and Navigation Study Area (2002-2011)

202. There were 28 unique incidents recorded within the shipping and navigation study area in the ten-year period, corresponding to an average of approximately three incidents per year. Of the recorded incidents, "*machinery failure*" (46%), "*accident to person*" (21%), and "*hazardous incident*" (21%), were the main incident types recorded.

203. Similarly, the number of incidents recorded within the ECC study area has decreased over time, with eight unique incidents being recorded in the ten-year period, corresponding to one incident per year. These are colour-coded by incident type and presented in Figure 9.19.

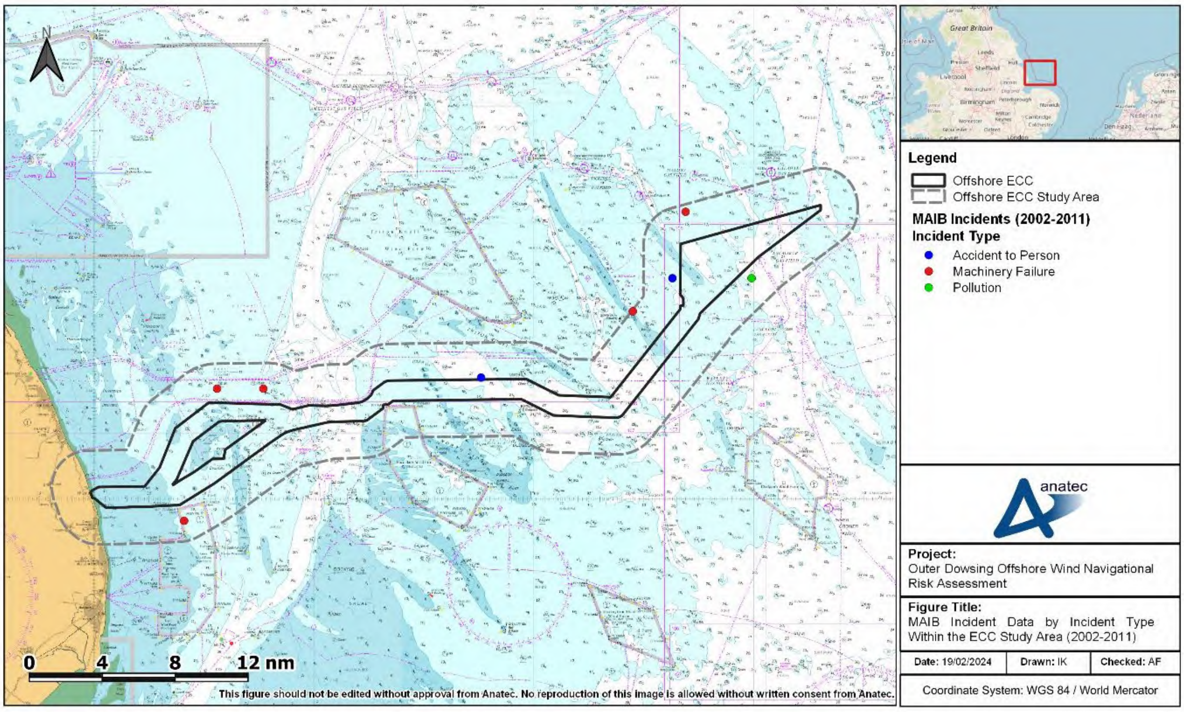

Figure 9.19 MAIB Incidents by Incident Type within the ECC Study Area (2002-2011)

204. Of the recorded incidents, "*machinery failure*" (63%), "*accident to person*" (25%), and "*pollution*" (13%) were the main incident types recorded.

205. The number of incidents recorded within the ORCP area study area has decreased over time also, with 39 unique incidents being recorded in the ten-year period, corresponding to an average of four incidents per year. These are colour-coded by incident type and presented in Figure 9.20.

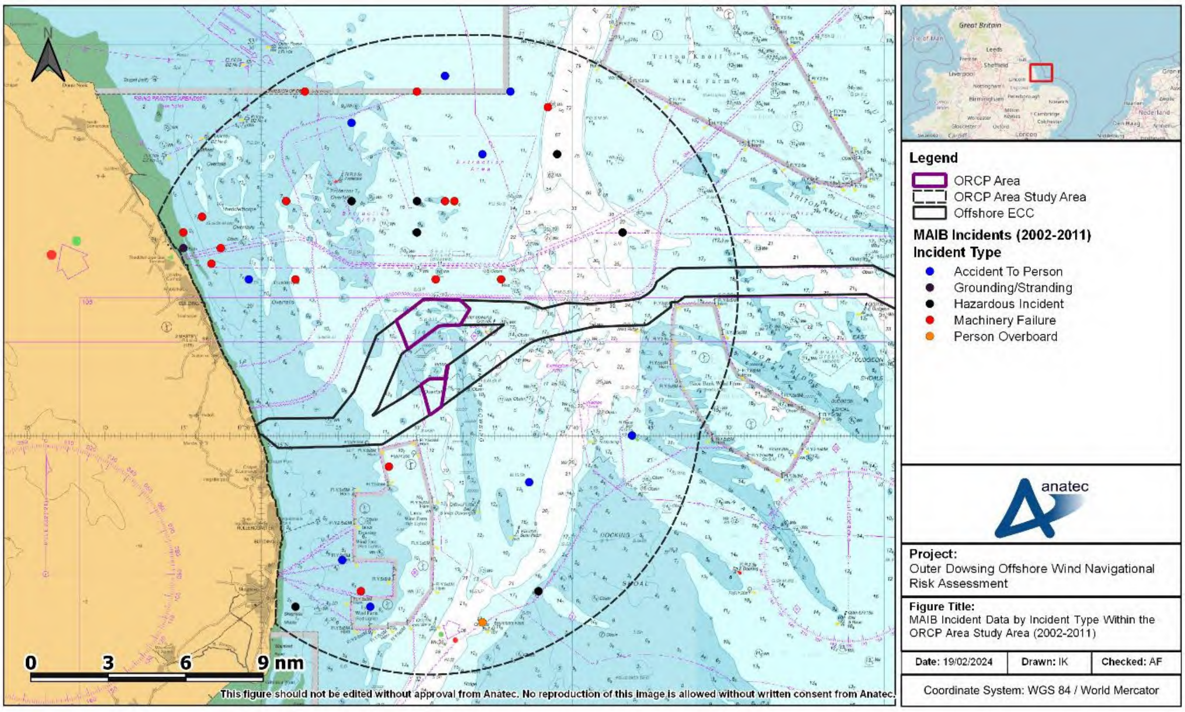

Figure 9.20 MAIB Incidents by Incident Type within the ORCP Area Study Area (2002-2011)

206. Of the recorded incidents, “*machinery failure*” (41%), “*hazardous incident*” (31%), and “*accident to person*” (23%) were the main incident types recorded.

207. The decrease in incidents may be attributable to a number of factors, potentially including a reduction of oil and gas activity in the area over time and a trend of improvement in safety standards/regulations.

9.6 Historical OWF Incidents

208. As of December 2023, there are 42 fully commissioned and generating OWFs in the UK, ranging from the North Hoyle OWF (fully commissioned in 2003) to Hornsea Two (fully commissioned in 2022). These developments consist of approximately 22,509 fully operational WTG years.

9.6.1 Incidents involving UK OWF Developments

209. MAIB incident data has been used to collate a list of reported historical collision and allision incidents involving UK OWF developments[5], which is summarised in Table 9-1. Other sources have also been used to produce this list including the UK Confidential Human Factors Incident Reporting Programme (CHIRP) for Aviation and

[5] Includes only incidents reported to an accident investigation branch or an anonymous reporting service. Unconfirmed incidents have not been considered.

Maritime, International Marine Contractors Association (IMCA) and basic web searches. This list is limited to collision and allision incidents given their specific relevance to shipping and navigation. Only incidents that have been formally reported are captured.

210. The worst consequences reported for vessels involved in a collision or allision incident involving a UK OWF development has been flooding, with no life-threatening injuries to persons reported.

211. As of December 2023, there have been no third-party collisions directly as a result of the presence of an OWF in the UK. The only reported collision incident in relation to a UK OWF involved a project vessel hitting a third party vessel whilst in harbour.

Table 9-1 Summary of Historical Collision and Allison Incidents Involving UK OWF Developments

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Allision	7 August 2005	WTG installation vessel allision with WTG base whilst manoeuvring alongside it. Minor damage sustained to a gangway on the vessel, the WTG tower and a WTG blade.	Minor damage to gangway on the vessel	None	MAIB
Project	Allision	29 September 2006	Offshore services vessel allision with rotating WTG blade.	None	None	MAIB
Project	Allision	8 February 2010	Work boat allision with disused pile following human error with throttle controls whilst in proximity. Passenger later diagnosed with injuries and no serious damage sustained by vessel.	Minor	Injury	MAIB
Project / third-party	Collision	23 April 2011	Third-party catamaran collision with project guard vessel within harbour.	Moderate	None	MAIB
Project	Allision	18 November 2011	Cable-laying vessel allision with WTG foundation following watchkeeping failure. Two hull breaches to vessel.	Major	None	MAIB
Project / project	Collision	2 June 2012	Crew Transfer Vessel (CTV) allision with flotel. Nine persons safely evacuated and transferred to nearby vessel before being brought back in to port.	Moderate	None	UK CHIRP

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Allision	20 October 2012	Project vessel allision with WTG monopile following human error (misjudgement of distance). Minor damage sustained by vessel.	Minor	None	MAIB
Project	Allision	21 November 2012	Passenger transfer catamaran allision with buoy following navigational error. Vessel abandoned by crew of 12 having been holed, causing extensive flooding but no injuries sustained.	Major	None	MAIB
Project	Allision	21 November 2012	Work boat allision with unlit WTG transition piece at moderate speed following navigational error. Vessel able to proceed to port unassisted with no water ingress but some structural damage sustained.	Moderate	None	MAIB
Project	Allision	1 July 2013	Service vessel allision with WTG foundation following machinery failure. Minor damage sustained by vessel.	Minor	None	IMCA Safety Flash
Project	Allision	14 August 2014	Standby safety vessel allision with WTG pile. Oil leaked by vessel which moved away from environmentally sensitive areas until leak was stopped.	Minor with pollution	None	UK CHIRP
Third-party	Allision	26 May 2016	Third-party fishing vessel allision with WTG due to human error. Lifeboat attended the incident.	Moderate	Injury	Web search (RNLI, 2016)
Third party	Allision	24 May 2018	A fishing vessel allided with a WTG within an under-construction windfarm.	Unknown	Unknown	Anatec in-house AIS data
Project	Allision	14 February 2019	A vessel undertaking a survey at an OWF ran too close to a windfarm jacket whilst under autopilot.	Minor	None	MAIB
Project	Allision	16 January 2020	Project vessel allision with WTG. Injury sustained by crew member but vessel able to proceed to port unassisted.	None	Injury	Web search (Vessel Tracker, 2020)

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Allision	27 January 2020	Project vessel allision with WTG. Minor damage to vessel and WTG sustained, with no personal injuries.	Minor	None	Marine Safety Forum
Third-party	Allision	9 June 2022	Fishing vessel allision with WTG resulting in damage to vessel and two minor injuries for crew members. RNLI lifeboat escorted vessel under its own power to port.	Minor	Injury	Web search (RNLI, 2022)

(*) As per incident reports.

212. As of December 2023, there have been 13 reported[6] cases of an allision between a vessel and a WTG (under construction, operational or disused) in the UK, with all but two involving a support vessel for the development and the errant vessel in each case under power rather than drifting. Therefore, there has been an average of 1,739 years of WTG operation per WTG allision incident in the UK. This is a conservative calculation given that only operational WTGs years have been included (whereas allision incidents counted include non-operational WTGs).

9.6.2 Incidents Involving Non-UK OWF

213. It is noted that collision and allision incidents involving non-UK OWF developments have also occurred. However, it is not possible to maintain a comprehensive list of such incidents.

214. One high profile non-UK incident is that involving a bulk carrier in January 2022 which dragged anchor during a storm in Dutch waters and collided with another anchored vessel. The vessel began to take on water, leading to all crew members being evacuated by helicopter. The vessel then continued to drift towards shore including though an under construction OWF where it allided with a WTG foundation and a platform foundation before being taken under tow.

9.7 Incidents Responded to by Vessels Associated with UK OWFs

215. A list has been collated from news reports, basic web searches and experience of working with existing OWF developments, of historical incidents responded to by vessels associated with UK OWF developments. This list is summarised in Table 9-2. It

[6] Reported to an accident investigation branch or an anonymous reporting service. Unconfirmed incidents have not been considered noting that to date only one further alleged incident has been rumoured but there is no evidence to confirm.

is noted that the initial causes of these incidents were not related to the associated OWFs.

216. Table 9-2 comprises known incidents that were responded to by a windfarm vessel. Additional incidents associated with windfarms themselves are also known to have occurred. These incidents typically involve an accident to person which requires medical attention (including emergency response) but does not affect the operation of the vessel involved.

Table 9-2 Historical Incidents Responded to by Vessels Associated with UK OWF Developments

Incident Type	Date	Related Development	Description of Incident	Source
Capsize	21 June 2018	Walney OWF	HMCG issued mayday relay broadcast following trimaran capsize. Support vessel for Walney arrived and recovered two persons from the water who were then winched onboard a Coastguard helicopter.	Web search (4C Offshore, 2018)
Capsize	5 November 2018	Race Bank OWF	Fishing vessel capsized resulting in two persons in the water. Vessel operating at the nearby Race Bank reported to have assisted with the rescue which also involved a Belgian military helicopter and the RNLI.	Web search (British Broadcasting Corporation (BBC), 2018)
Vessel in distress	15 May 2019	London Array OWF	Yacht in difficult sought shelter by tying up to a WTG but suffered damage and a person in the water. Support vessel for London Array identified and secured the casualty vessel and recovered the person in the water. The support vessel raised the alarm to the Coastguard. The Coastguard later instructed the support vessel to return to port and seek medical assistance for the casualty vessel's occupant.	Web search (The Isle of Thanet News, 2019)
Drifting	7 July 2019	Gwynt y Môr OWF	Speedboat suffered mechanical failure stranding four persons. Support vessel for Gwynt y Môr responded to an 'all-ships' broadcast from the Coastguard and prevented the casualty vessel drifting into the Gwynt y Môr array. The support vessel later towed the casualty vessel back towards port.	Web search (Renews, 2019)
Machinery failure	28 September 2019	Race Bank OWF	Fishing vessel suffered mechanical failure and launched flares. Guard vessel and Service Operation Vessel (SOV) for Race Bank both immediately offered assistance until the MCA's arrival on-scene.	Internal daily progress report received by Anatec
Vessel in distress	13 December 2019	Race Bank OWF	Passing vessel got into difficulty and guard vessel for Race Bank was requested to assist. The	Internal daily progress

Incident Type	Date	Related Development	Description of Incident	Source
			Coastguard later requested that the guard vessel tow the casualty vessel into port.	report received by Anatec
Search	21 May 2020	Walney OWF	Coastguard contacted guard vessel for Walney reporting red flare sighting at the windfarm. Guard vessel proceeded to undertake search but did not find anything to report.	Internal daily progress report received by Anatec
Aircraft crash	15 June 2020	Hornsea Project One	United States (US) jet crashed into sea during routine flight. CTV and SOV for Hornsea Project One joined the search for the missing pilot.	Web search (4C Offshore, 2020)
Fire/ explosion	15 December 2020	Dudgeon OWF	Fishing vessel experienced explosions on board with crew injured. SOV for Dudgeon deployed its Fast Rescue Boat (FRB) and evacuated the casualty vessel.	Web search (Offshore WIND, 2020)
Vessel in distress	3 June 2021	Robin Rigg	Windfarm CTV fire alarm sounded, with the engine then shut down. A support vessel for Robin Rigg was able to assist in escorting the vessel to port.	Web search (Vessel Tracker, 2021)
Drifting	17 July 2021	Neart na Gaoithe (NNG)	Small dinghy with two children aboard drifted offshore due to strong winds. A guard vessel associated with NNG was able to retrieve the children.	Web search (Edinburgh Evening News, 2021)
Allision	9 June 2022	Westermost Rough	Fishing vessel allided with a WTG at Westermost Rough. A supply vessel was among the responders as an RNLI lifeboat escorted the vessel under its own power to port.	Web search (Vessel Tracker, 2022)

10 Vessel Traffic Movements

217. This section presents an analysis of vessel traffic movements in relation to the array area, Offshore ECC, and the ORCP area. The methodology for vessel traffic data collection, including details of the on-site vessel traffic surveys, is provided in section 5.2.

10.1 Array Area

218. A plot of the vessel tracks recorded during a 14-day summer survey period, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 10.1. Following this, Figure 10.2 presents the same data converted to a density heat map.

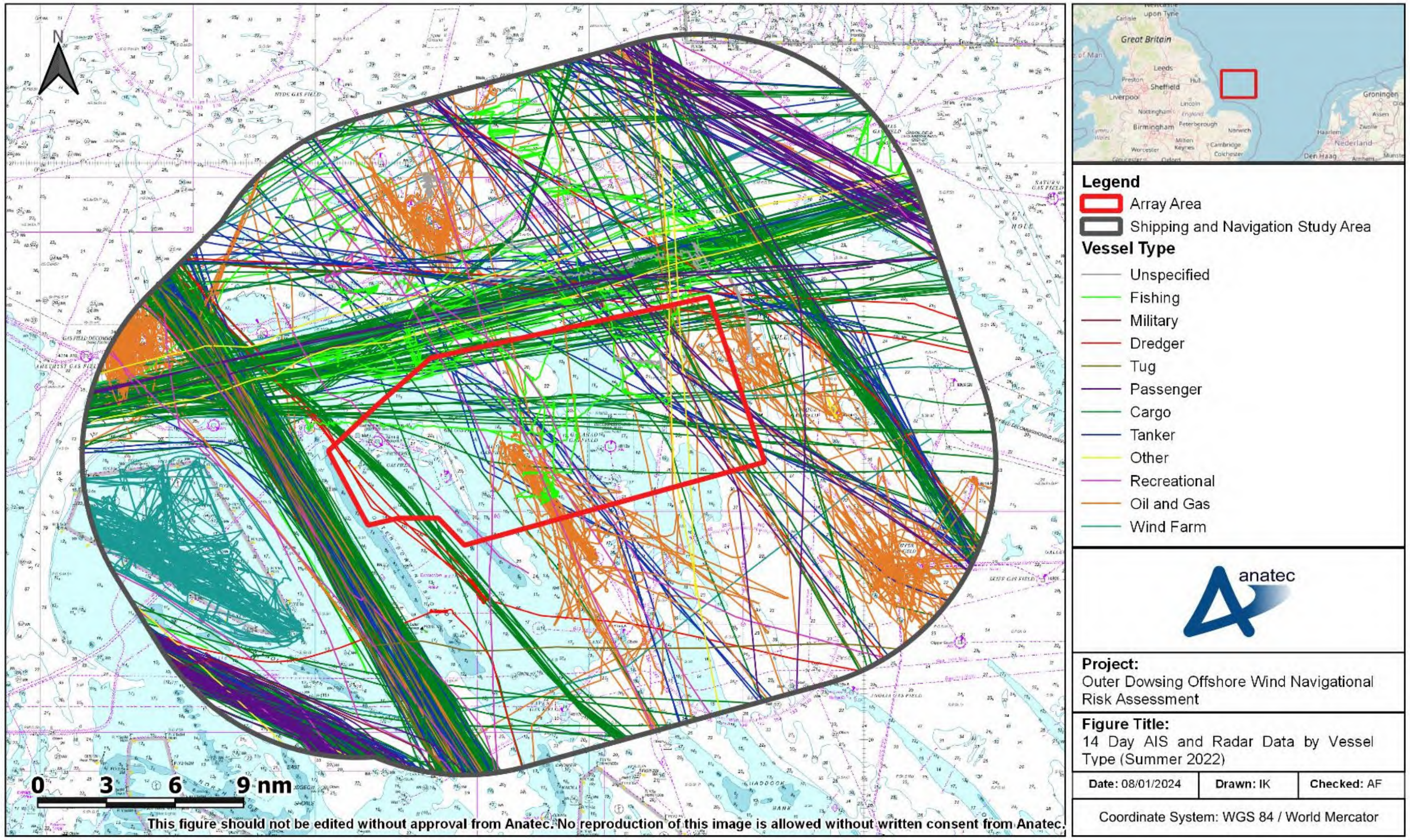

Figure 10.1 Vessel Traffic Survey Data by Vessel Type (14-Days, Summer 2022)

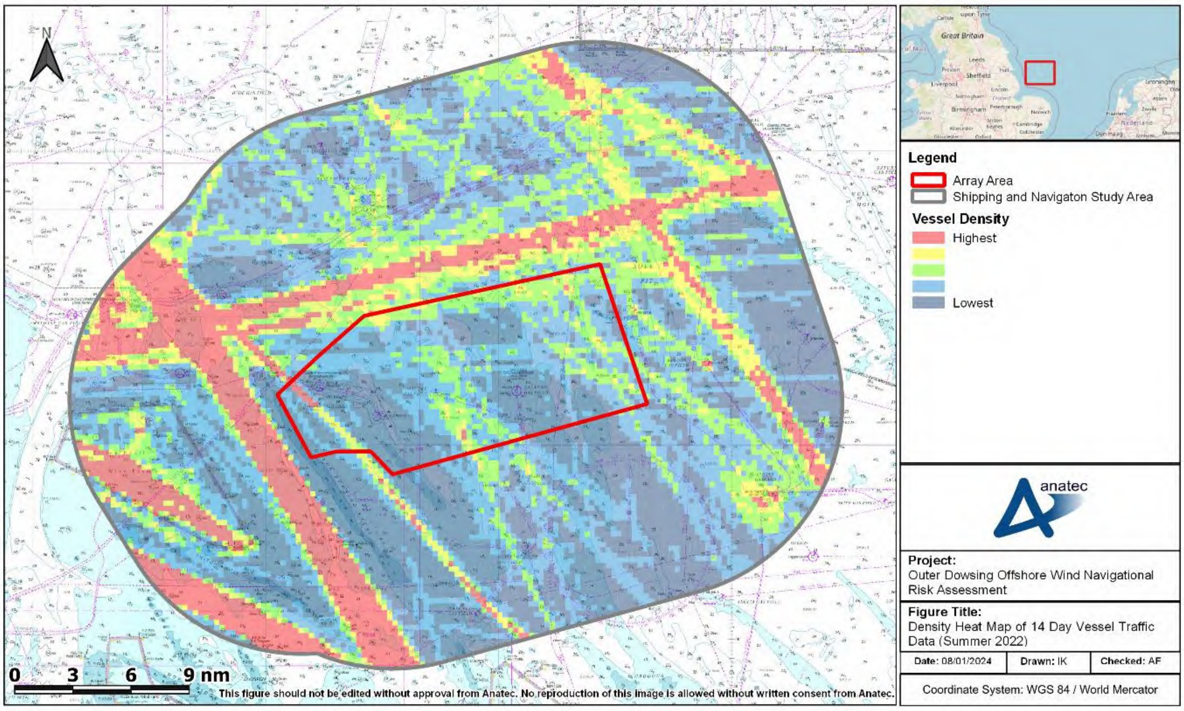

Figure 10.2 Vessel Traffic Density Heat Map (14-Days, Summer 2022)

219. A plot of the vessel tracks recorded during the 14-day winter survey period, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 10.3. Following this, Figure 10.4 presents the same data converted to a density heat map. It is noted that the same density ranges have been used in the winter data as that of the summer to allow direct comparison.

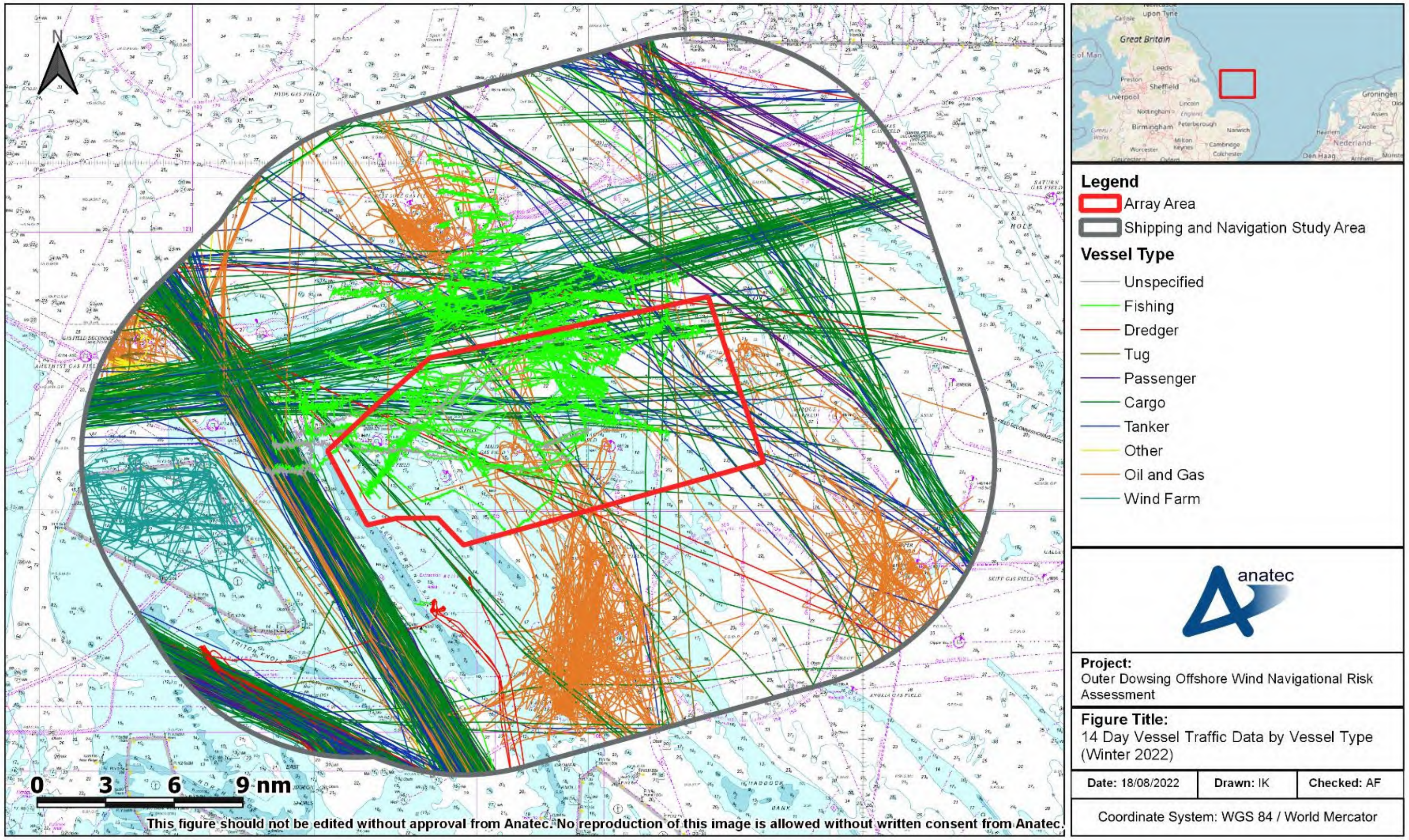

Figure 10.3 Vessel Traffic Survey Data by Vessel Type (14-Days, Winter 2022)

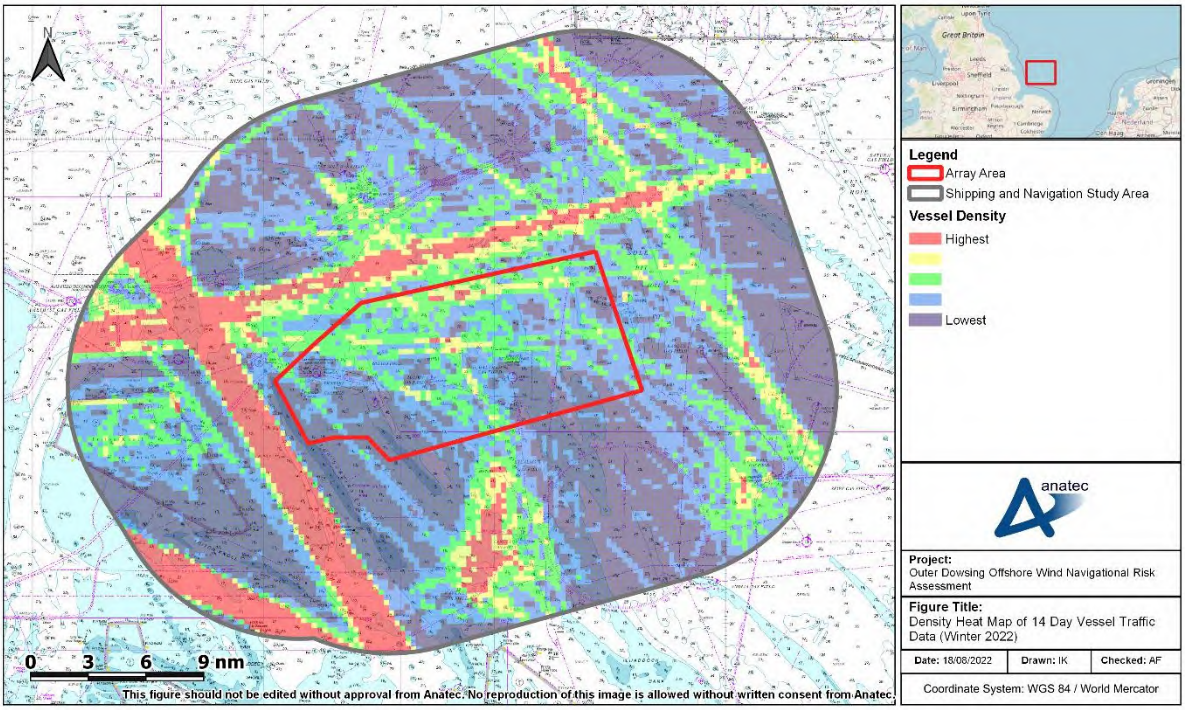

Figure 10.4 Vessel Traffic Density Heat Map (14-Days, Winter 2022)

10.1.1 Vessel Counts

220. The daily number of unique vessels recorded within the shipping and navigation study area, as well as intersecting the array area, during the summer survey period is presented in Figure 10.5. Throughout the summer survey period, approximately 13% of vessel traffic recorded within the shipping and navigation study area intersected the array area.

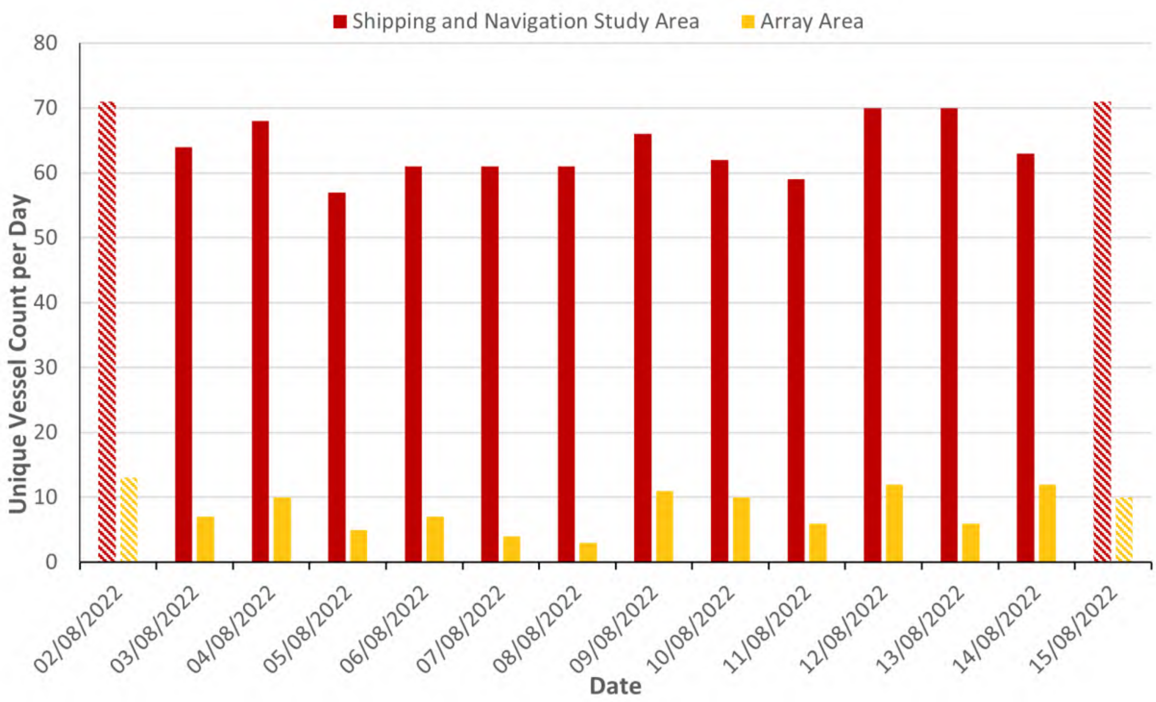

Figure 10.5 Daily Unique Vessel Counts within the Shipping and Navigation Study Area and Array Area (14-Days, Summer 2022)

221. For the 14-days analysed in the summer survey period, there was an average of between 64 and 65 unique vessels recorded per day within the shipping and navigation study area. An average of eight unique vessels per day intersected the array area.

222. The busiest days recorded within the shipping and navigation study area during the summer survey period was 2 and 15 August, on which 71 unique vessels were recorded each day. The busiest days recorded within the array area during the summer survey period was 2 August, on which 13 unique vessels were recorded.

223. The quietest day recorded within the shipping and navigation study area during the summer survey period was 5 August, on which 57 unique vessels were recorded. The quietest day recorded within the array area during the summer survey period was 8 August, on which three unique vessels were recorded.

224. The daily number of unique vessels recorded within the shipping and navigation study area, as well as intersecting the array area, during the winter survey period is presented in Figure 10.6. Throughout the winter survey period, approximately 13% of vessel traffic recorded within the shipping and navigation study area intersected the array area.

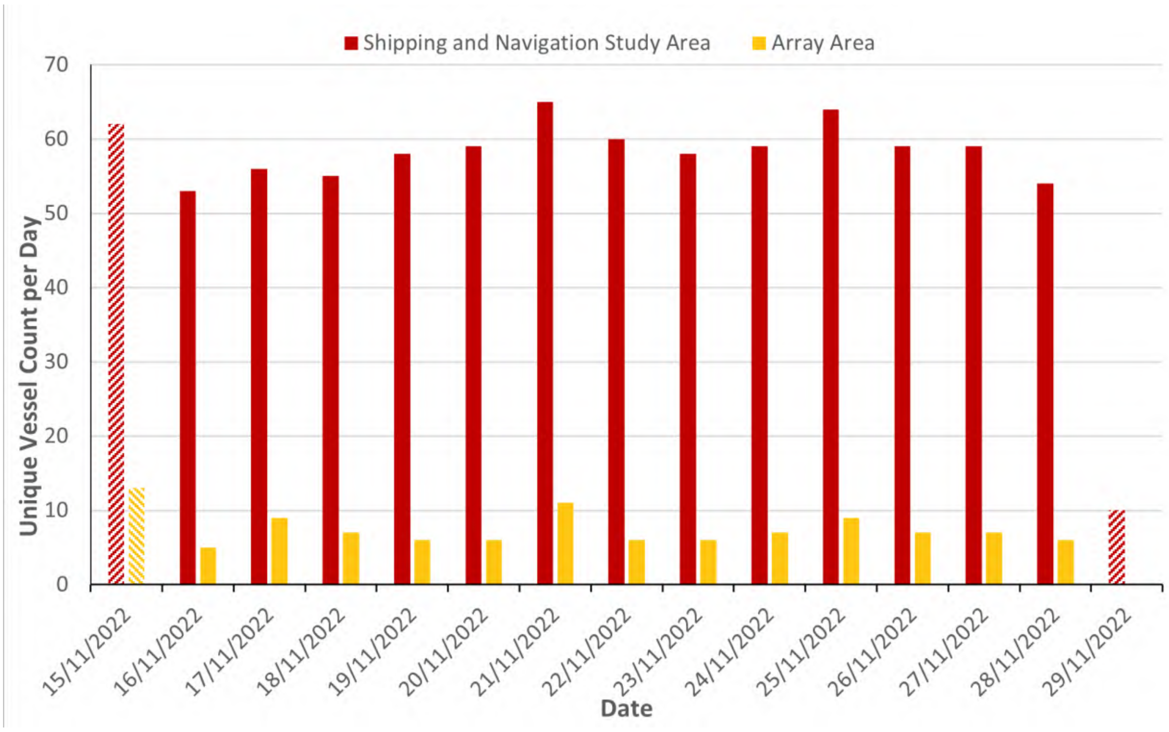

Figure 10.6 Daily Unique Vessel Counts within the Shipping and Navigation Study Area and Array Area (14-Days, Winter 2022)

225. For the 14-days analysed in the winter survey period, there was an average of 58 unique vessels recorded per day within the shipping and navigation study area. An average of seven unique vessels per day intersected the array area.

226. The busiest day recorded within the shipping and navigation study area during the winter survey period was 21 November, on which 65 unique vessels were recorded. The busiest day recorded within the array area during the winter survey period was 15 November, on which 13 unique vessels were recorded.

227. The quietest full day recorded within the shipping and navigation study area during the winter survey period was 16 November, on which 53 unique vessels were recorded. The quietest full day recorded within the array area during the winter survey period was also the 16 November, on which five unique vessels were recorded.

10.1.2 Vessel Type

228. The percentage distribution of the main vessel types recorded passing within the shipping and navigation study area and the array area during the summer survey period is presented in Figure 10.7.

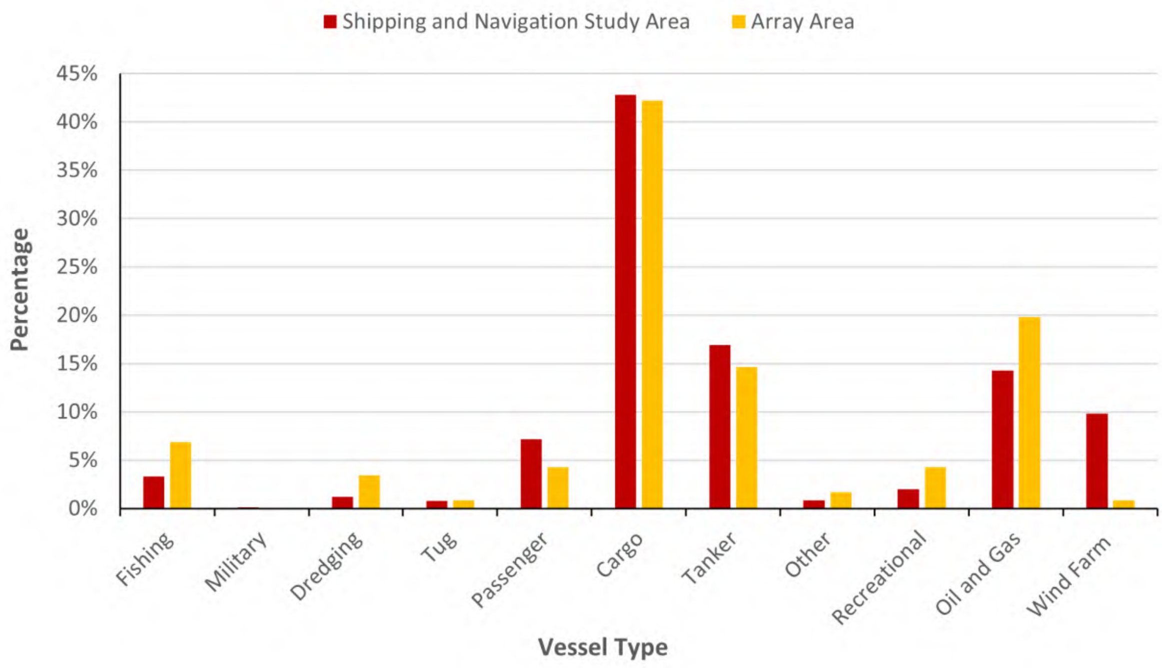

Figure 10.7 Vessel Type Distribution (14-Days, Summer 2022)

229. Throughout the summer survey period, the main vessel types within the shipping and navigation study area were cargo vessels (43%), tankers (17%), and oil and gas vessels (11%). This was the same general trend as for vessel types intersecting the array area.

230. The percentage distribution of the main vessel types recorded passing within the shipping and navigation study area and the array area during the winter survey period is presented in Figure 10.8.

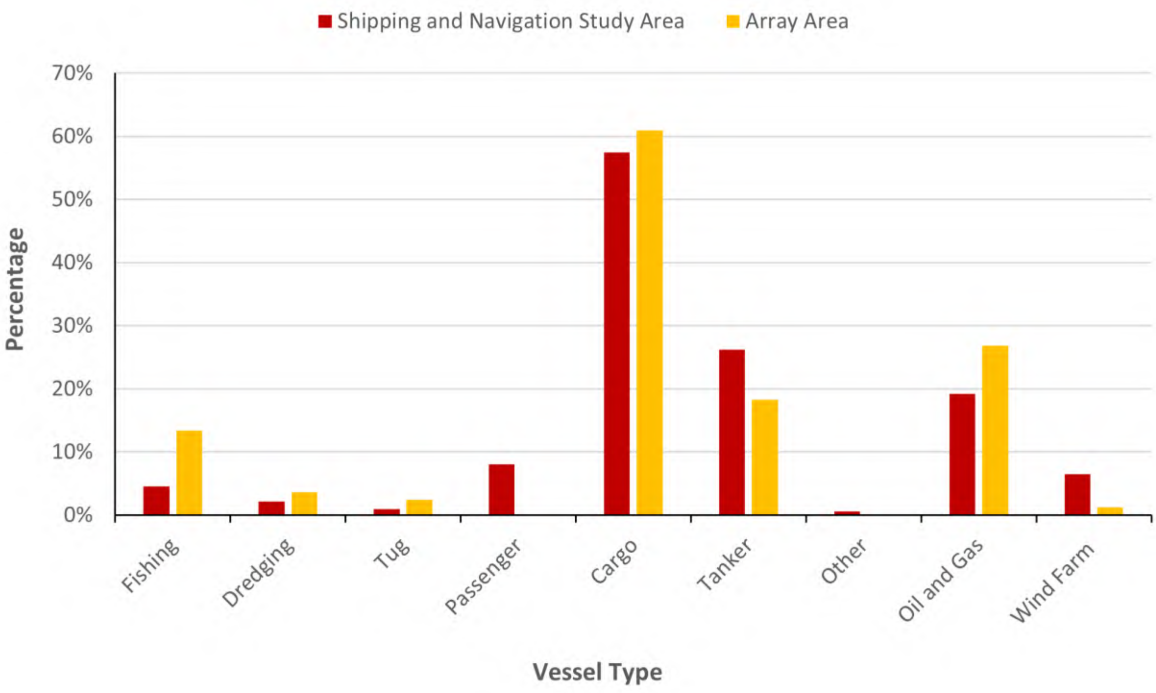

Figure 10.8 Vessel Type Distribution (14-Days, Winter 2022)

231. Throughout the winter survey period, the main vessel types recorded within the shipping and navigation study area were cargo vessels (46%), tankers (21%), and oil and gas vessels (15%). This was the same general trend as for vessel types intersecting the array area.

232. The following subsections consider each of the main vessel types individually.

10.1.2.1 Cargo Vessels

233. Figure 10.9 presents a plot of cargo vessels, including commercial ferries, recorded within the shipping and navigation study area during the 14-day summer survey period.

234. Throughout the summer survey period, an average of between 27 and 28 unique cargo vessels per day were recorded within the shipping and navigation study area. The most common cargo vessel sub-types present within the shipping and navigation study area during the summer survey period were general cargo (32%), Ro-Ro (23%), and containerships (22%)

235. The regular cargo vessels operating within the shipping and navigation study area included Ro-Ro vessels operated by DFDS Seaways, CLdN, and Bore. Ro-Ro vessels are presented in Figure 10.10 for the 14-day summer survey period, colour-coded by vessel operator.

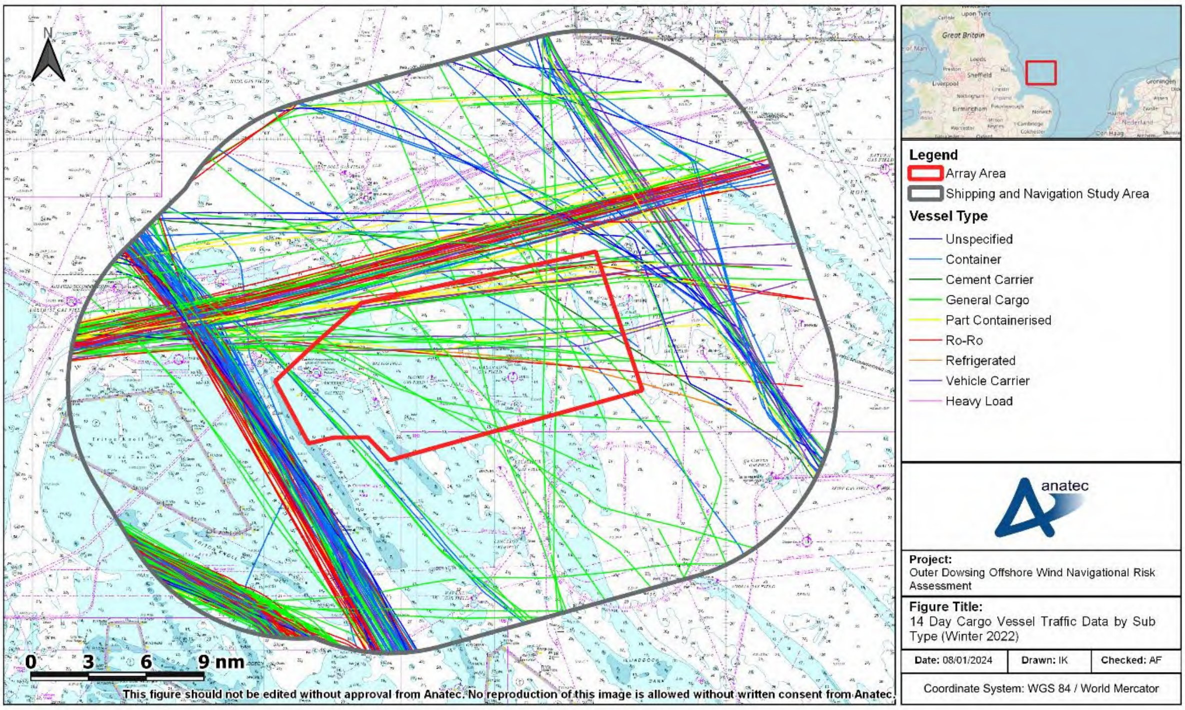

Figure 10.9 Cargo Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

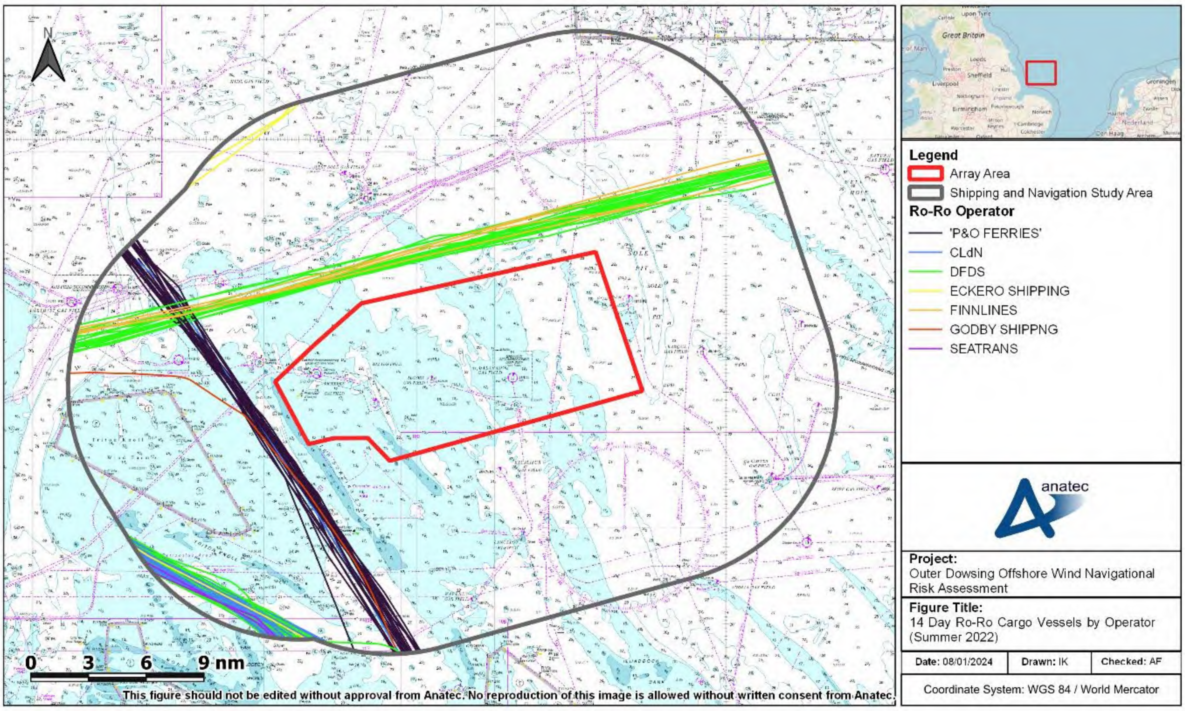

Figure 10.10 Ro-Ro Vessels within the Shipping and Navigation Study Area by Vessel Operator (14-Days, Summer 2022)

236. On average between six and seven unique Ro-Ro vessels per day were recorded within the shipping and navigation study area during the summer survey period. The most common Ro-Ro operators during the summer survey period were DFDS Seaways (30%), CLdN (28%), and Bore (28%).

237. Figure 10.11 presents a plot of cargo vessels, including commercial ferries, recorded within the shipping and navigation study area during the 14-day winter survey period.

238. Throughout the winter survey period, an average of between 27 and 28 unique cargo vessels per day were recorded within the shipping and navigation study area. The most common cargo vessel sub-types present within the shipping and navigation study area during the winter survey period were general cargo (36%), Ro-Ro cargo (21%), container vessels (19%), and vehicle carriers (11%).

239. As for summer, the regular cargo vessels operating within the shipping and navigation study area included Ro-Ro vessels operated by DFDS Seaways, Bore, and CLdN. Ro-Ro vessels are presented in Figure 10.12 for the 14-day winter survey period, colour-coded by vessel operator.

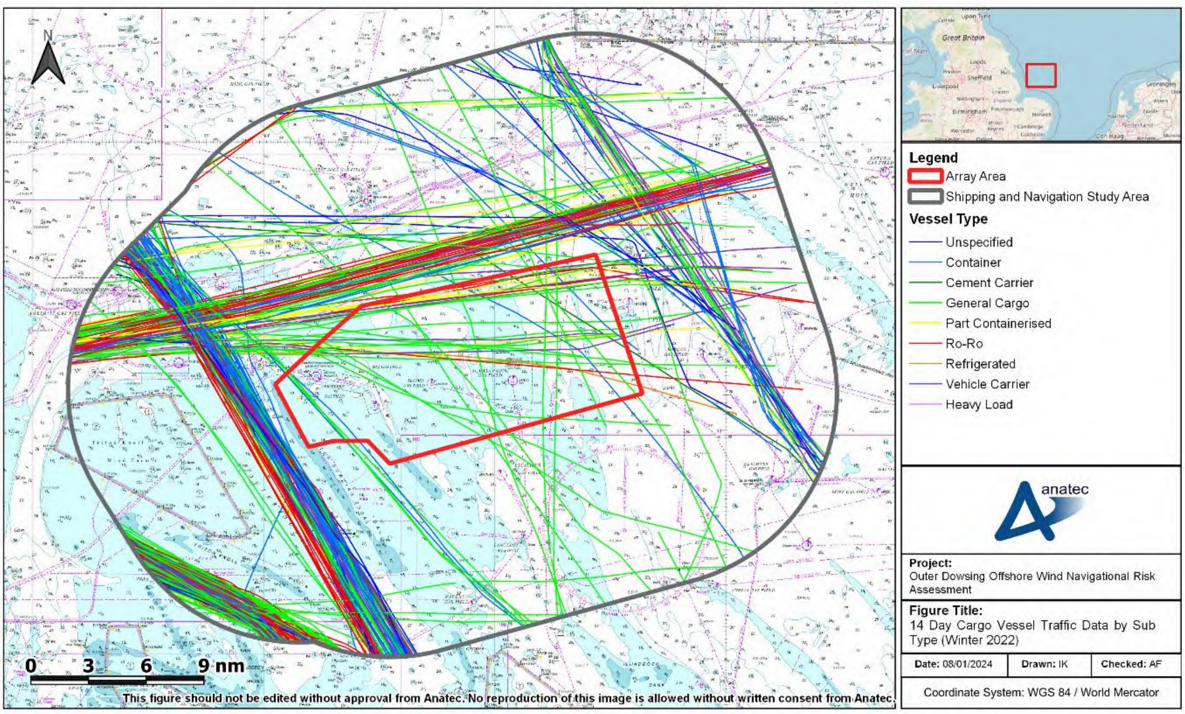

Figure 10.11 Cargo Vessels within the Shipping and Navigation Study Area (14-Days Winter 2022)

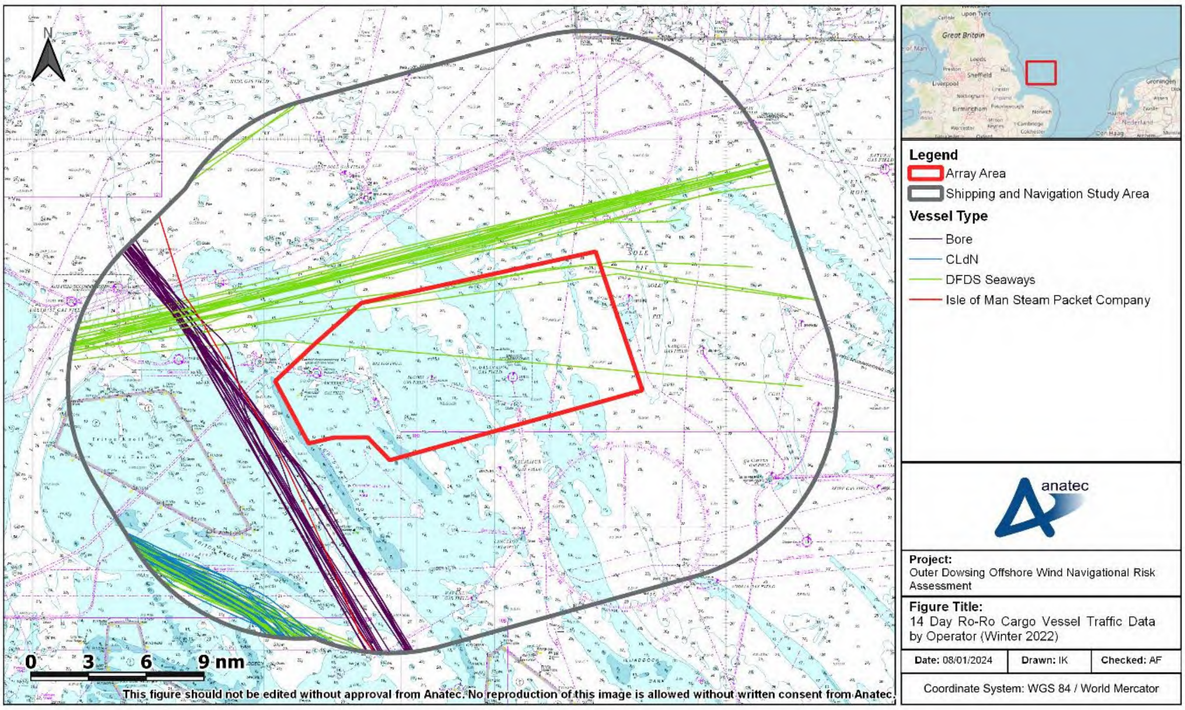

Figure 10.12 Ro-Ro Vessels within the Shipping and Navigation Study Area by Vessel Operator (14-Days Winter 2022)

240. On average between five and six unique Ro-Ro vessels per day were recorded within the shipping and navigation study area during the winter survey period. The most common Ro-Ro operators during the summer survey period were DFDS Seaways (47%), Bore (27%), and CLdN (24%).

10.1.2.2 Tankers

241. Figure 10.13 presents a plot of tankers recorded within the shipping and navigation study area during the 14-day summer survey period.

242. Throughout the summer survey period, an average of between ten and 11 unique tankers per day were recorded within the shipping and navigation study area with them most common tanker sub-types were combined oil/chemical (40%), liquified petroleum gas carriers (LPG) (27%), product tankers (17%), and chemical tankers (12%).

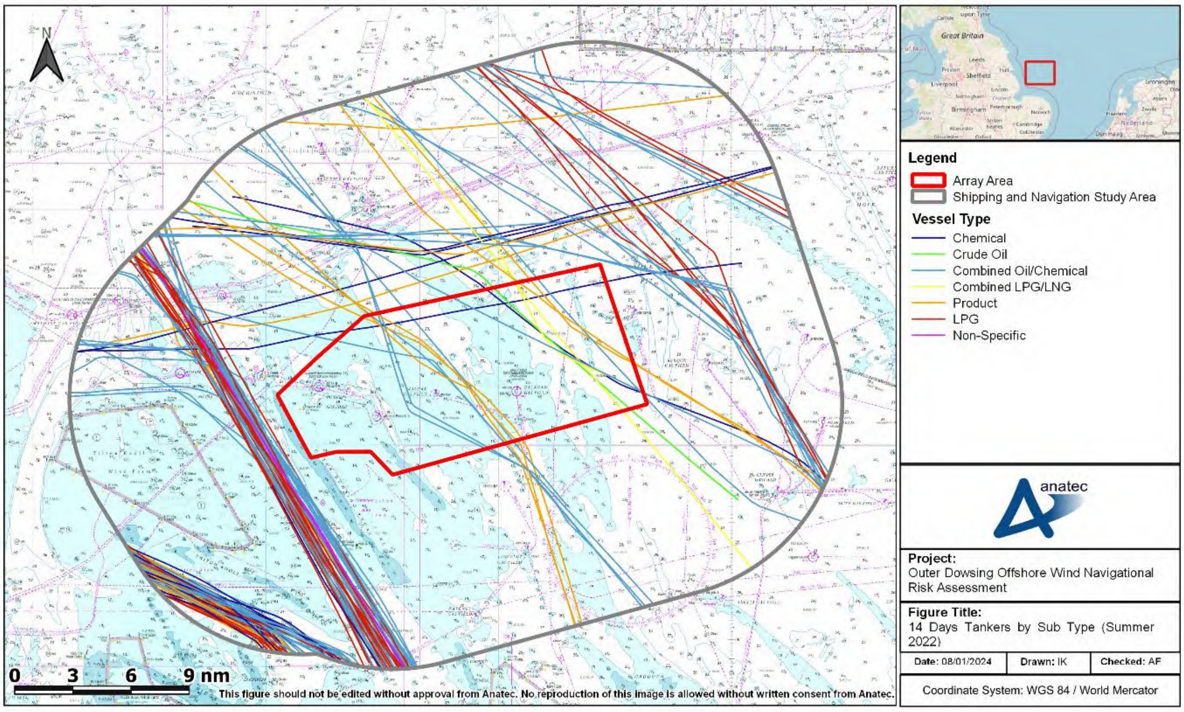

Figure 10.13 Tankers within the Shipping and Navigation Study Area (14-Days, Summer 2022)

243. Figure 10.14 presents a plot of tankers recorded within the shipping and navigation study area during the 14-day winter survey period.

244. Throughout the winter survey period, an average of between 12 and 13 unique tankers per day were recorded within the shipping and navigation study area with them most common tanker sub-types being combined oil/chemical (53%), LPG (24%), chemical tankers (11%), and product tankers (9%).

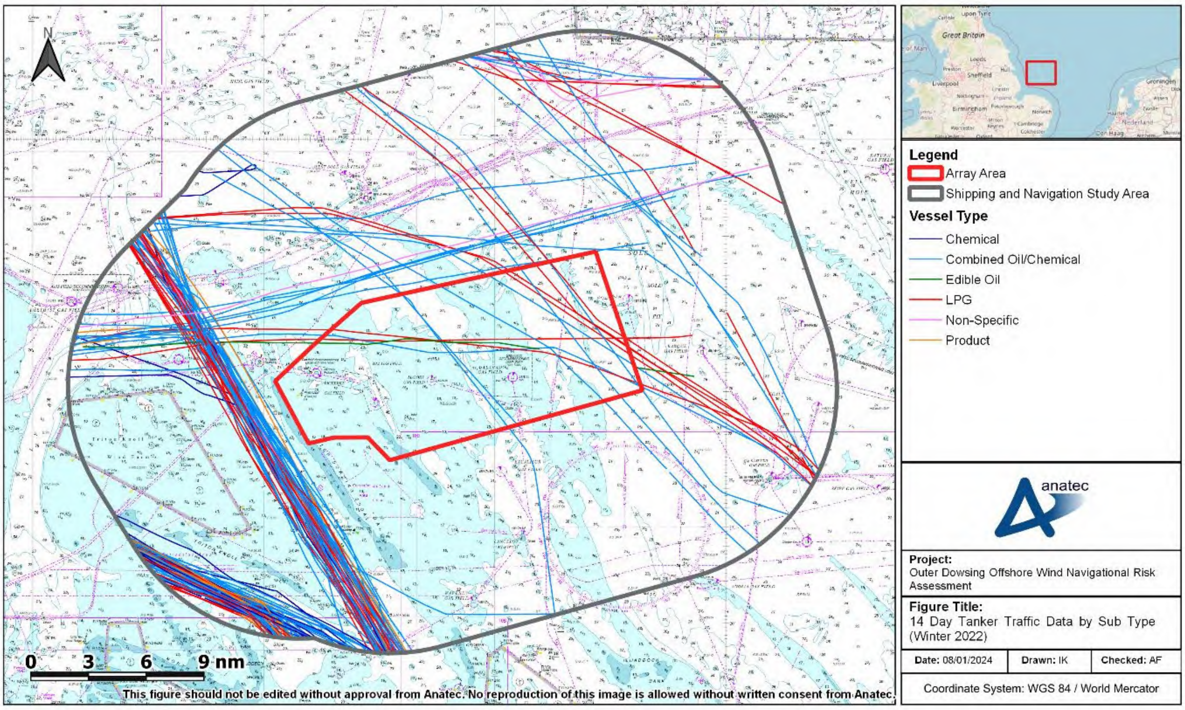

Figure 10.14 Tankers within the Shipping and Navigation Study Area (14-Days, Winter 2022)

10.1.2.3 Passenger Vessels

245. Figure 10.15 presents a plot of passenger vessels recorded within the shipping and navigation study area during the 14-day summer survey period.

246. Throughout the summer survey period, an average of five unique passenger vessels per day were recorded within the shipping and navigation study area with the most common passenger vessel type being RoPax (92%) with the rest being cruise liners.

247. RoPax vessels were operated by DFDS Seaways (50%), P&O Ferries (25%), and StenaLine (25%). Routeing of RoPax during the summer period was noted between the UK and the Netherlands on many routes including Killingholme – Hoek Van Holland for StenaLine vessels, Hull – Rotterdam for P&O Ferries, and North Shields – Ijmuiden for DFDS.

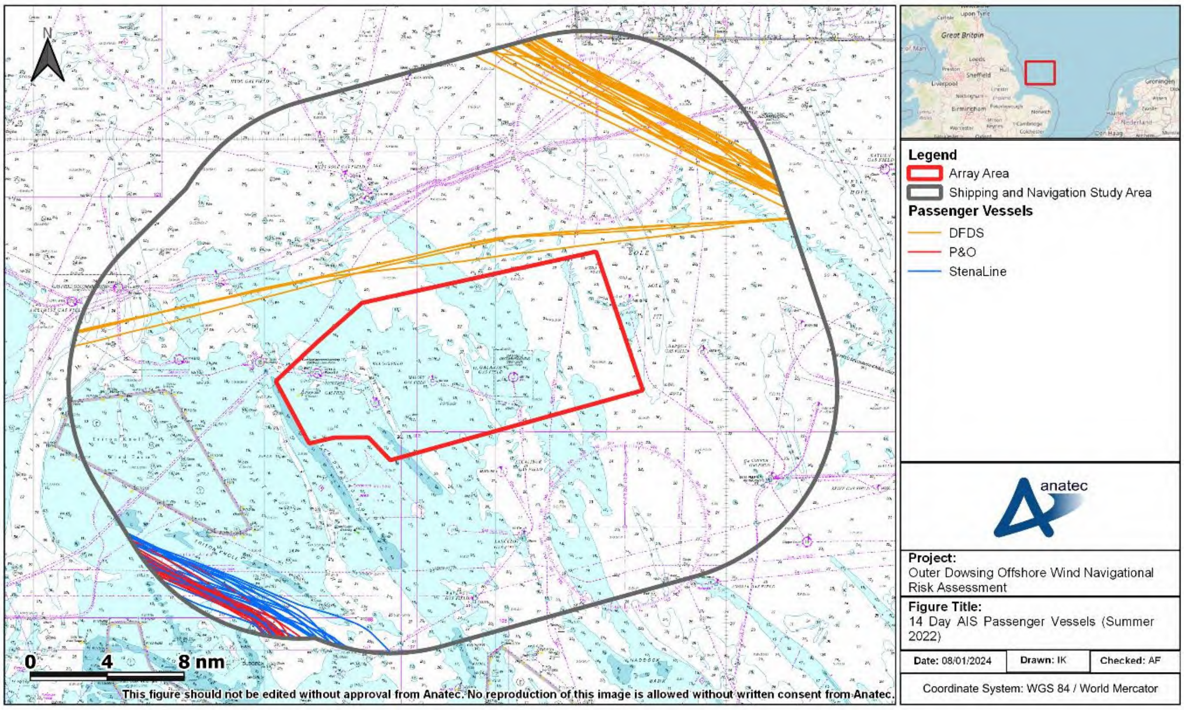

Figure 10.15 Passenger Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

248. Figure 10.16 presents a plot of passenger vessels recorded within the shipping and navigation study area during the 14-day winter survey period.

249. Throughout the winter survey period, an average of between three and four unique passenger vessels per day were recorded within the shipping and navigation study area. All passenger vessels recorded were RoPax.

250. RoPax vessels were operated by DFDS Seaways (47%), P&O Ferries (26%), and StenaLine (26%). DFDS Seaways vessels were routeing between Tyne ports (North Shields and Newcastle (UK)) and Ijmuiden (The Netherlands). These vessels were seen to the north-east of the shipping and navigation study area with vessels also heading to Ijmuiden passing though the navigational corridor to the west of, and within, the north-east of the array area. These two smaller routes on the east and western periphery of the array area are already known to be adverse weather routes for DFDS vessels on this specific route seen to the northeast of the shipping and navigation study area. The timing of these re-routes of vessels correlates with the rougher sea states in the area as noted by crew on board the Karima at the time of the survey. Adverse weather routes are discussed in more detail in section 12.

251. P&O Ferries and StenaLine vessels were seen routeing to the south of Triton Knoll OWF on routes between Hull (UK) and Europoort Rotterdam (The Netherlands)

for P&O Ferries, and between Killingholme (UK) and Hoek Van Holland (The Netherlands) for StenaLine vessels.

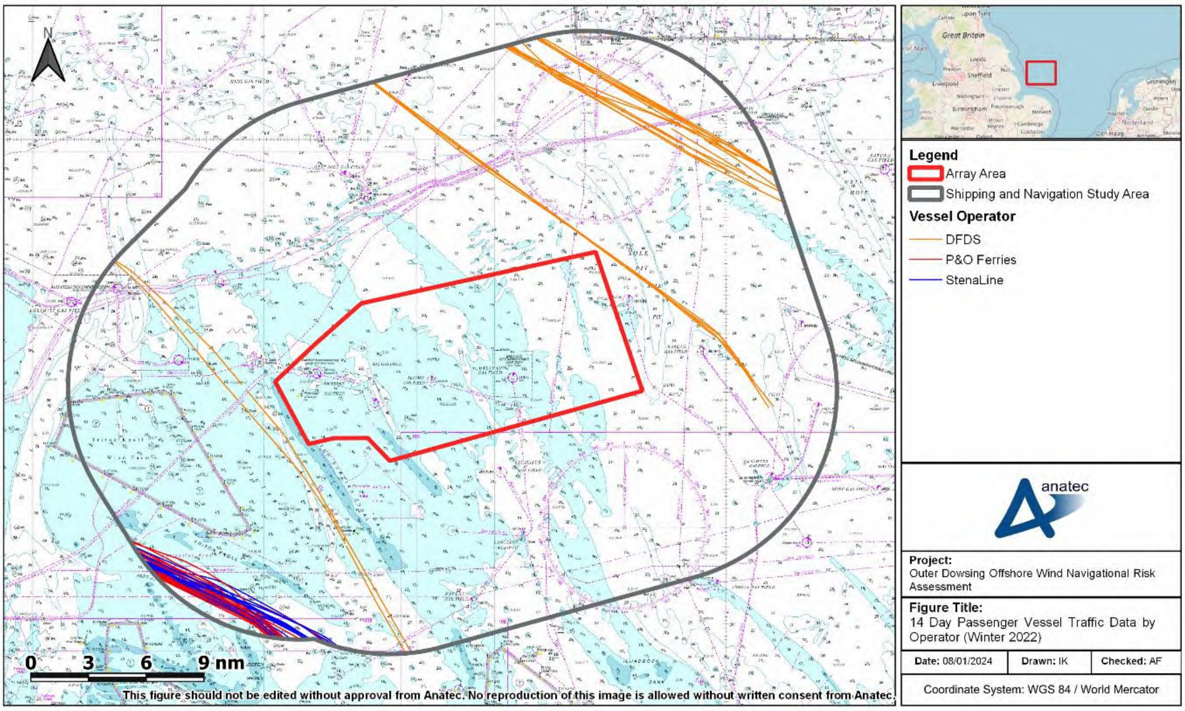

Figure 10.16 Passenger Vessels within the Shipping and Navigation Study Area (14-Days, Winter 2022)

10.1.2.4 Oil and Gas Vessels

252. Figure 10.17 presents a plot of oil and gas vessels recorded within the shipping and navigation study area during the 14-day summer survey period, along with the relevant surface platforms in proximity to the array area.

253. Throughout the summer survey period, an average of nine unique oil and gas vessels per day were recorded within the shipping and navigation study area.

254. Vessels were noted to be on transit through the shipping and navigation study area as well as being engaged in activity at platforms and gas fields within the area. Such platforms and gas fields were Clipper, Barque, Galleon, Amethyst, Malory, Excalibur, and West Sole. The vessels passing between Triton Knoll OWF and the array area were transiting to platforms including York, Haeva, Rough, and to ports and harbours including Great Yarmouth, Lowestoft and Ramsgate (all UK).

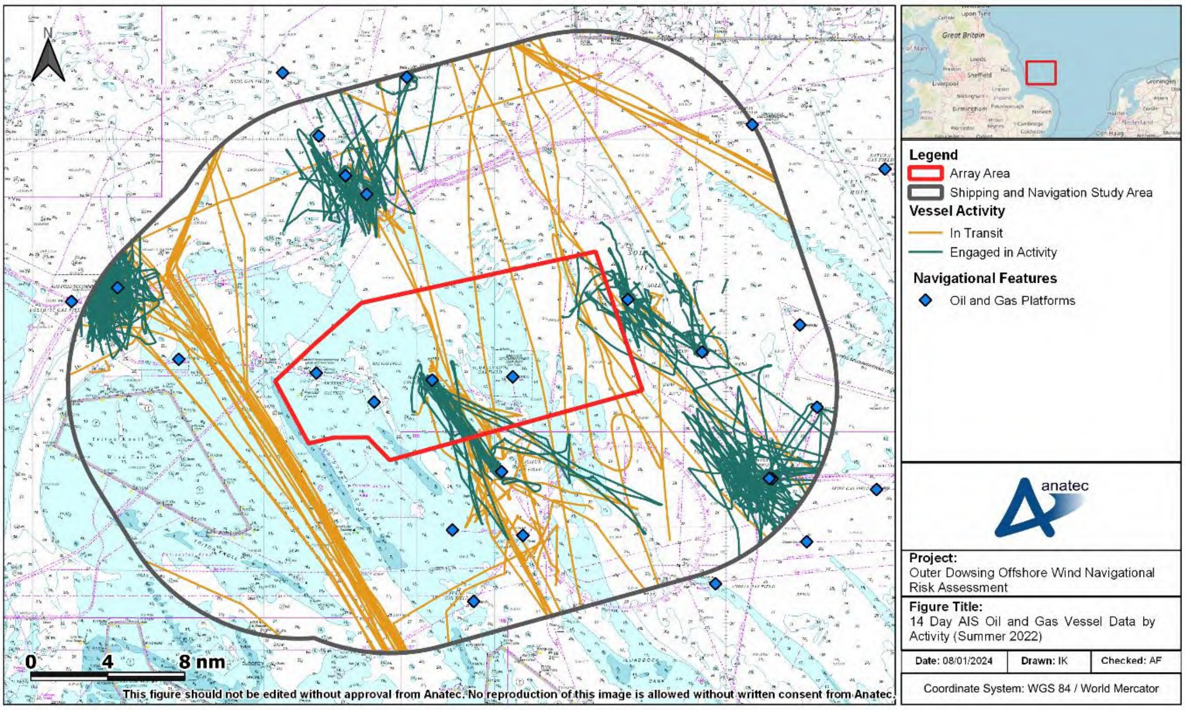

Figure 10.17 Oil and Gas Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

255. Figure 10.18 presents a plot of oil and gas vessels recorded within the shipping and navigation study area during the 14-day winter survey period, along with the relevant surface platforms in the proximity to the array area.

256. Throughout the winter survey period, an average of nine unique oil and gas vessels per day were recorded within the shipping and navigation study area.

257. Vessels were seen on transit and engaged in likely operation and maintenance activity at platforms and oil and gas fields within proximity to the study area including fields Clipper, Barque, Galleon, Amethyst, and West Sole. Transiting vessels seen to the west of the array area were mainly transiting to Great Yarmouth (UK) with other vessels transiting to North Sea oil and gas fields and other UK ports and harbours.

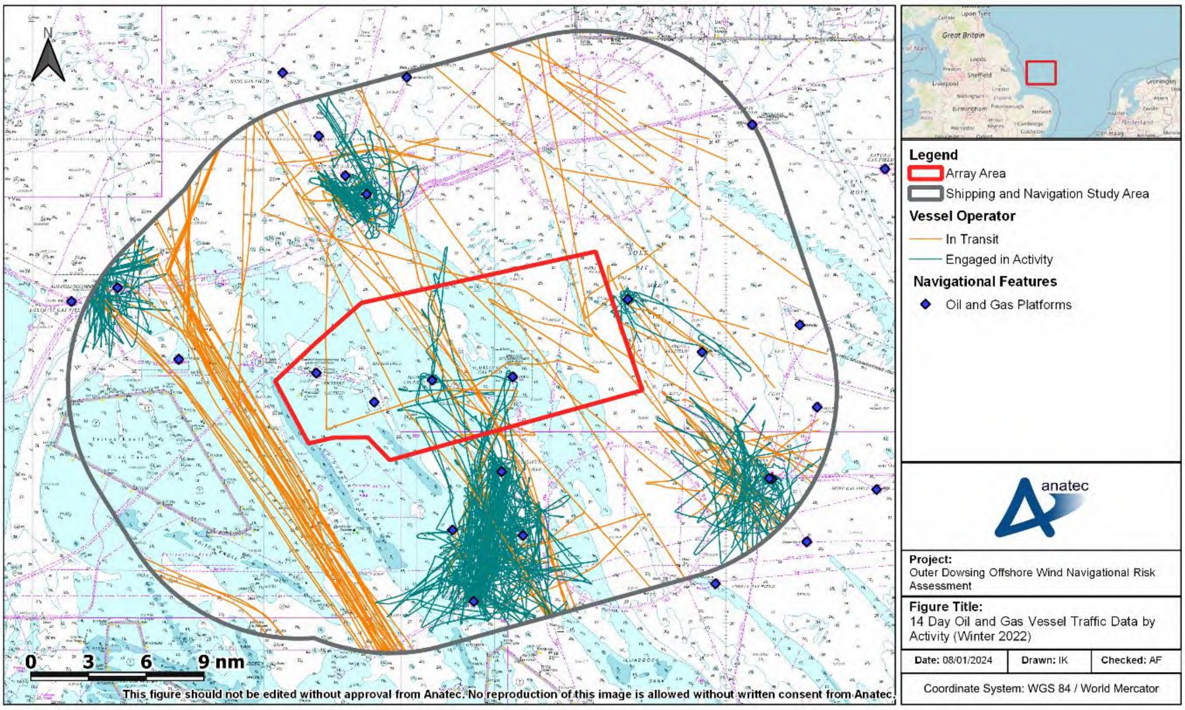

Figure 10.18 Oil and Gas Vessels within the Shipping and Navigation Study Area (14-Days, Winter 2022)

10.1.2.5 Windfarm Vessels

258. Figure 10.19 presents a plot of windfarm vessels recorded within the shipping and navigation study area during the 14-day summer survey period.

259. Throughout the summer survey period, an average of seven unique windfarm vessels per day were recorded within the shipping and navigation study area.

260. Vessels were mostly associated with Triton Knoll OWF with other vessels routeing to/from Hornsea Project One or ports and harbours including Grimsby, Hull, Montrose (all UK) and Esbjerg (Denmark).

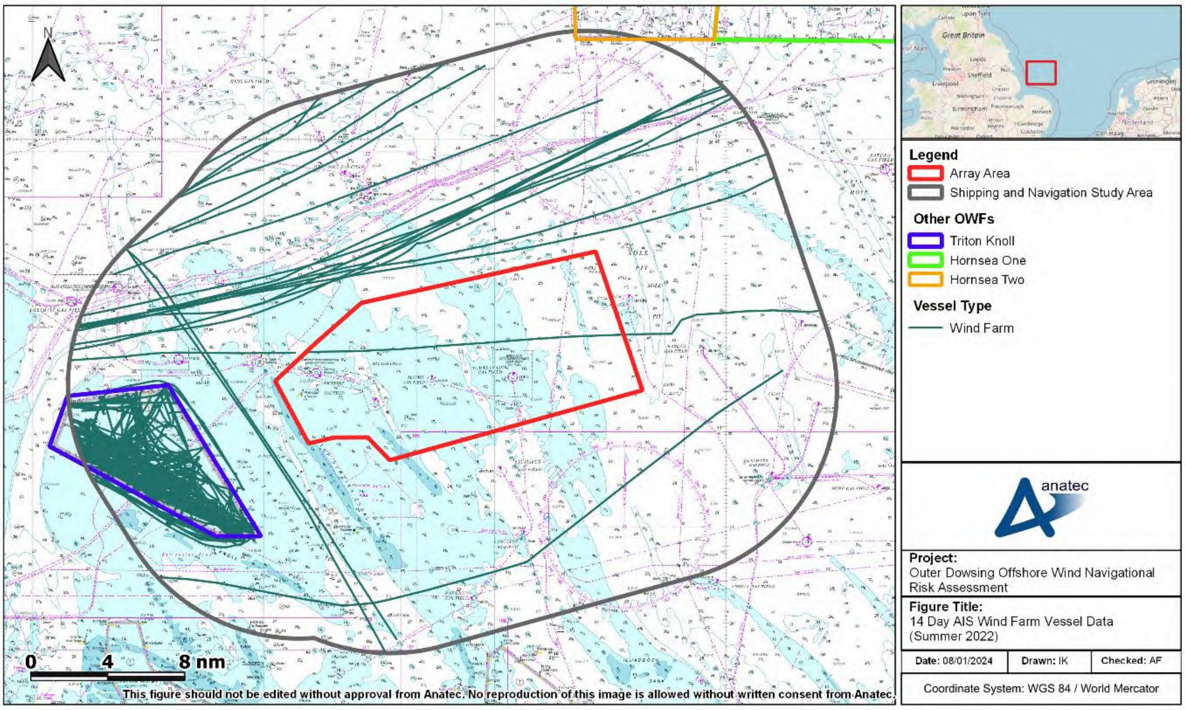

Figure 10.19 Windfarm Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

261. Figure 10.20 presents a plot of windfarm vessels recorded within the shipping and navigation study area during the 14-day winter survey period.

262. Throughout the winter survey period, an average of between two and three unique windfarm vessels per day were recorded within the shipping and navigation study area.

263. As for summer, the majority of these vessels were either transiting to/from or carrying out operational and maintenance activity at Triton Knoll OWF. Other windfarm vessels were generally transiting through the shipping and navigation study area, to the north of the array, routeing between Grimsby (UK) and Hornsea Project One.

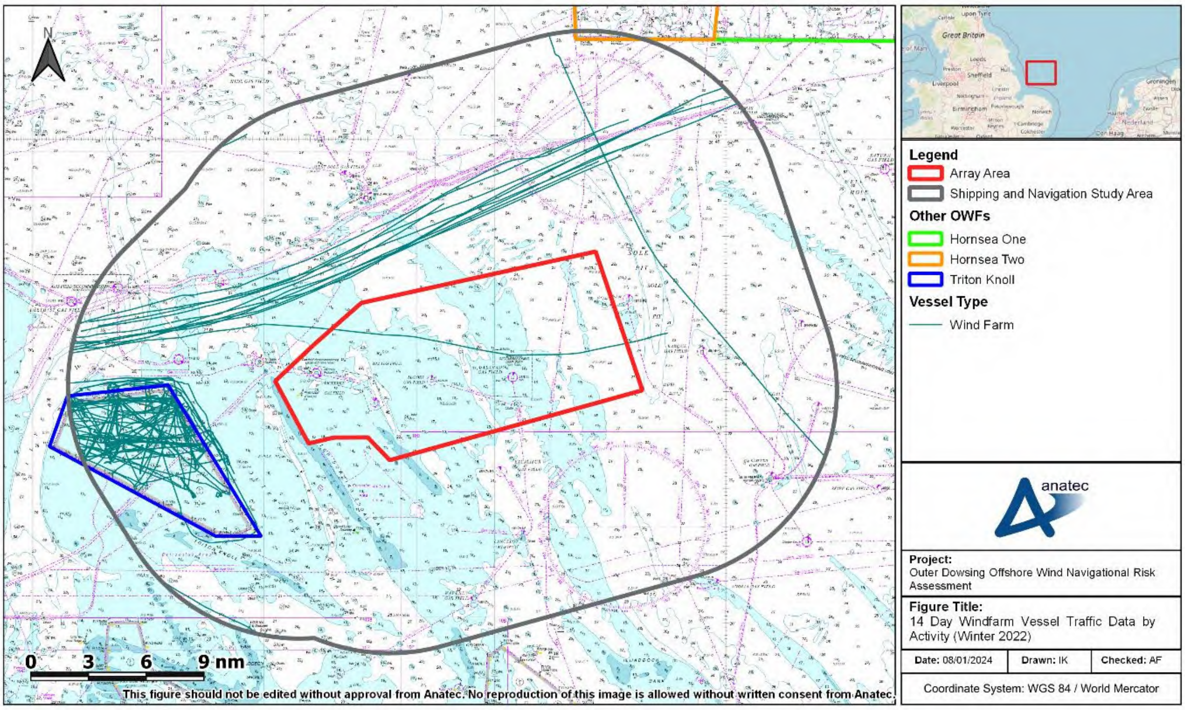

Figure 10.20 Windfarm Vessels within the Shipping and Navigation Study Area (14-Days, Winter 2022)

10.1.2.6 Marine Aggregate Dredgers and Subsea Operation Vessels

264. Figure 10.21 presents a plot of marine aggregate dredger/subsea operation vessels recorded within the shipping and navigation study area during the 14-day summer survey period, along with the relevant TCE aggregate areas.

265. An average of less than one unique marine aggregate dredger/subsea operation vessel per day was recorded within the shipping and navigation study area during the summer survey period.

266. Aggregate dredging activity was present within both Outer Dowsing TCE areas 515/1 and 515/2. Most vessels were routing between marine aggregate dredging areas within the shipping and navigation study area or near the Humber.

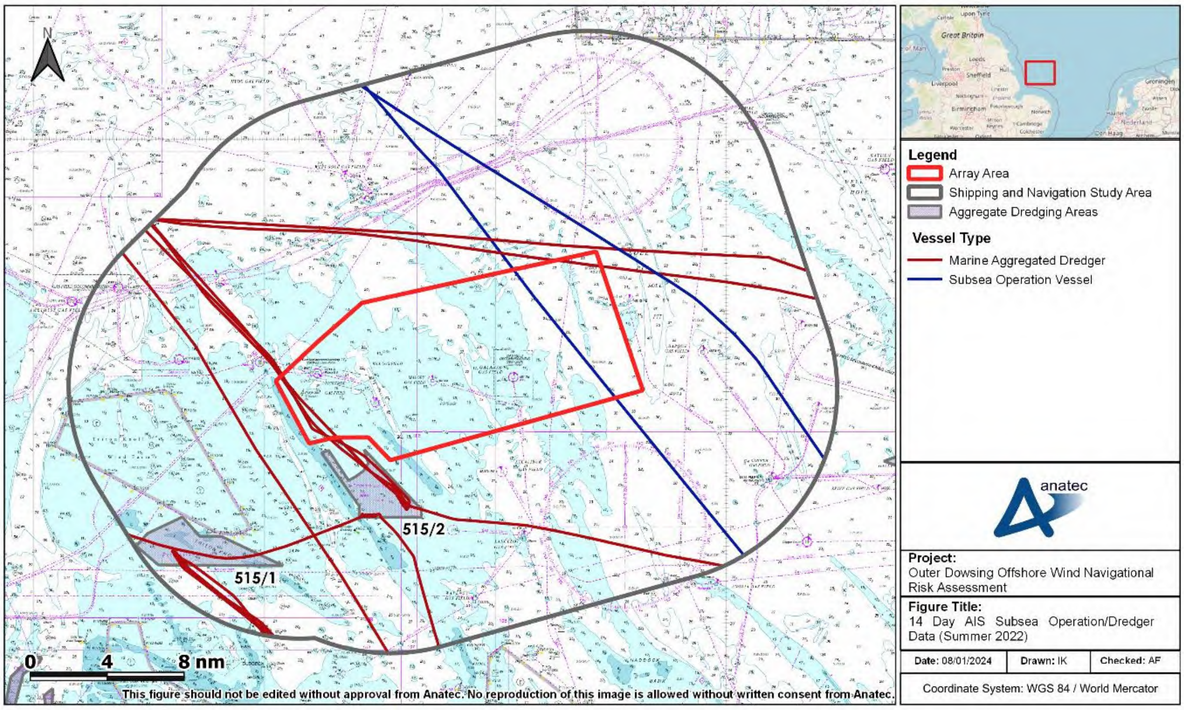

Figure 10.21 Marine Aggregate Dredgers/Subsea Operation Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

267. Figure 10.22 presents a plot of marine aggregate dredger/subsea operation vessels recorded within the shipping and navigation study area during the 14-day winter survey period, along with the relevant TCE aggregate areas.

268. All vessels recorded during the winter survey period were marine aggregate dredgers and an average of one vessel per day was recorded within the shipping and navigation study area.

269. As for summer, aggregate dredging activity was present within both Outer Dowsing TCE areas 515/1 and 515/2, and most vessels were routeing between marine aggregate dredging areas within the shipping and navigation study area or near the Humber.

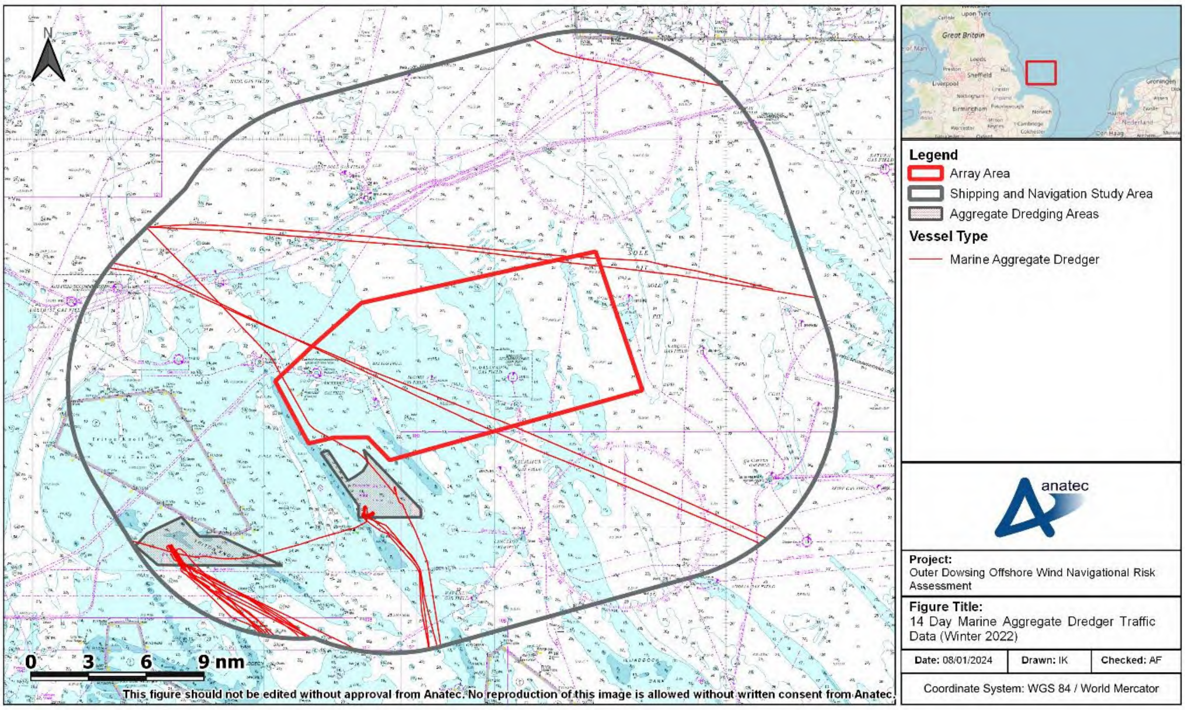

Figure 10.22 Marine Aggregate Dredgers within the Shipping and Navigation Study Area (14-Days, Winter 2022)

10.1.2.7 Fishing Vessels

270. Figure 10.23 presents a plot of fishing vessel activity recorded within the shipping and navigation study area during 14-day summer survey period.

271. Throughout the summer survey period there was an average of two unique fishing vessels per day recorded within the shipping and navigation study area. Fishing vessels were recorded on transit as well as actively engaged in fishing, most notably within the north of the array area and shipping and navigation study area, with the associated vessels being mostly whelkers/potters. Most fishing vessels in transit were routeing to/from fishing grounds and Grimsby (UK).

272. For the summer survey data, approximately 90% of fishing vessel tracks were recorded on AIS with the remaining 10% on Radar.

273. Input received from NFFO in the hazard workshop indicates that the data show broad agreement with the patterns of fishing activity in the area with most fishing activity carried out by potter/whelkers and levels of activity regarding the seasonality of the fishery (see Table 4.1).

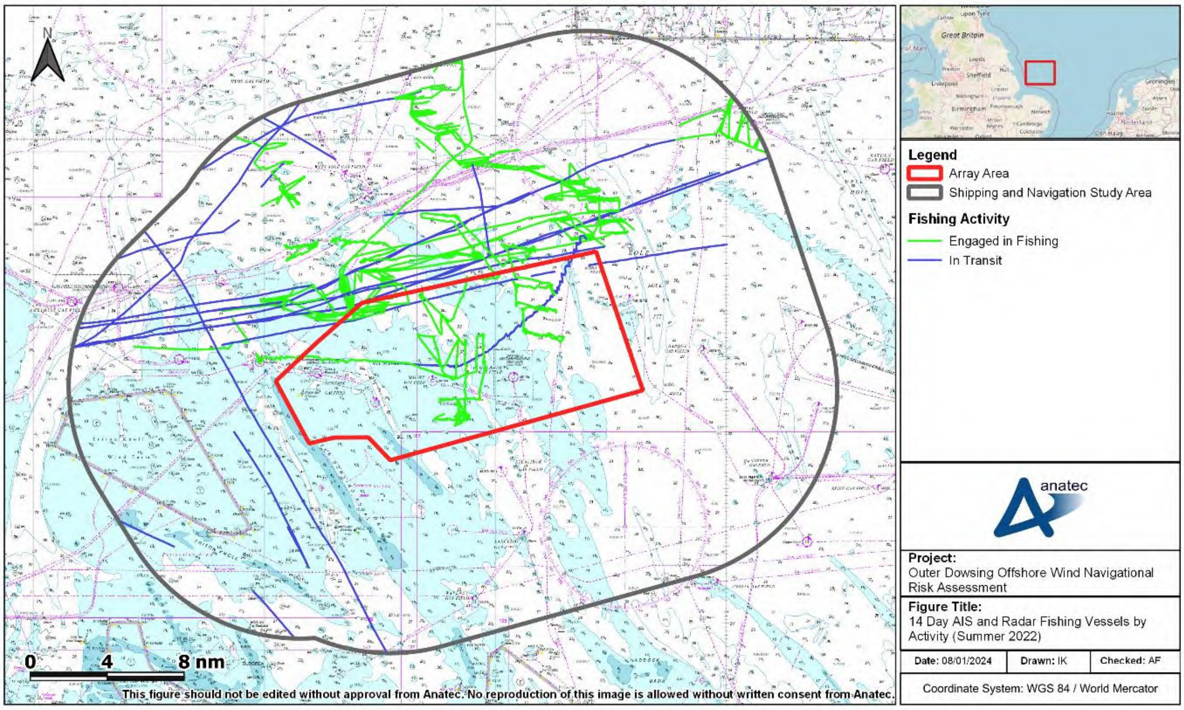

Figure 10.23 Fishing Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

274. Figure 10.24 presents a plot of fishing vessel activity recorded within the shipping and navigation study area during 14-day winter survey period.

275. Throughout the winter survey period there was an average of two unique fishing vessels per day recorded within the shipping and navigation study area. As for summer, fishing vessels were recorded on transit as well as actively engaged in fishing, most notably within the of the array area and north of the shipping and navigation study area, with the associated vessels being mostly whelkers/potters. Vessels transiting through the study area were likely enroute to/from fishing grounds.

276. For the winter survey data, approximately 41% of fishing vessel tracks were recorded on AIS with the remaining 59% on Radar.

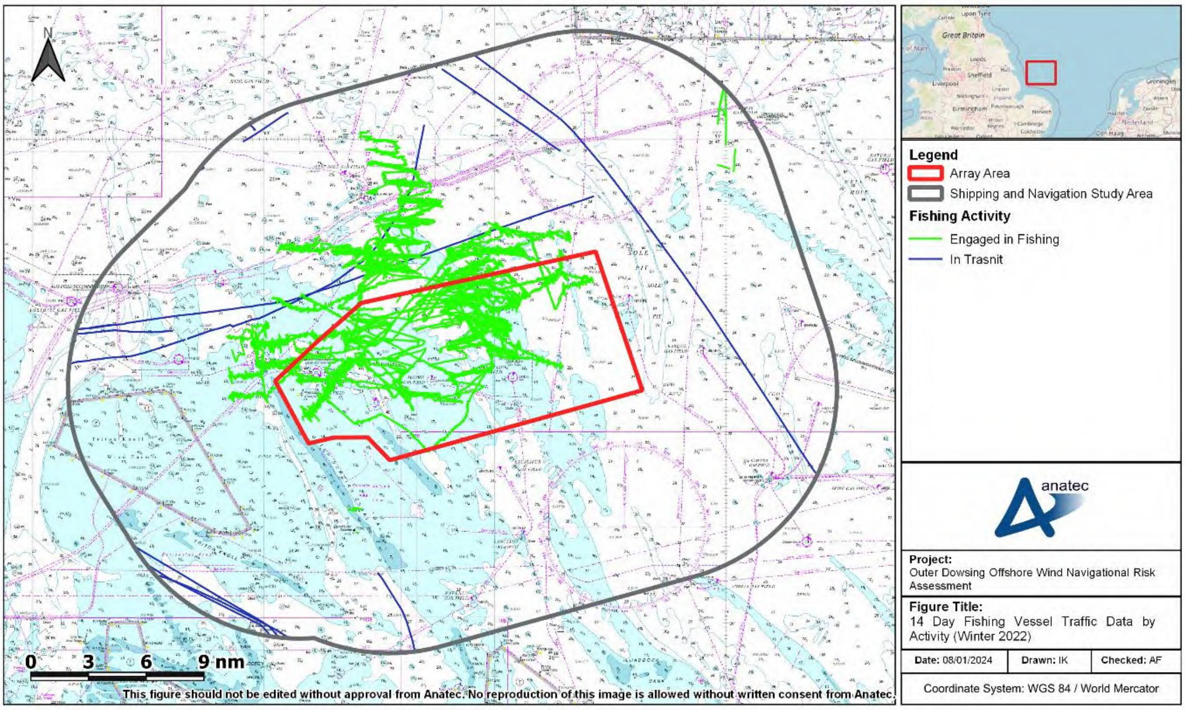

Figure 10.24 Fishing Vessels within the Shipping and Navigation Study Area (14-Days, Winter 2022)

10.1.2.8 Recreational Vessels

277. Figure 10.25 presents a plot of recreational vessel activity recorded within the shipping and navigation study area during the 14-day summer survey period.

278. Throughout the summer survey period, an average of one unique recreational vessel per day was recorded within the shipping and navigation study area. Most recreational vessels were transiting to the west in shallower waters closer to the coast.

279. For the summer survey data, approximately 85% of recreational vessel tracks were recorded on AIS with the other 15% on Radar.

280. It is noted that no recreational vessels were recorded within the shipping and navigation study are during the winter survey period. This is expected given the distance offshore and time of year the survey was conducted.

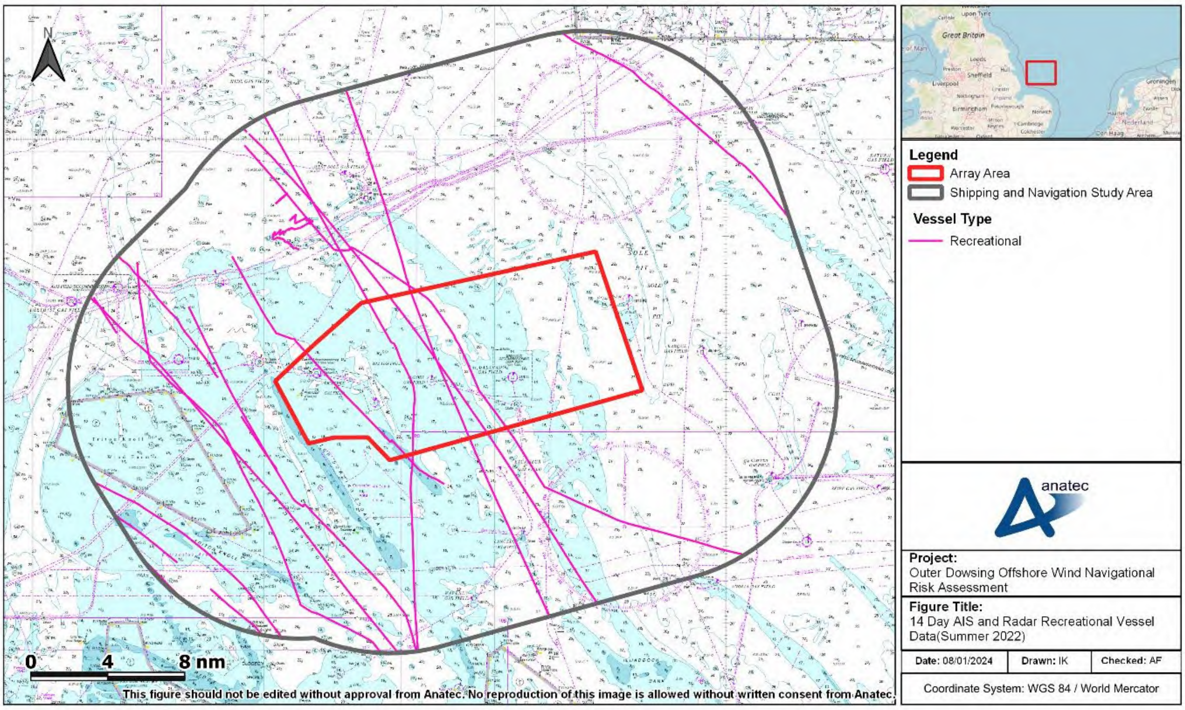

Figure 10.25 Recreational Vessels within the Shipping and Navigation Study Area (14-Days, Summer 2022)

281. The majority of recreational vessels were recorded inshore of the array area. Further information on recreational traffic in proximity to the array area from the RYA Coastal Atlas is provided in section 10.4.

10.1.3 Vessel Size

10.1.3.1 Vessel Length

282. Vessel length information was available for over 99% of all vessels recorded throughout the 14-day summer survey period. Figure 10.26 illustrates the distribution of vessel length recorded throughout the survey period.

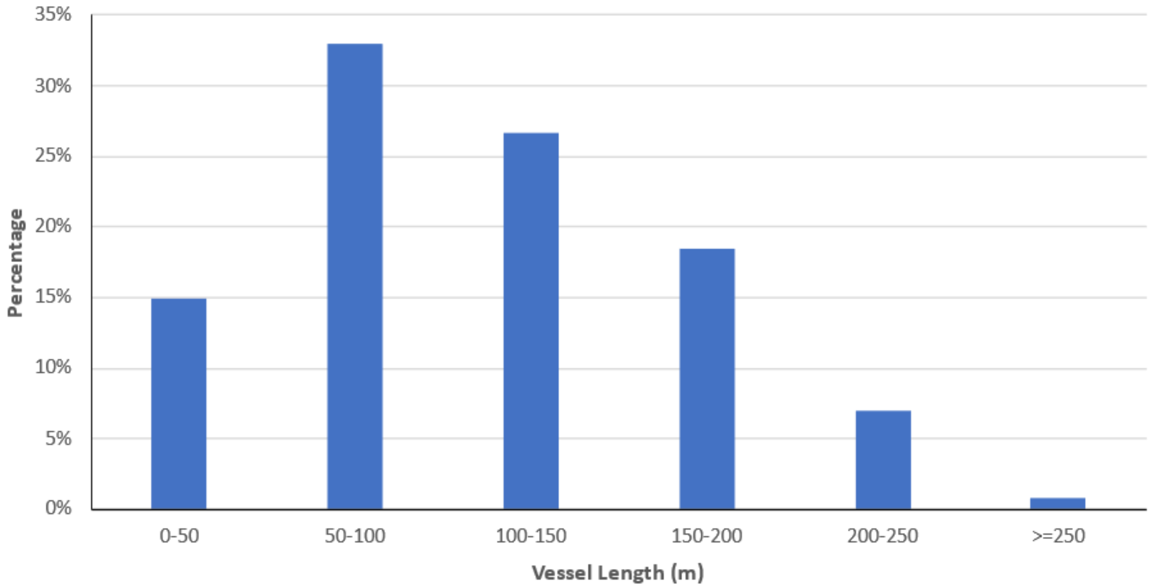

Figure 10.26 Vessel Length Distribution (14-Days, Summer 2022)

283. Excluding the proportion of vessels for which a length was not available the average length of vessels within the shipping and navigation study area throughout the summer survey period was 111m. The largest vessel recorded was a passenger cruise liner at 296m heading to Rotterdam (the Netherlands).

284. The vessel tracks recorded during the summer survey period are colour-coded by vessel length and presented in Figure 10.27.

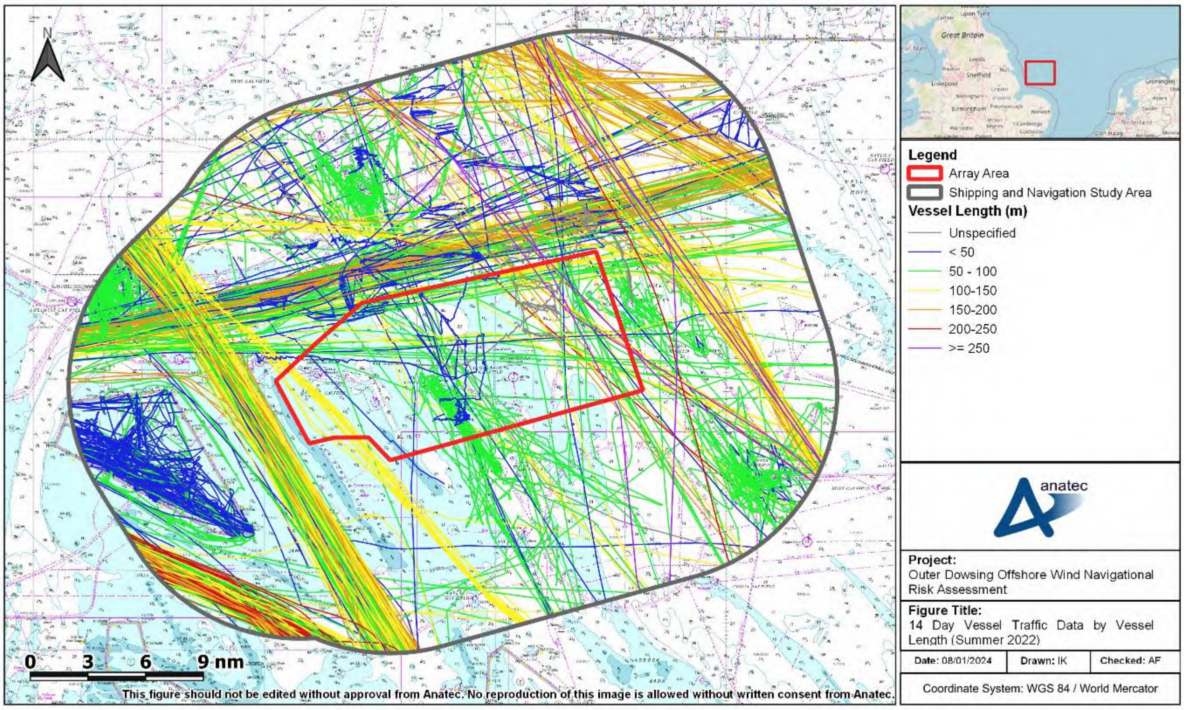

Figure 10.27 14-Day Vessel Traffic Survey Data by Vessel Length (14-Days, Summer 2022)

285. Vessels of greater lengths were primarily commercial vessels. These were seen transiting to the southwest of the shipping and navigation study area passing south of the Triton Knoll OWF and passenger vessels specifically transiting northwest-southeast to the east of the array area. Vessels with smaller recorded lengths were primarily oil and gas , windfarm, fishing, and recreational vessels. Oil and gas vessels were associated with the local platforms and gas fields in proximity to the array area. Windfarm vessels were attending Triton Knoll OWF and transiting between Hornsea Project One and Grimsby (UK).

286. Vessel length information was available for over 99% of vessels recorded throughout the 14-day winter survey period. Figure 10.28 illustrates the distribution of vessel lengths recorded throughout the survey period.

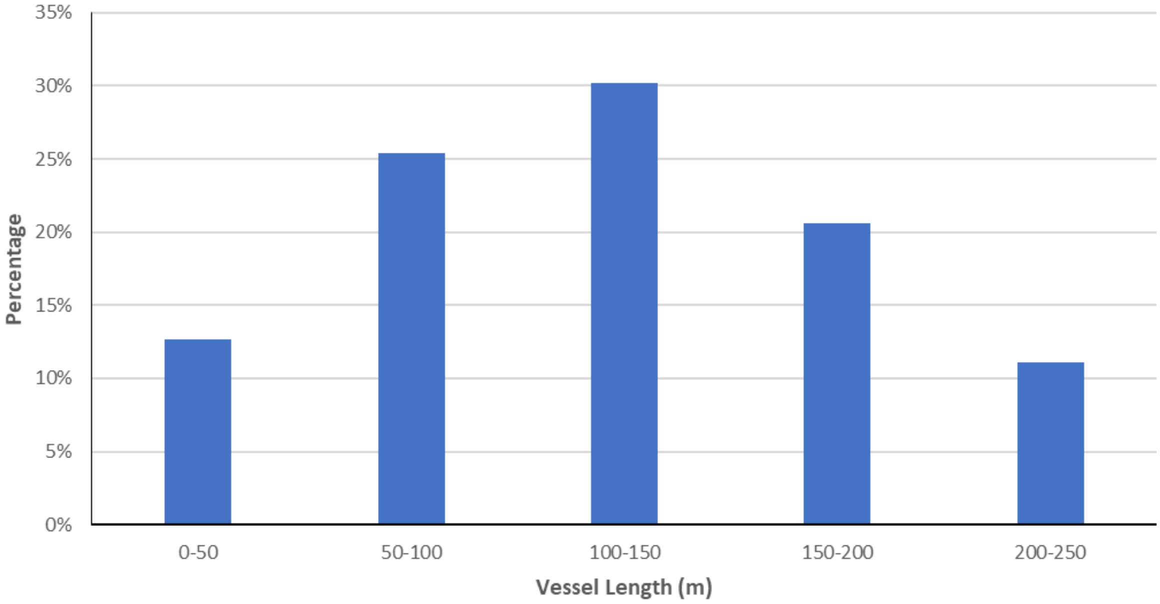

Figure 10.28 Vessel Length Distribution (14-Days, Winter 2022)

287. Excluding the proportion of vessels for which a length was not available, the average length of vessels within the shipping and navigation study area throughout the winter survey period was 122m. The largest vessel recorded was a bulk carrier at 250m heading to Glensanda (UK).

288. The vessel tracks recorded during the winter survey period are colour-coded by vessel length and presented in Figure 10.29.

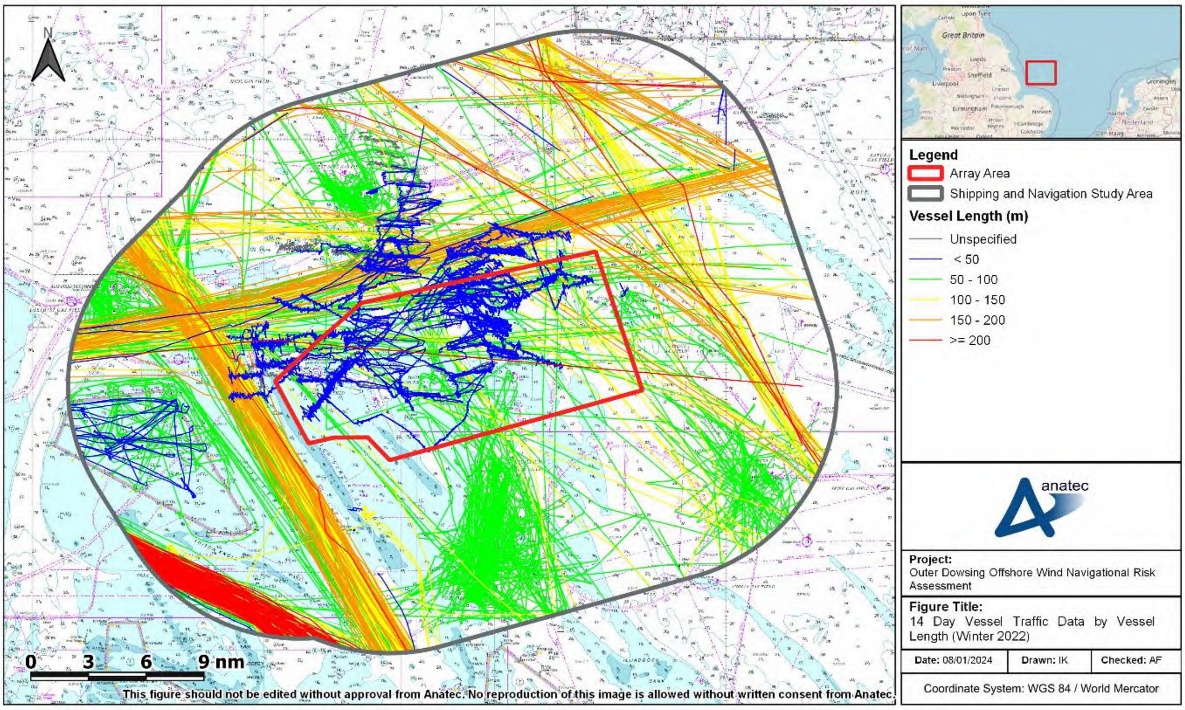

Figure 10.29 14-Day Vessel Traffic Survey Data by Vessel Length (14-Days, Winter 2022)

289. Vessels of greater lengths were primarily cargo and passenger vessels. These were seen transiting heavily to the south-west of the study area passing under Triton Knoll OWF. Vessels with smaller recorded lengths were primarily fishing and windfarm vessels. Those smaller windfarm vessels were concentrated within Triton Koll while the fishing vessels are seen to heavily populate the array area.

10.1.3.2 Vessel Draught

290. Vessel draught information was available for approximately 91% of all vessels recorded during the 14-day summer survey period. Figure 10.30 illustrates the distribution of vessel draught recorded throughout the survey period.

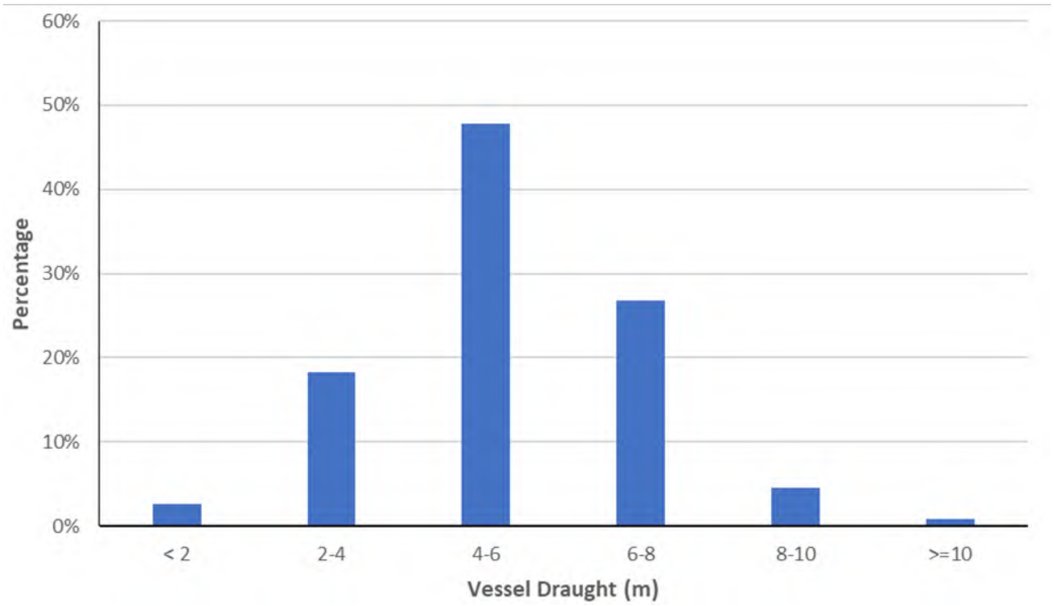

Figure 10.30 Vessel Draught Distribution (14-Days, Summer 2022)

291. Excluding the proportion of vessels for which draught was not available the average draught of vessels within the shipping and navigation study area throughout the summer survey period was 5.2m. The vessel with the largest draught recorded was a bulk carrier at 13.5m heading to the Isle of Grain, UK.

292. The vessel tracks recorded during the summer survey period are colour-coded by vessel draught and presented in Figure 10.31.

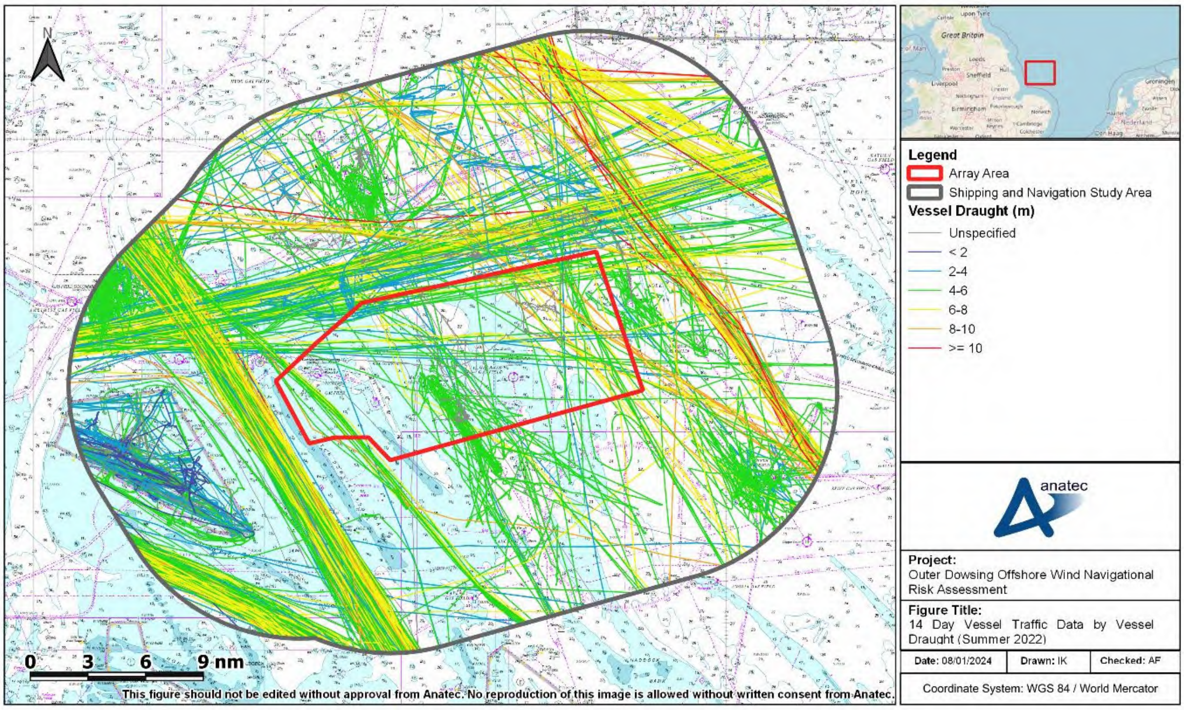

Figure 10.31 14-Day Vessel Traffic Survey Data by Vessel Draught (14-Days, Summer 2022)

293. Vessels with the lowest recorded draughts during the survey period were windfarm vessels. These vessels were attending Triton Knoll OWF and transiting between Hornsea Project One and Grimsby, UK. Vessels with higher draughts were primariliy cargo vessels, tankers, and dredgers.

294. Vessel draught information was available for approximately 94% of all vessels recorded during the 14-day winter survey period. Figure 10.32 illustrates the distribution of vessel length recorded throughout the survey period.

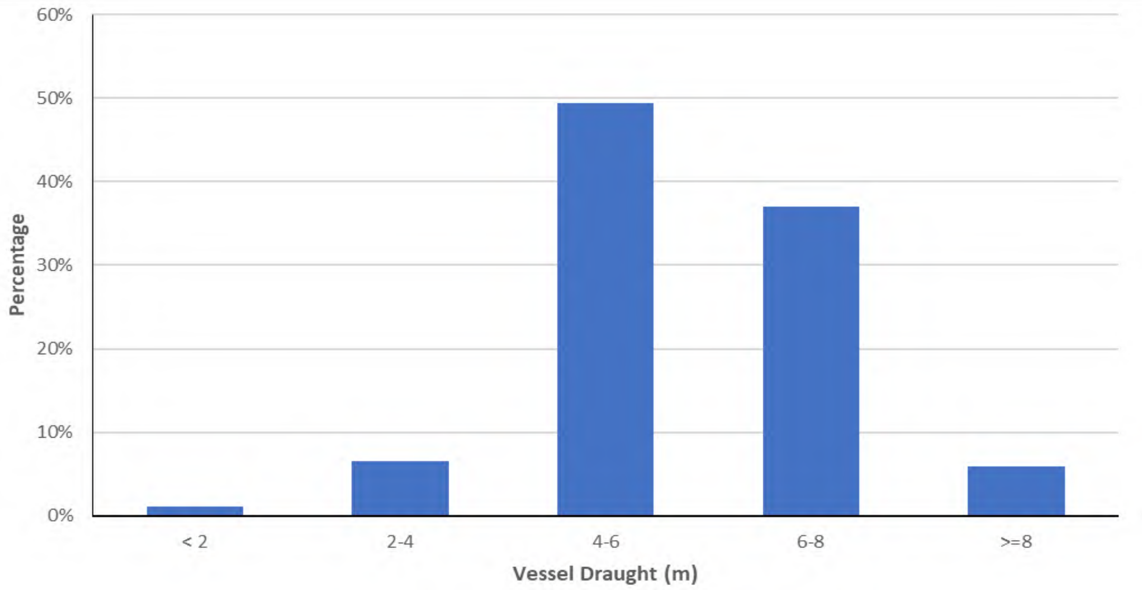

Figure 10.32 Vessel Draught Distribution (14-Days Winter 2022)

295. Excluding the proportion of vessels for which draught was not available, the average draught of vessels within the shipping and navigation study area throughout the winter survey period was 5.7m. The majority of vessels in the had a recorded draught of between 4-6m (49% of all vessels). The vessel with the largest draught recorded was a bulk carrier at 14m heading to Immingham and intersected the north-east corner of the array area.

296. The vessel tracks recorded during the winter survey period are colour-coded by vessel draught and presented in Figure 10.33.

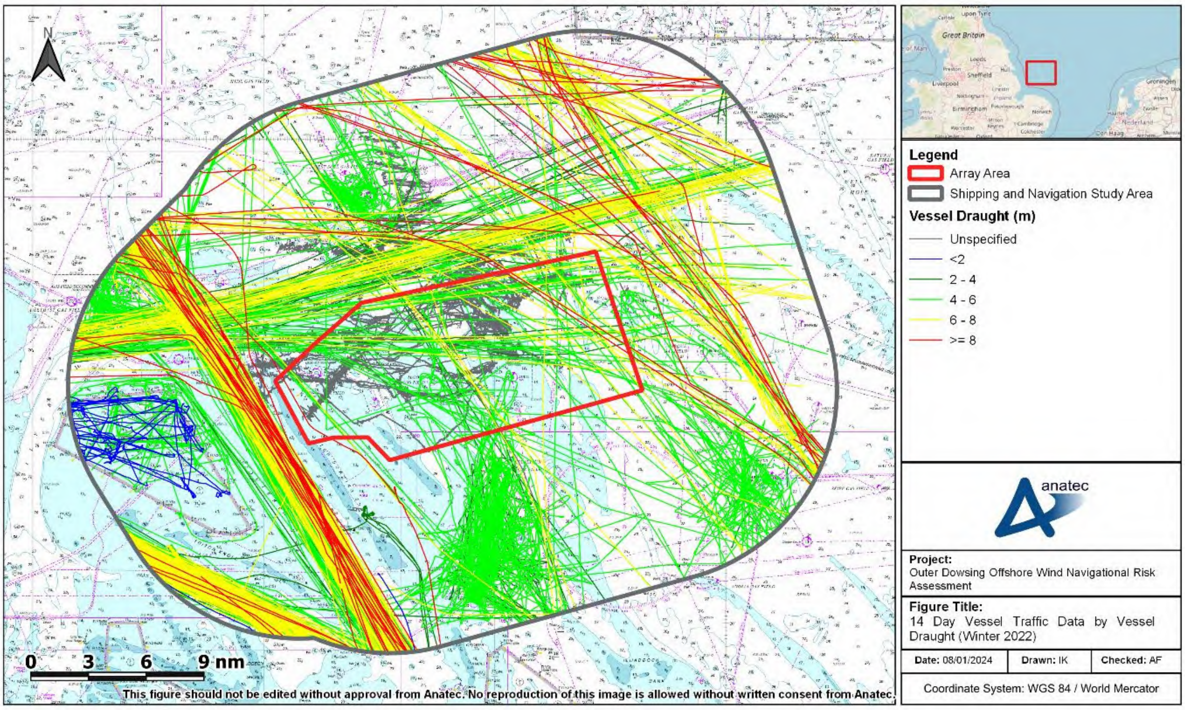

Figure 10.33 14-Day Vessel Traffic Survey Data by Vessel Draught (14-Days Winter 2022)

297. Vessels with the lowest recorded draughts during the winter survey period were windfarm vessels. These vessels were attending Triton Knoll OWF as well as transiting between Hornsea Project One and Grimsby (UK). Oil and gas vessels were also recorded having lower draughts than any other vessel type. Vessels with greater draughts were primarily cargo vessels and tankers and these vessels were transiting mostly to the direct west of the array area between Triton Koll OWF and the Outer Dowsing Shoal as well as some vessels transiting east of the array.

10.2 Offshore Export Cable Corridor

298. This section presents an overview of vessel traffic movements within the ECC study area based on assessment of AIS data alone. The same data periods were used as those for the array area (see section 10.1).

299. Temporary traffic has been removed in line with the approach taken for the assessment of the array area (see section 10.1).

300. A plot of the vessel tracks recorded during the 14-day summer data period within the ECC study area is colour-coded by type and presented in Figure 10.34. Following this, Figure 10.35 presents the same data converted to a density heat map.

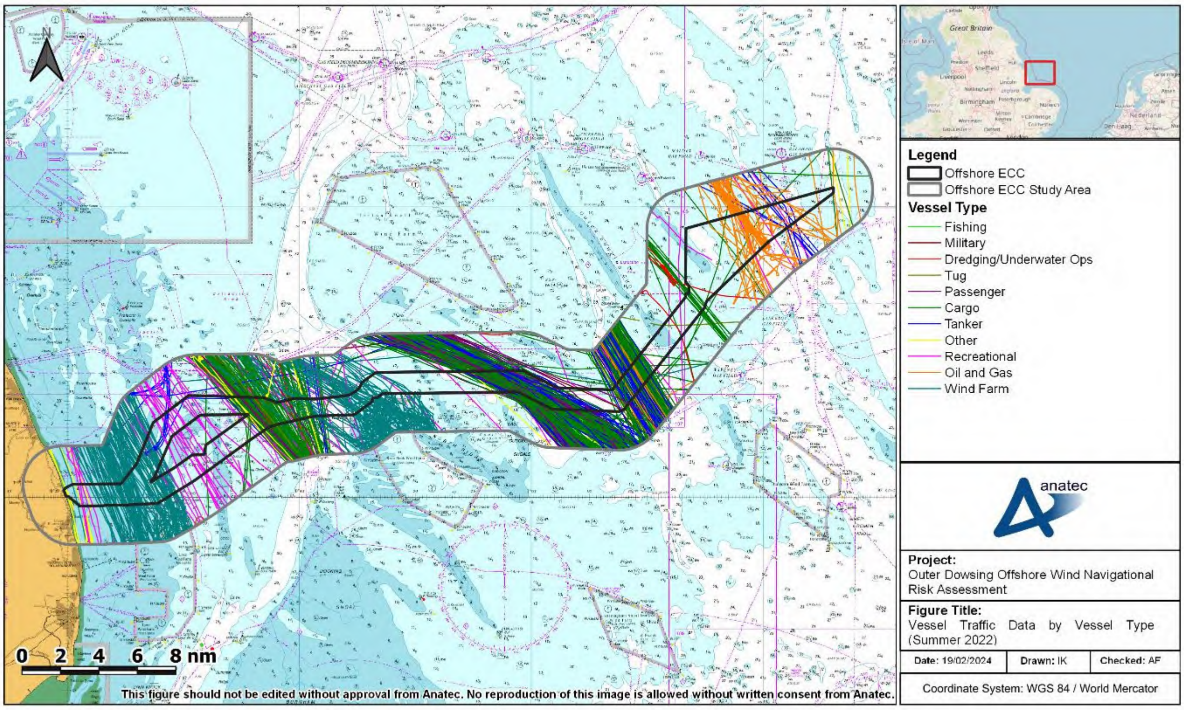

Figure 10.34 14-Day Offshore ECC Vessel Traffic Data by Vessel Type (Summer 2022)

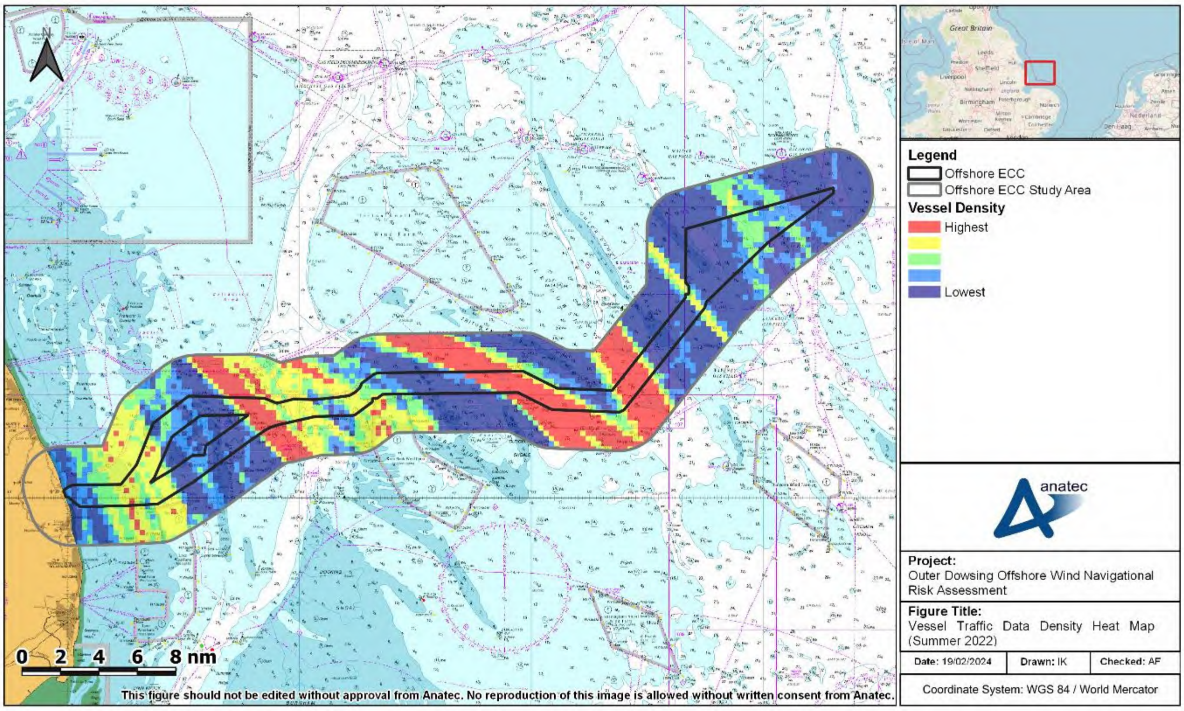

Figure 10.35 14-Day Offshore ECC Vessel Traffic Data Density Heat Map (Summer 2022)

301. A plot of the vessel tracks recorded during the 14-day winter data period within the ECC study area is colour-coded by type and presented in Figure 10.36. Following this, Figure 10.37 presents the same data converted to a density heat map.

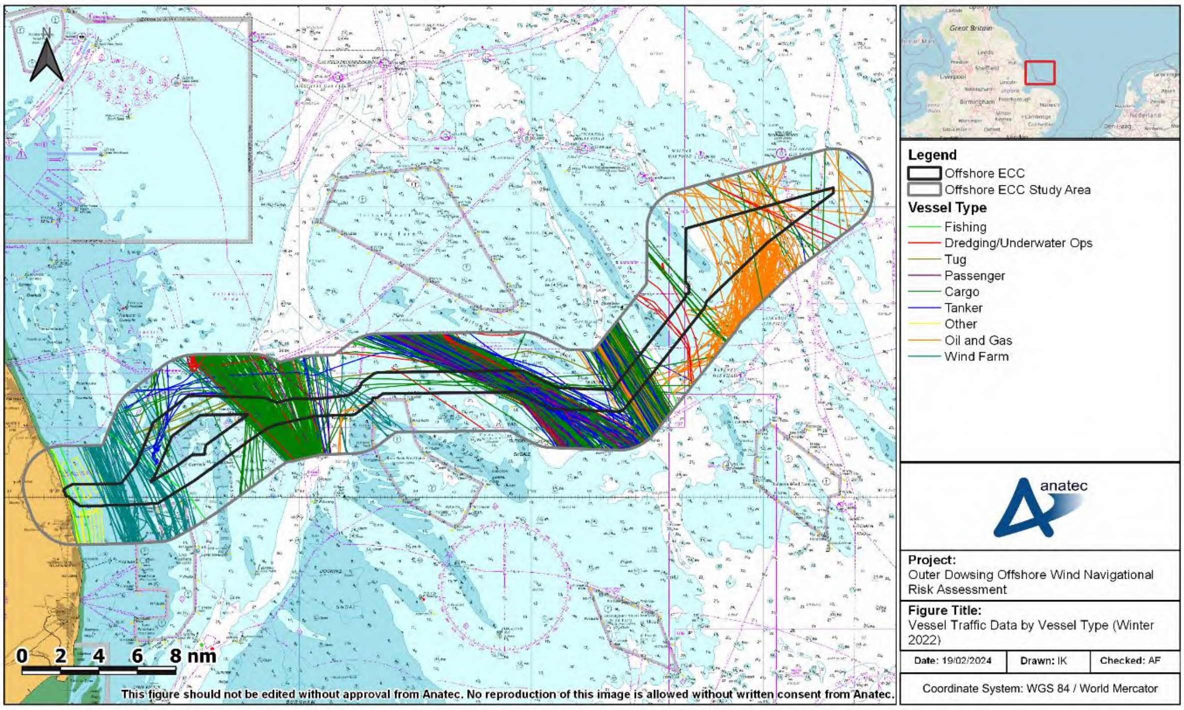

Figure 10.36 14-Day Offshore ECC Vessel Traffic Data by Vessel Type (Winter 2022)

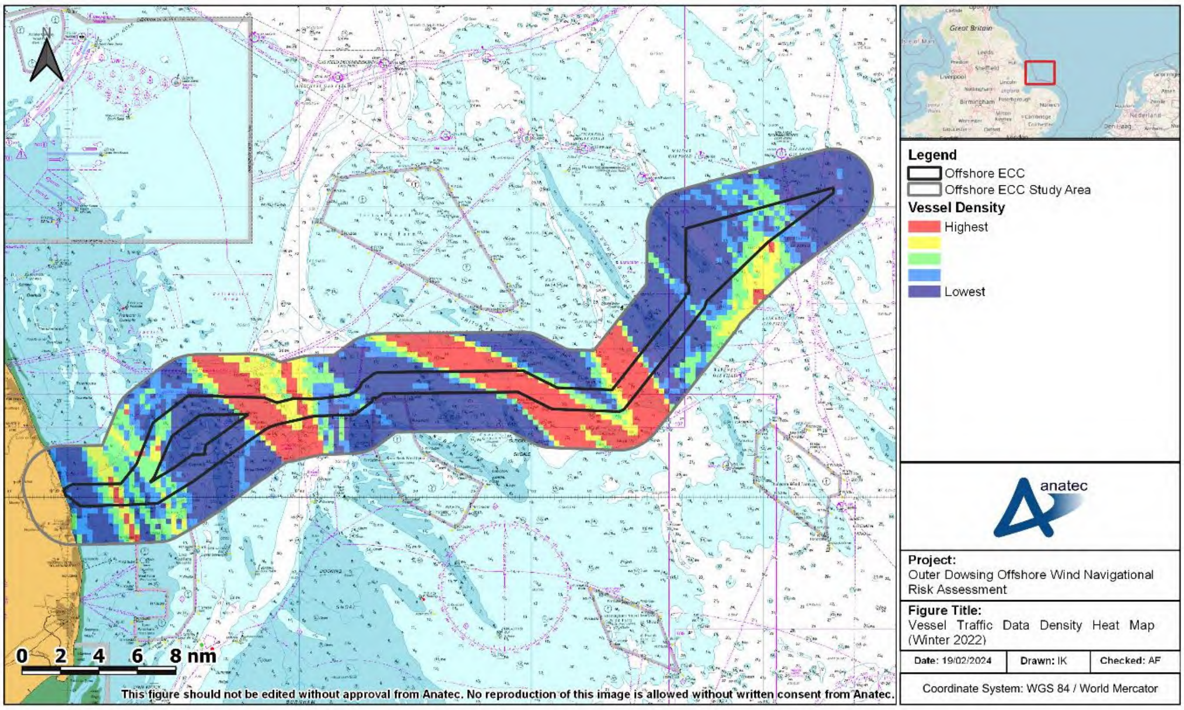

Figure 10.37 14-Day Offshore ECC Vessel Traffic Data Density Heat Map (Winter 2022)

10.2.1 Vessel Counts

302. The daily number of unique vessels recorded within the ECC study area, as well as intersecting the offshore ECC, during the summer survey period is presented in Figure 10.38. Throughout the summer survey period, approximately 95% of vessel traffic recorded within the ECC study area intersected the offshore ECC.

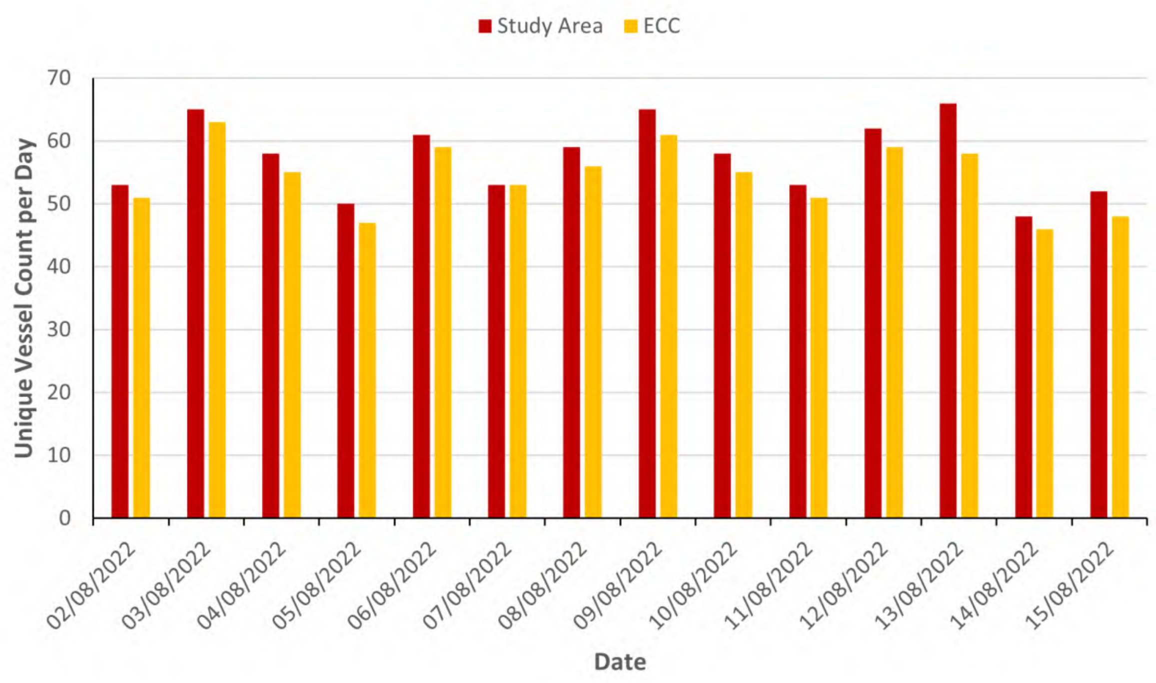

Figure 10.38 Daily Unique Vessel Counts within the ECC Study Area and Offshore ECC (Summer 2022)

303. For the 14-days analysed in the summer survey period, there was an average of 58 unique vessels recorded per day within the ECC study area. An average of 55 unique vessels per day intersected the offshore ECC.

304. The busiest day recorded within the ECC study area during the summer survey period was 13 August, on which 66 unique vessels were recorded. The busiest day recorded within the offshore ECC during the summer survey period was 3 August, on which 63 unique vessels were recorded.

305. The quietest day recorded within the ECC study area during the summer survey period was 14 August, on which 48 unique vessels were recorded. The quietest day recorded within the offshore ECC during the summer survey period was also 14 August, on which 46 unique vessels were recorded.

306. The daily number of unique vessels recorded within the ECC study area, as well as intersecting the offshore ECC, during the winter survey period is presented in Figure 10.39. Throughout the winter survey period, approximately 95% of vessel traffic recorded within the ECC study area intersected the offshore ECC.

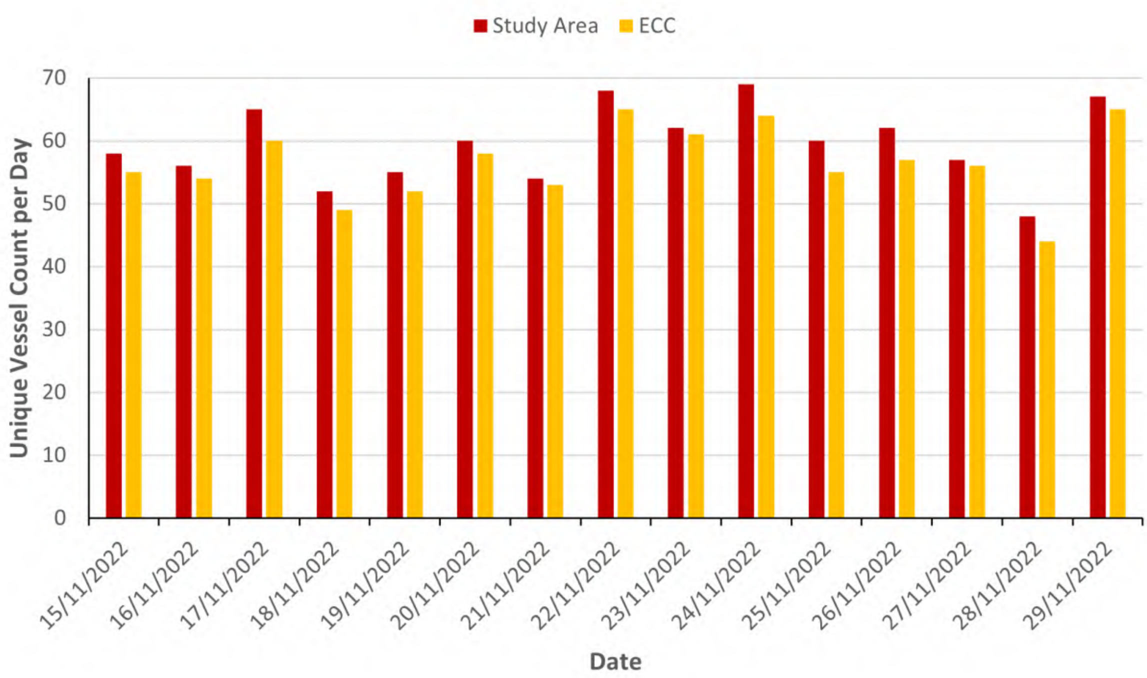

Figure 10.39 Daily Unique Vessel Counts within the ECC Study Area and Offshore ECC (Winter 2022)

307. For the 14-days analysed in the winter survey period, there was an average of 60 unique vessels recorded per day within the ECC study area. An average of 57 unique vessels per day intersected the offshore ECC.

308. The busiest day recorded within the ECC study area during the winter survey period was 24 November, on which 69 unique vessels were recorded. The busiest day recorded within the offshore ECC during the winter survey period was 29 November, on which 65 unique vessels were recorded.

309. The quietest day recorded within the ECC study area during the winter survey period was 28 November, on which 48 unique vessels were recorded. The quietest day recorded within the offshore ECC during the winter survey period was also 14 August, on which 44 unique vessels were recorded.

10.2.2 Vessel Type

310. The percentage distribution of the main vessel types recorded passing within the ECC study area, as well as intersecting the offshore ECC, during the summer data period is presented in Figure 10.40.

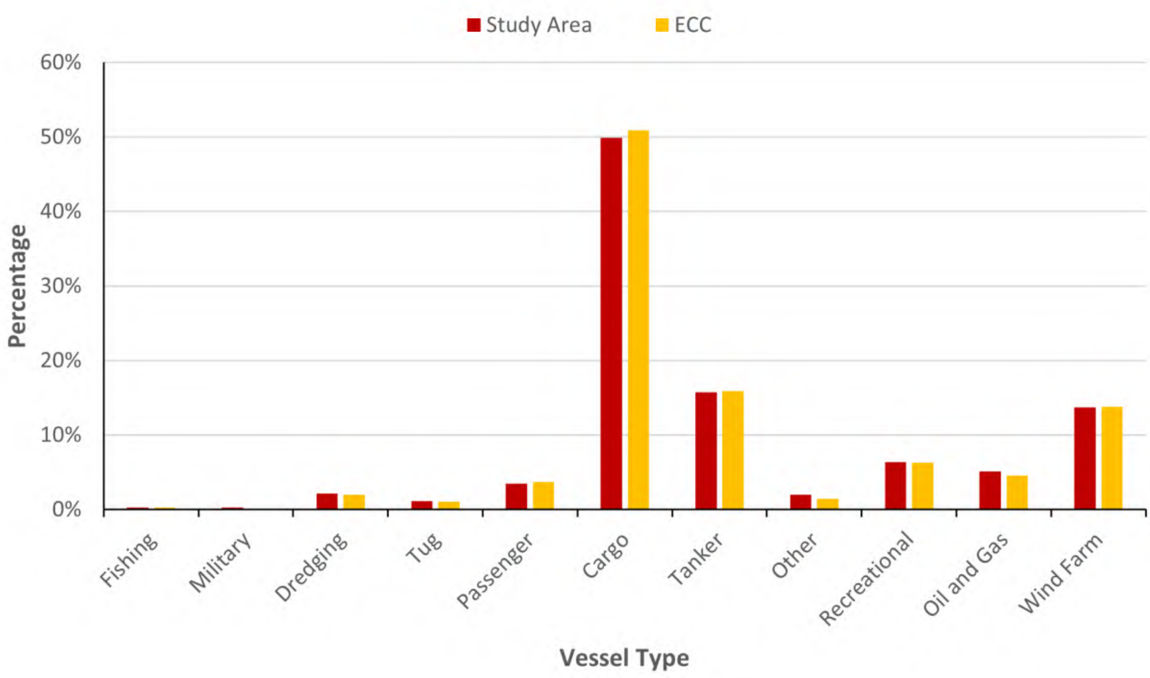

Figure 10.40 Vessel Type Distribution Offshore ECC (Summer 2022)

311. Throughout the summer data period, the main vessel types within the ECC study area were cargo vessels (50%), tankers (16%), and windfarm vessels (14%).

312. The percentage distribution of the main vessel types recorded passing within the ECC study area, as well as intersecting the offshore ECC, during the winter data period is presented in Figure 10.41.

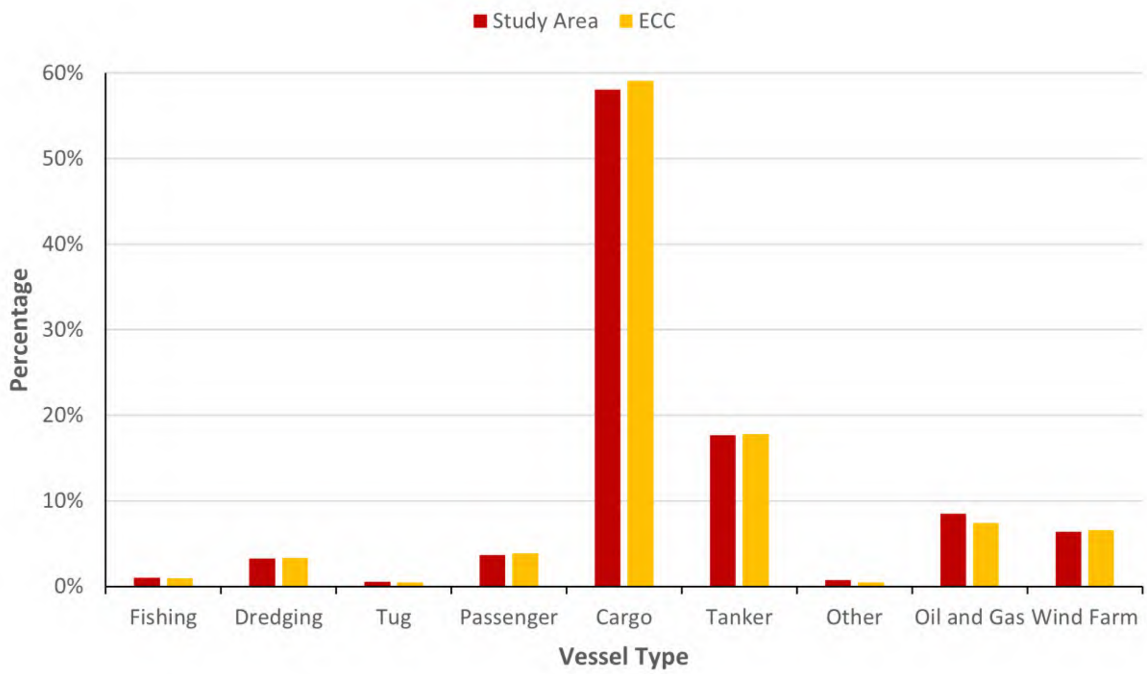

Figure 10.41 Vessel Type Distribution Offshore ECC (Winter 2022)

313. Throughout the winter data period, the main vessel types within the ECC study area were cargo vessels (58%), tankers (18%), and oil and gas vessels (9%).

314. Further information on recreational traffic in proximity to the offshore ECC from the RYA Coastal Atlas is provided in section 10.4.

10.2.3 Vessel Size

10.2.3.1 Vessel Length

315. Vessel length information was available for over 99% of all vessels recorded throughout the summer survey period and ranged from 5m to 238m. Figure 10.42 illustrates the distribution of vessel length recorded throughout the data period.

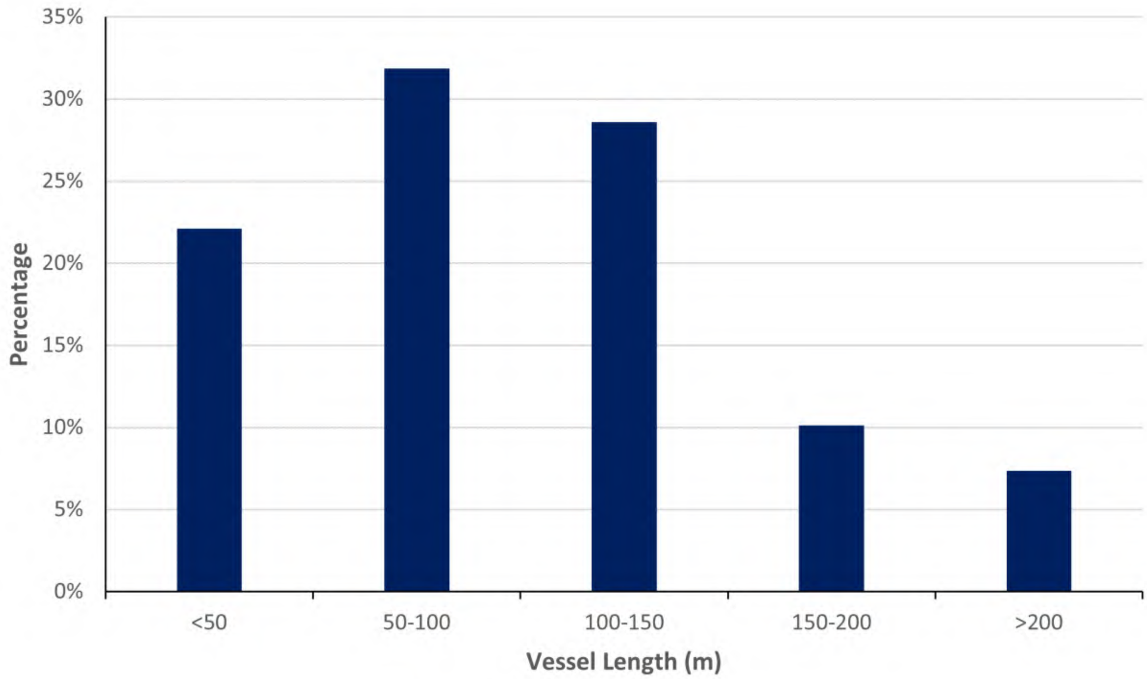

Figure 10.42 Vessel Length Distribution Offshore ECC (14-Days Summer 2022)

316. Excluding the proportion of vessels for which a length was not available the average length of vessels within the ECC study area throughout the summer data period was 98.6m.

317. The vessel tracks recorded during the summer survey period, colour-coded by vessel length, are presented in Figure 10.27.

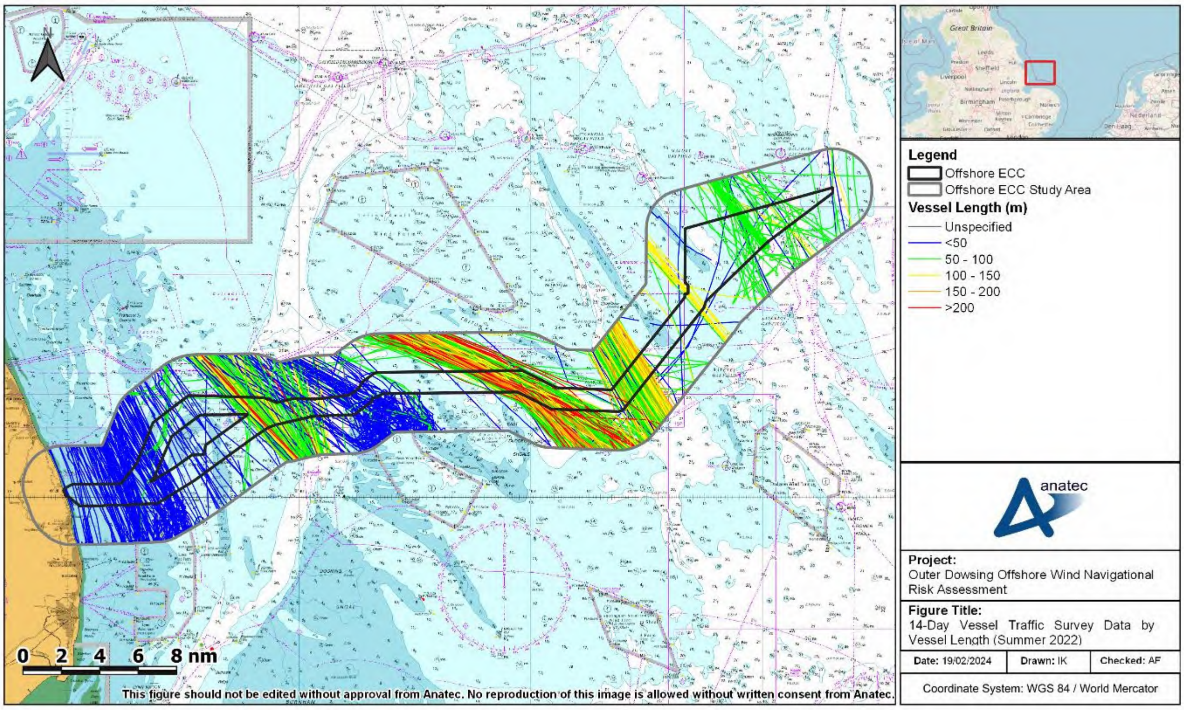

Figure 10.43 14-Day Offshore ECC Vessel Traffic Survey Data by Vessel Length (Summer 2022)

318. The vessels which are shorter in length (less than 50m) were observed transiting nearer to the coast, as well as operating in the north of the Race Bank OWF. Vessels over 200m were recorded travelling in a northwest/southeast direction south of Triton Knoll OWF.

319. Vessel length information was available for over 99% of all vessels recorded throughout the winter survey period and again ranged from 5m to 238m. Figure 10.44 illustrates the distribution of vessel length recorded throughout the winter survey period.

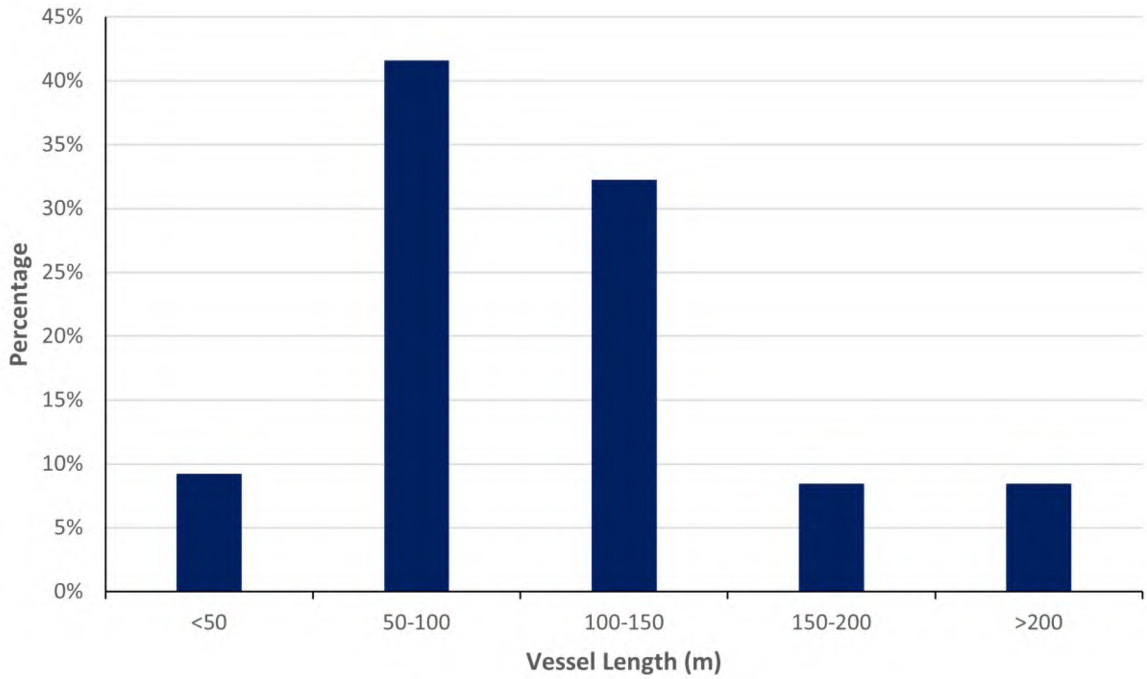

Figure 10.44 Vessel Length Distribution Offshore ECC (14-Days Winter 2022)

320. Excluding the proportion of vessels for which a length was not available the average length of vessels within the ECC study area throughout the winter data period was 109.2m.

321. The vessel tracks recorded during the winter survey period, colour-coded by vessel length, are presented in Figure 10.45.

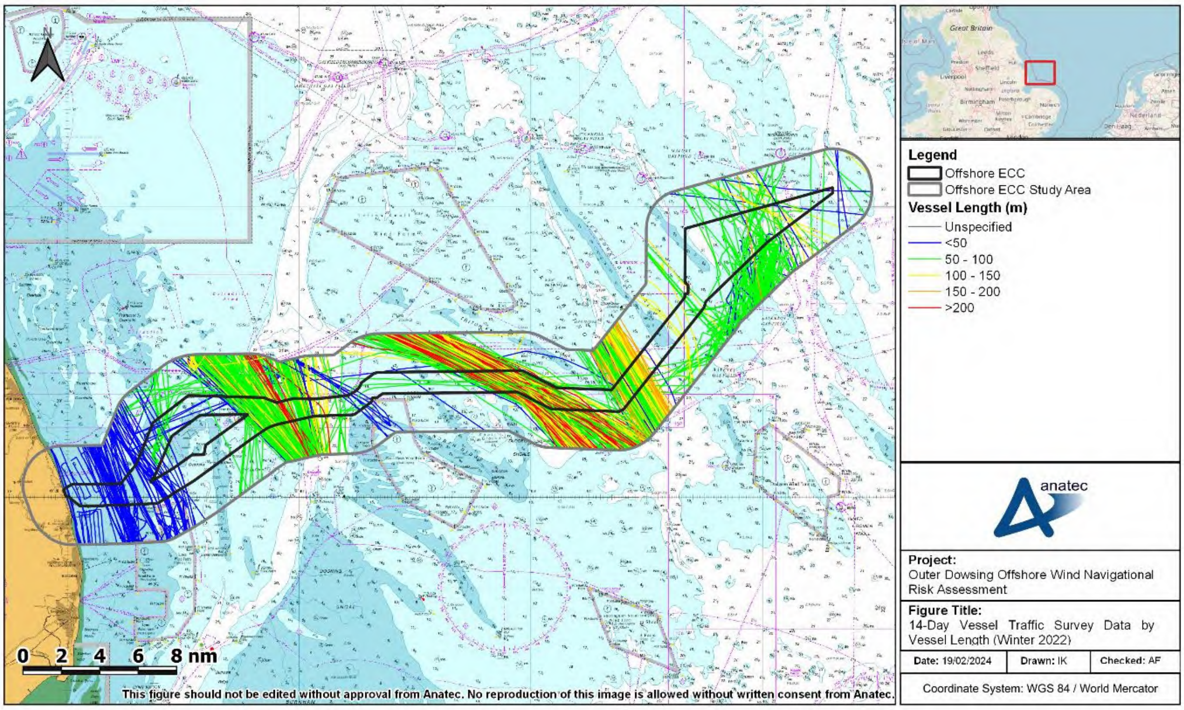

Figure 10.45 14-Day Offshore ECC Vessel Traffic Survey Data by Vessel Length (Winter 2022)

322. As with the summer survey period, vessels which are shorter in length (less than 50m) were observed transiting nearer to the coast, with vessels over 200m recorded travelling in a northwest/southeast direction south of Triton Knoll OWF.

10.2.3.2 Vessel Draught

323. Vessel draught information was available for approximately 89% of all vessels recorded throughout the summer survey period and ranged from 1.0m to 10.4m. Figure 10.46 illustrates the distribution of vessel draught recorded throughout the data period.

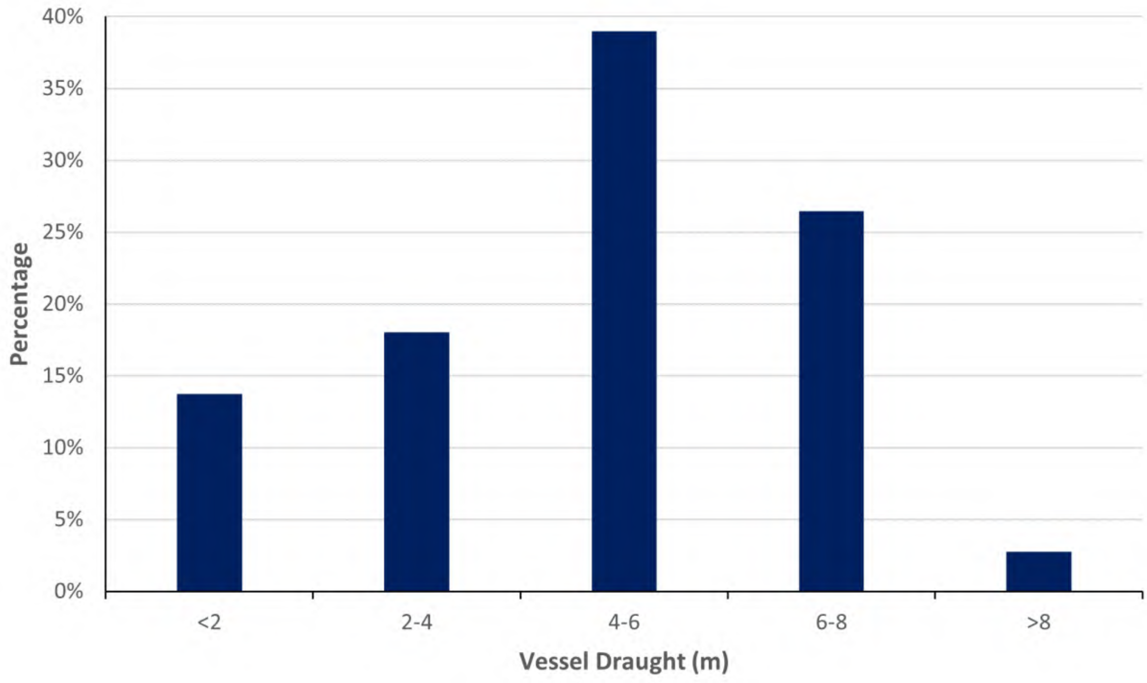

Figure 10.46 Vessel Draught Distribution Offshore ECC (14-Days, Summer 2022)

324. Excluding the proportion of vessels for which draught was not available the average draught of vessels within the ECC study area throughout the summer data period was 4.7m.

325. The vessel tracks recorded during the data period, colour-coded by vessel length are presented in Figure 10.47.

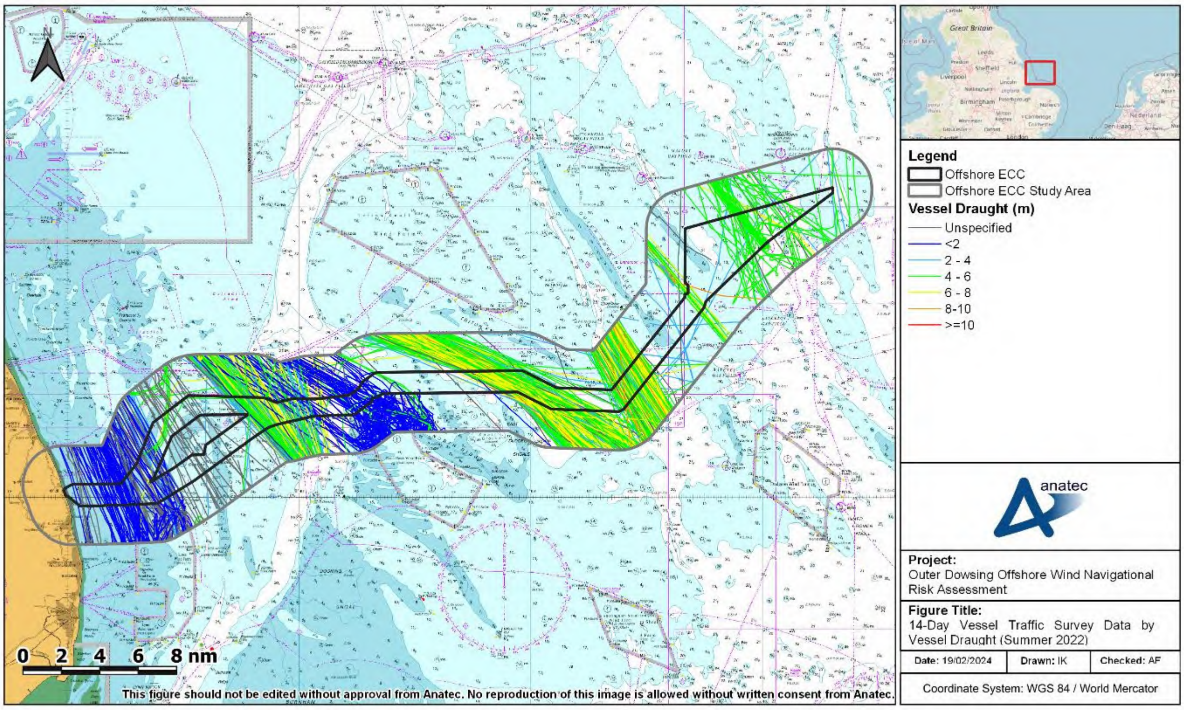

Figure 10.47 14-Day Offshore ECC Vessel Traffic Survey Data by Vessel Draught (Summer 2022)

326. The vessels with shallowest draughts (less than 2m) were generally observed to remain coastal, as well as operating in the north of the Race Bank.

327. Vessel draught information was available for approximately 96% of all vessels recorded throughout the winter survey period and ranged from 1.2m to 12.6m. Figure 10.48 illustrates the distribution of vessel draught recorded throughout the data period.

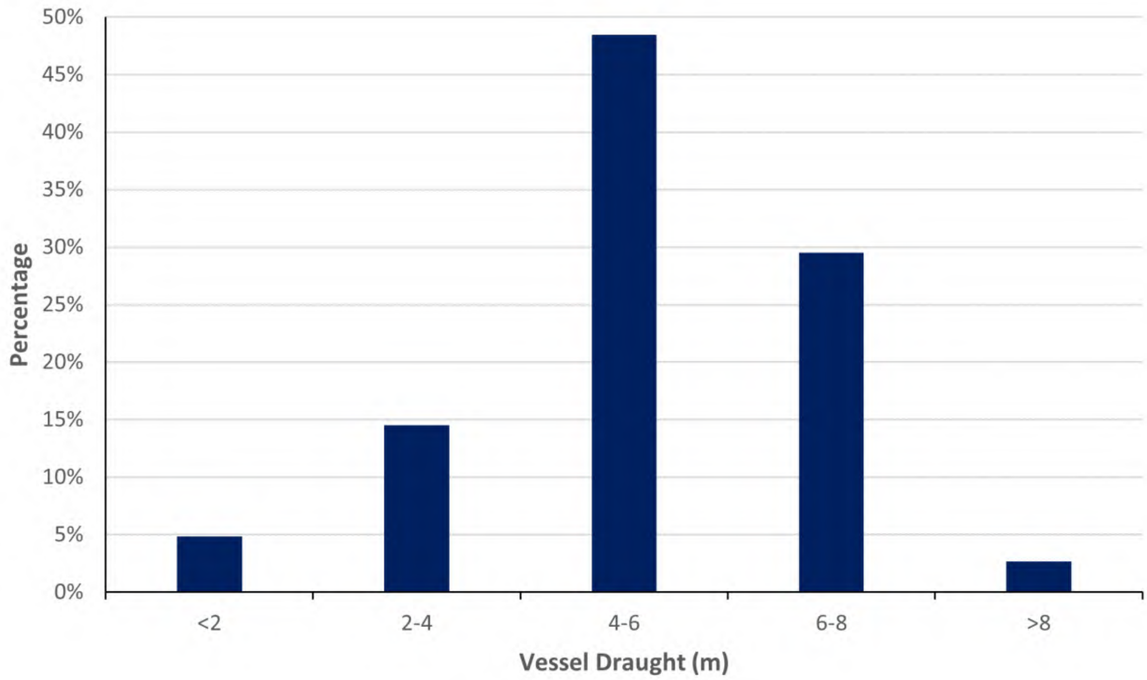

Figure 10.48Vessel Draught Distribution Offshore ECC (14-Days, Winter 2022)

328. Excluding the proportion of vessels for which draught was not available the average draught of vessels within the ECC study area throughout the winter survey period was 5.1m.

329. The vessel tracks recorded during the data period, colour-coded by vessel length are presented in Figure 10.49.

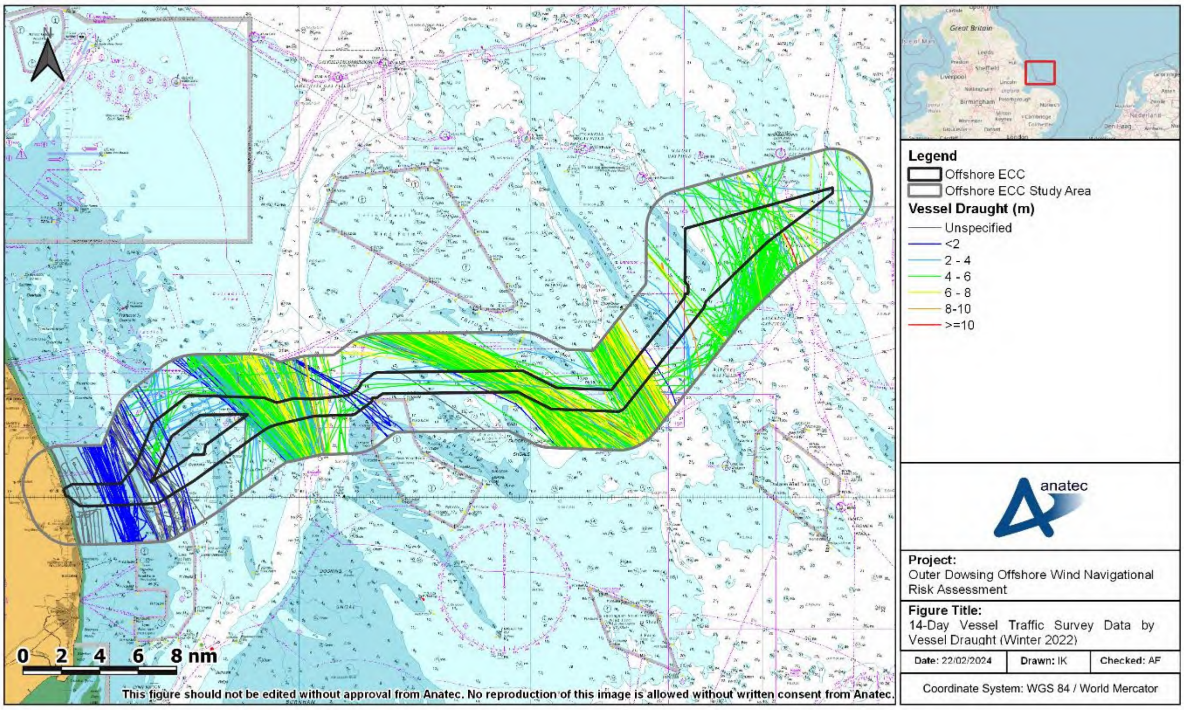

Figure 10.49 14-Day Offshore ECC Vessel Traffic Survey Data by Vessel Draught (Winter 2022)

330. As with the summer survey data, vessels with shallowest draughts (less than 2m) were generally observed to remain coastal.

10.3 Offshore Reactive Compensation Platform

331. A plot of the vessel tracks recorded during a 14-day ORCP area winter survey period, colour-coded by vessel type and excluding any temporary traffic, is presented in Figure 10.50. Following this, Figure 10.51 presents the same data converted to a density heat map.

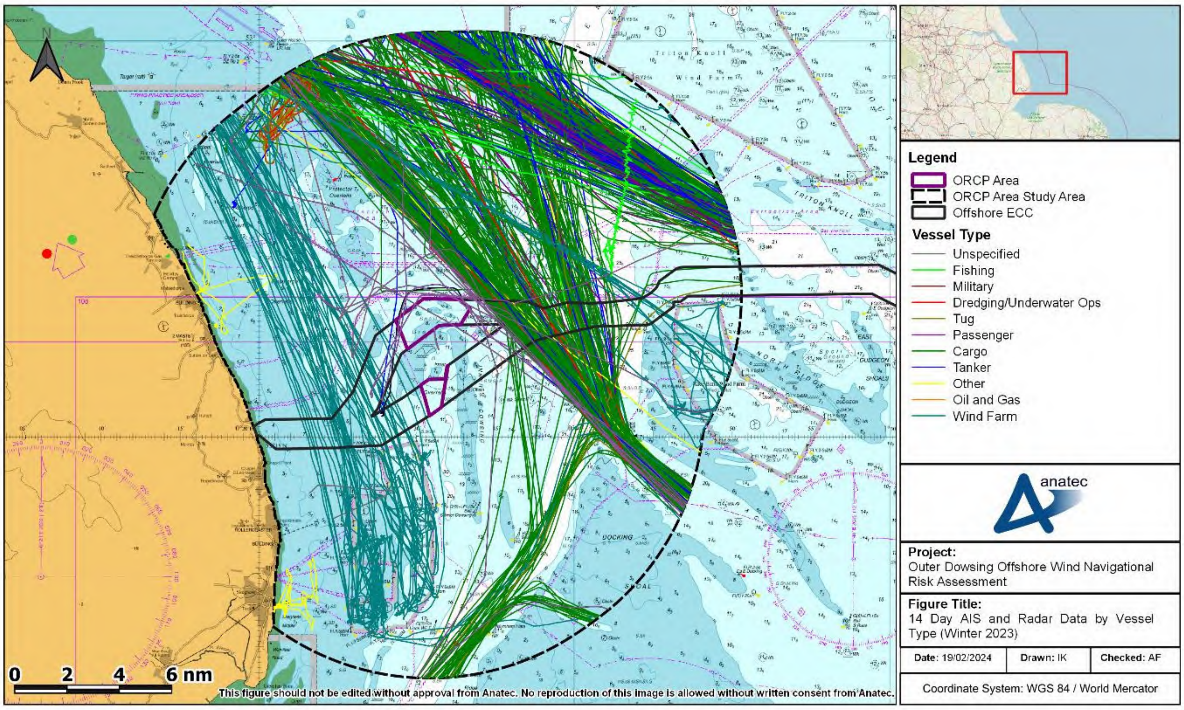

Figure 10.50 Vessel Traffic Survey Data by Vessel Type (14-Days, Winter 2023)

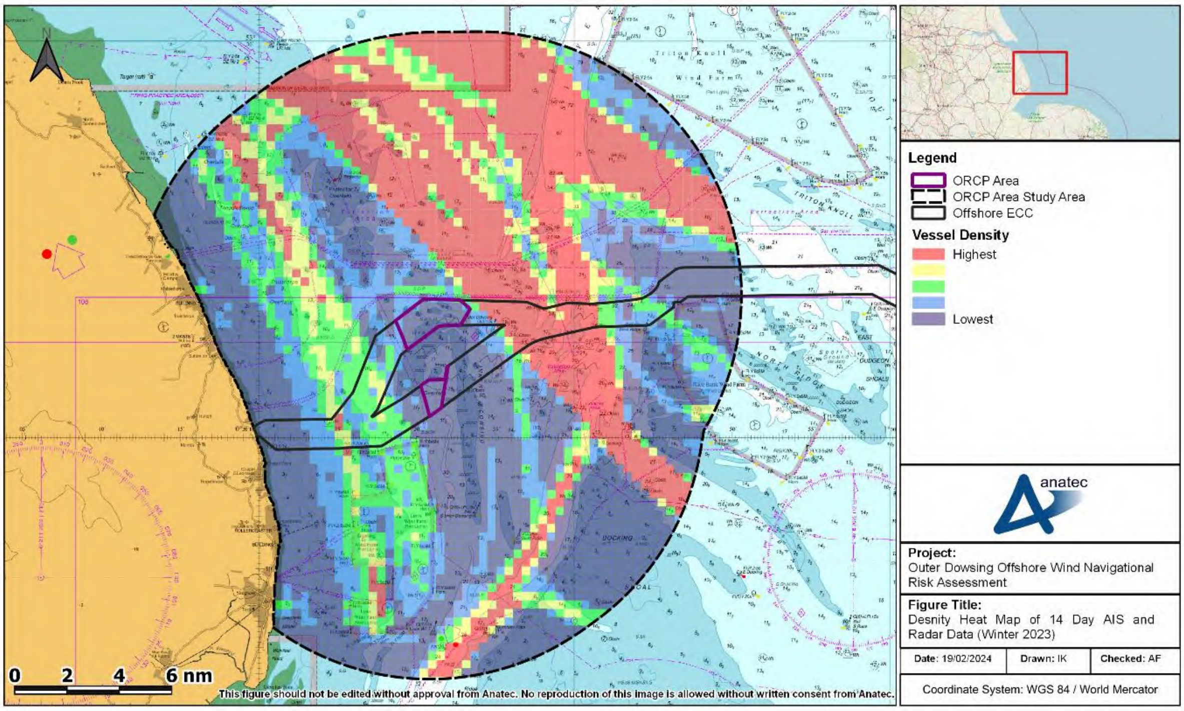

Figure 10.51 Vessel Traffic Density Heat Map (14-Days, Winter 2023)

332. A plot of the vessel tracks recorded during a 14-day ORCP area summer survey period, colour-coded by vessel type and excluding any temporary traffic, is presented

in Figure 10.52. Following this, Figure 10.53 presents the same data converted to a density heat map.

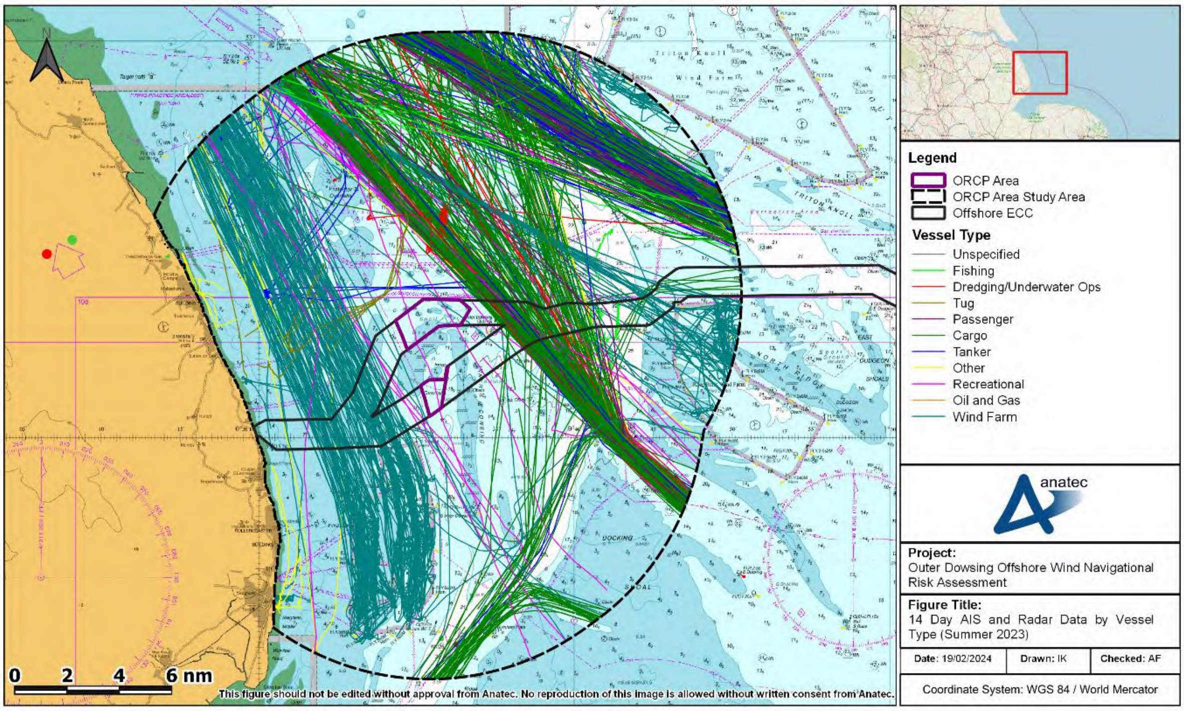

Figure 10.52 Vessel Traffic Survey Data by Vessel Type (14-Days, Summer 2023)

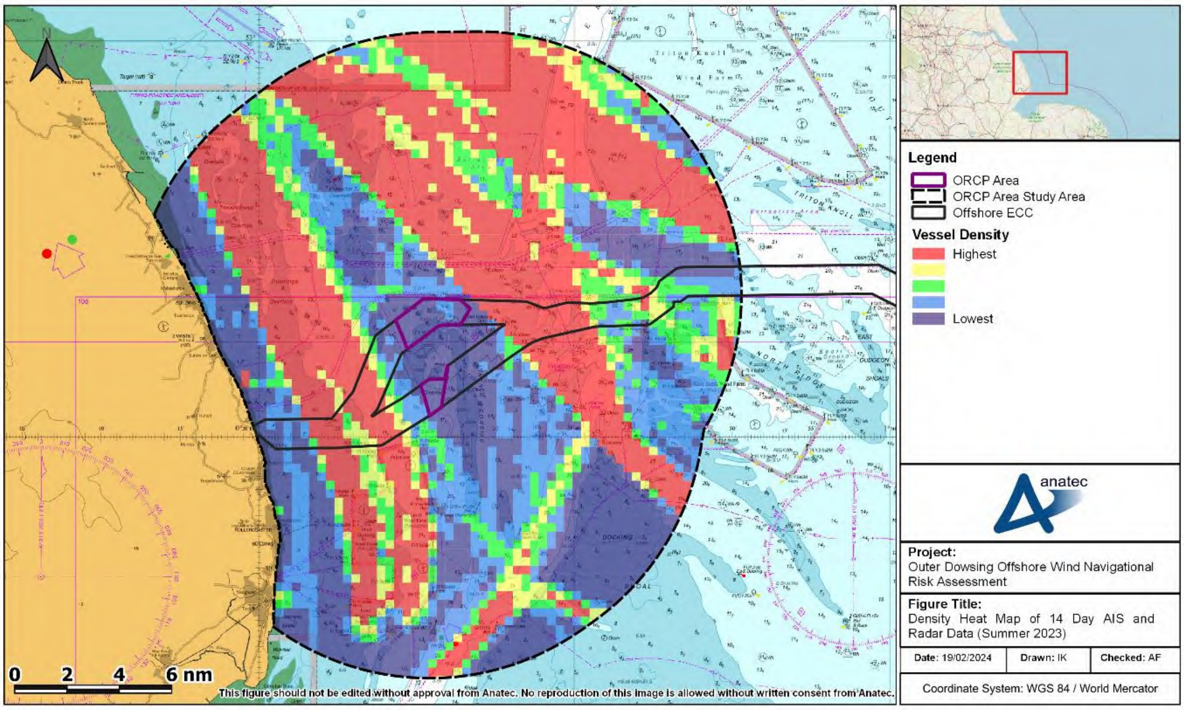

Figure 10.53 Vessel Traffic Density Heat Map (14-Days, Summer 2023)

10.3.1 Vessel Counts

333. The daily number of unique vessels recorded within the ORCP area study area, as well as intersecting the ORCP area, during the winter survey period is presented in Figure 10.54. Throughout the winter survey period, approximately 2% of vessel traffic recorded within the ORCP h area study area intersected the ORCP area.

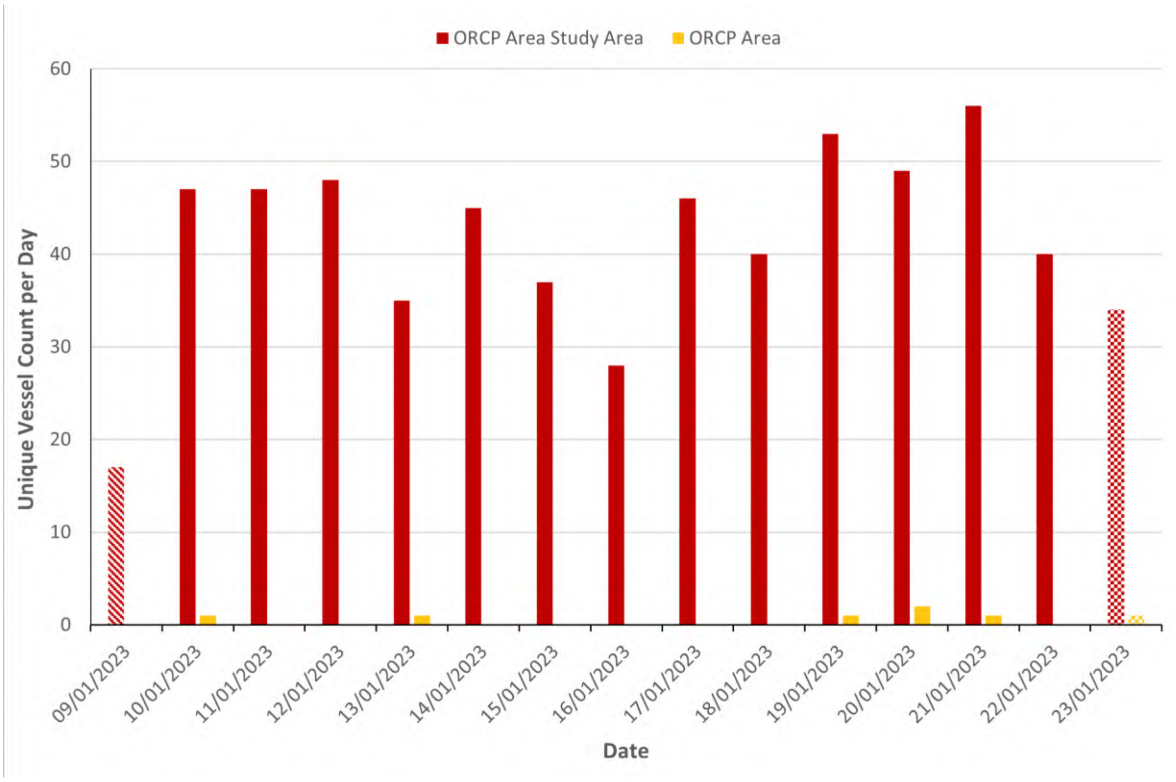

Figure 10.54 Daily Unique Vessel Counts Within the ORCP Area and ORCP Area Study Area (14-Days, Winter 2023)

334. For the 14-days analysis in the winter survey period, there was an average of 44 unique vessels recorded per day within the ORCP area study area. An average of one vessel every two days intersected the ORCP area.

335. The busiest day recorded within the ORCP area study area during the winter survey period was 21 January, on which 56 unique vessels were recorded. The busiest day recorded within the ORCP area during the winter survey period was 20 January when two unique vessels were recorded.

336. The quietest full day recorded within the ORCP area study area during the winter survey period was 16 January, on which 28 unique vessels were recorded. Other than 10, 13, 19, 20, 21, and 23 January, vessels were recorded on no other days within the ORCP area.

337. The daily number of unique vessels recorded within the ORCP area study area, as well as intersecting the ORCP area, during the summer survey period is presented in Figure 10.55. Throughout the winter survey period, less than 1% of vessel traffic recorded within the ORCP area study area intersected the ORCP area.

338.

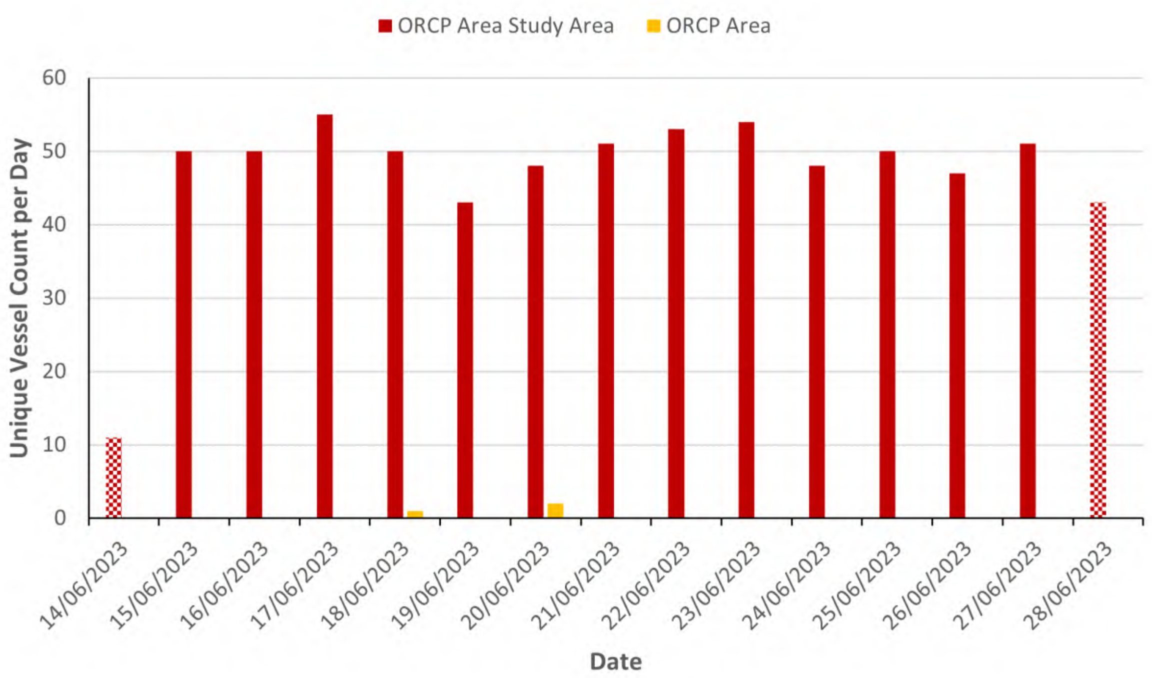

Figure 10.55 Daily Unique Vessel Counts Within the ORCP Area and ORCP Area Study Area (14-Days, Summer 2023)

339. For the 14-days analysis in the summer survey period, there was an average of 47 unique vessels recorded per day within the ORCP area study area. An average of one vessel every five days intersected the ORCP area.

340. The busiest day recorded within the ORCP area study area during the summer survey period was 17 June, on which 55 unique vessels were recorded. The busiest day recorded within the ORCP area during the winter survey period was 20 June when two unique vessels were recorded.

341. The quietest full day recorded within the ORCP area study area during the winter survey period was 19 June, on which 43 unique vessels were recorded. Other than 18 and 20 June, vessels were recorded on no other days within the ORCP area.

10.3.2 Vessel Type

342. The percentage distribution of the main vessel types recorded within the ORCP area study area, as well as intersecting the ORCP area, during the winter survey period is presented in Figure 10.56.

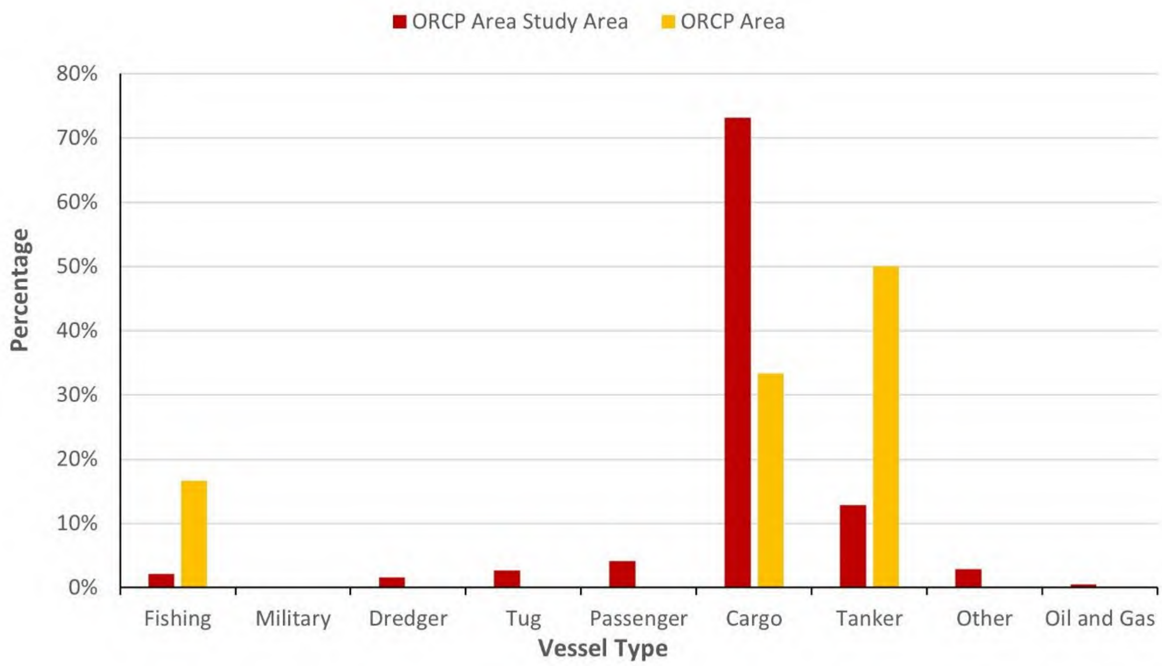

Figure 10.56 Vessel Type Distribution ORCP Area (14-Days, Winter 2023)

343. Throughout the winter survey period, the main vessel types recorded within the ORCP area study area were cargo vessels (73%), tankers (13%), and windfarm vessels (10%). It is noted that no recreational vessels were recorded within the ORCP area study area during the winter survey, but this can be expected due to the time of year the survey took place.

344. The percentage distribution of the main vessel types recorded within the ORCP area study area, as well as intersecting the ORCP area, during the summer survey period is presented in Figure 10.57.

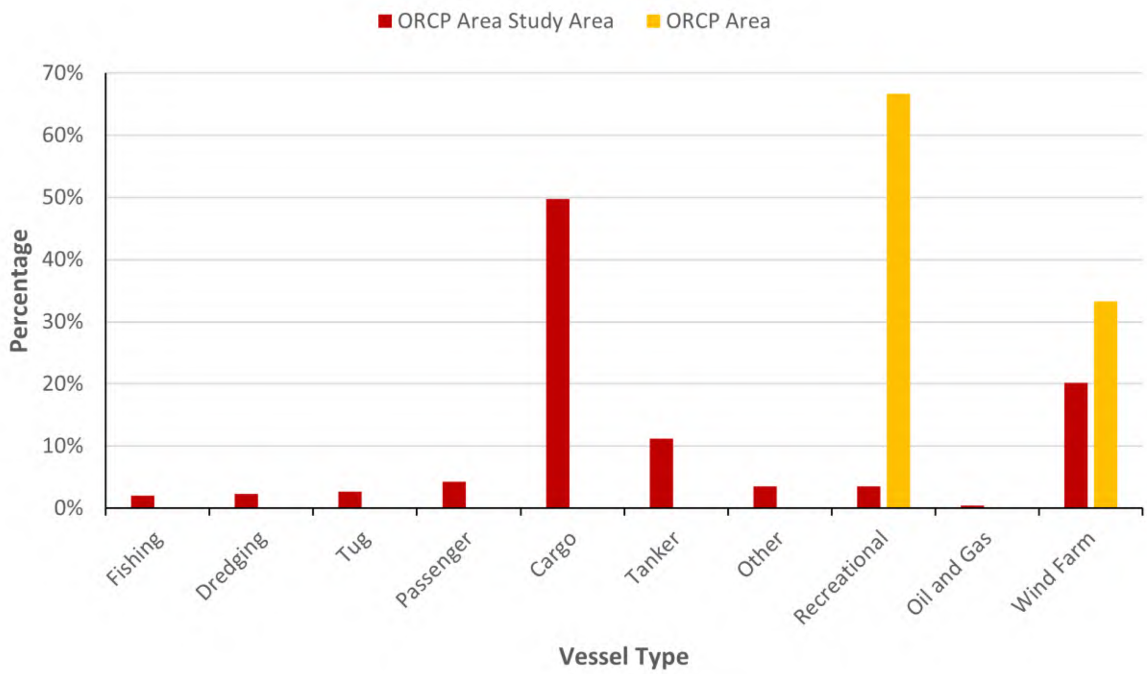

Figure 10.57 Vessel Type Distribution ORCP Area (14-Days, Summer 2023)

345. Throughout the summer survey period, the main vessel types recorded within the ORCP area study area were cargo vessels (50%), windfarm vessels (20%), and tankers (11%).

346. The following subsections consider each of the main vessel types individually.

10.3.2.1 Cargo Vessels

347. Figure 10.58 presents a plot of cargo vessels, including commercial ferries, recorded within the ORCP area study area during the 14-day winter survey period.

348. Throughout the winter survey period, an average of 28 unique cargo vessels per day were recorded within the ORCP area study area. The most common cargo vessel sub-types present within the ORCP area study area during the winter survey period were general cargo (54%), containerships (21%), and Ro-Ro (11%).

349. Cargo vessels were noted routeing in the deeper waters to the east and avoiding the shallow banks surrounding the ORCP area as well as routeing around the pre-existing OWFs already in proximity to the area.

350. The regular cargo vessels operating within the ORCP area study area included Ro-Ro vessels operated by DFDS Seaways, CLdN, Eckero Shipping, and Sea Cargo. Ro-Ro vessels are presented in Figure 10.59 for the 14-day winter survey period, colour-coded by vessel operator.

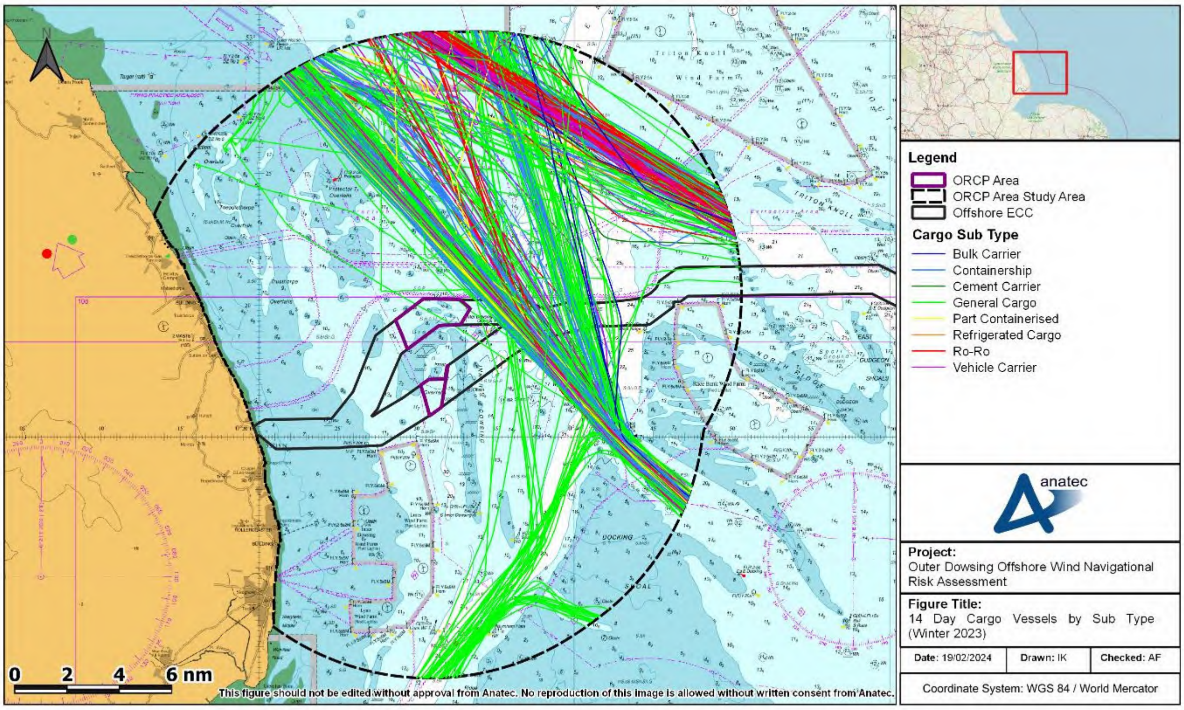

Figure 10.58 Cargo Vessels within ORCP Area Study Area by Sub Type (14-Days, Winter 2023)

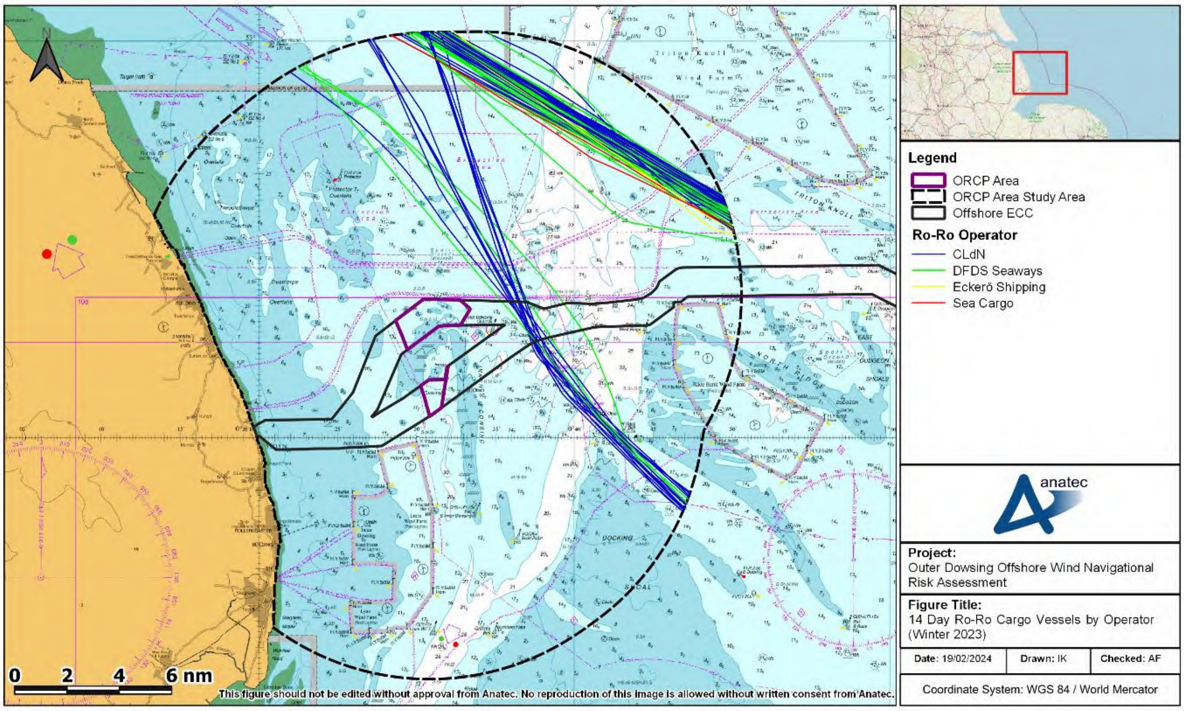

Figure 10.59 Ro-Ro Vessels within ORCP Area Study Area by Vessel Operator (14-Days, Winter 2023)

351. On average, three unique Ro-Ro vessels per day were recorded within the ORCP area study area during the winter survey period. The most common Ro-Ro operators during the winter survey period were CLdN (52%) and DFDS Seaways (39%). CLdN vessels were on routes Killingholme (UK) – Zeebrugge (Belgium) as well as Killingholme (UK) – Rotterdam (the Netherlands). DFDS Seaways vessels were on routes Immingham (UK) – Cuxhaven (Germany) and Immingham (UK) – Vlaardingen (the Netherlands). No Ro-Ro vessel or route passed within the ORCP area with all vessels noted to the east and north-east of the sites.

352. Figure 10.60 presents a plot of cargo vessels, including commercial ferries, recorded within the ORCP area study area during the 14-day summer survey period.

353. Throughout the summer survey period, an average of 25 unique cargo vessels per day were recorded within the ORCP area study area. The most common cargo vessel sub-types present within the ORCP area study area during the summer survey period were general cargo (50%), containerships (22%), and Ro-Ro (13%).

354. As with the winter survey period, the regular cargo vessels operating within the ORCP area study area included Ro-Ro vessels operated by DFDS Seaways, CLdN, Eckero Shipping, and Sea Cargo. Ro-Ro vessels are presented in Figure 10.61 for the summer survey period, colour-coded by vessel operator.

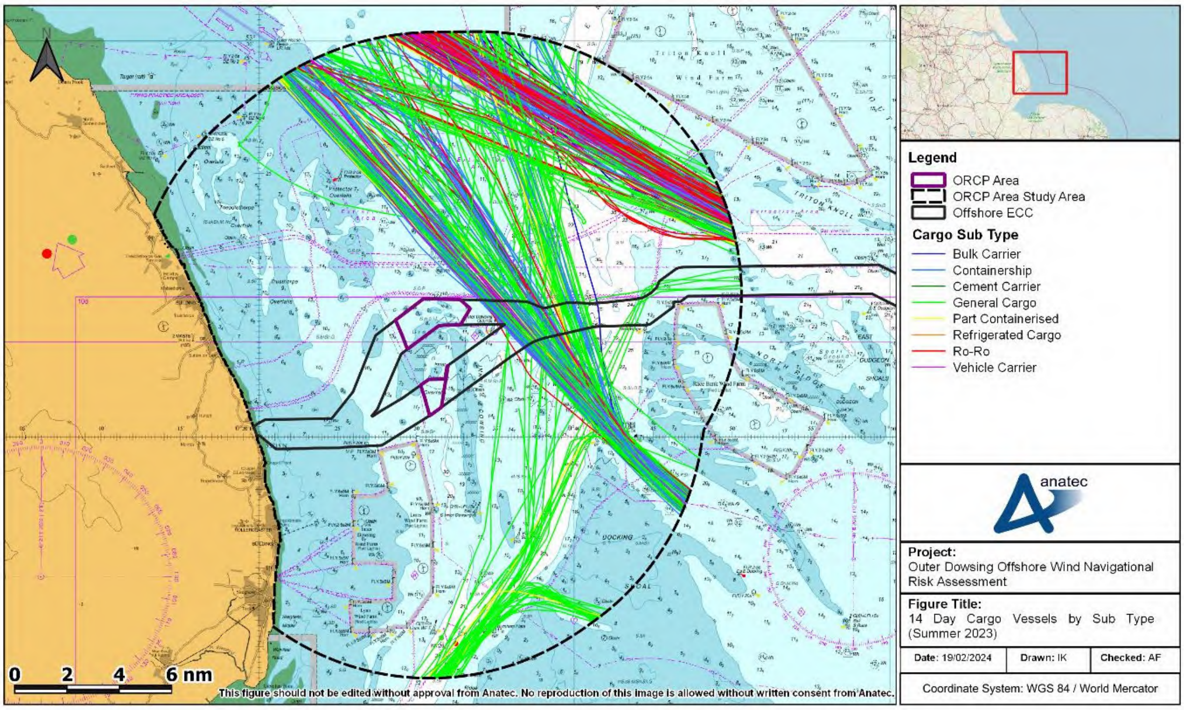

Figure 10.60 Cargo Vessels within ORCP Area Study Area by Sub Type (14-Days, Summer 2023)

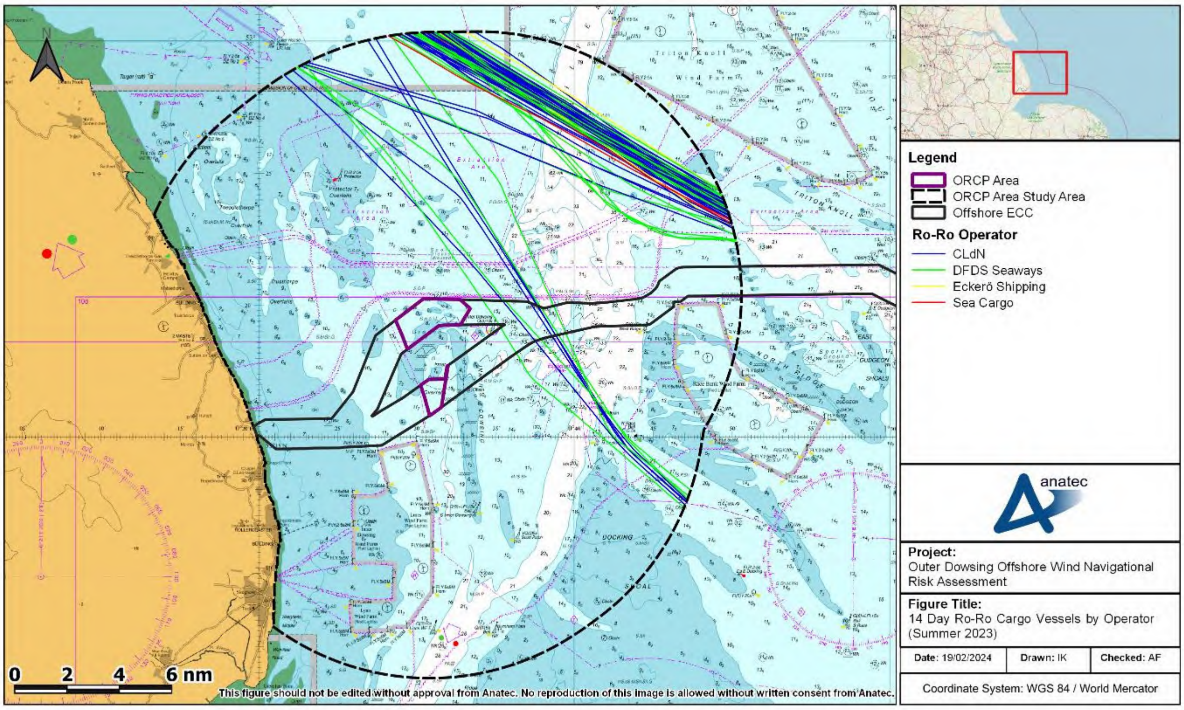

Figure 10.61 Ro-Ro Vessels within ORCP Area Study Area by Vessel Operator (14-Days, Summer 2023)

355. On average, three unique Ro-Ro vessels per day were recorded within the ORCP area study area during the summer survey period. The most common Ro-Ro operators during the winter survey period were CLdN (59%) and DFDS Seaways (32%). CLdN vessels were on routes Killingholme (UK) – Zeebrugge (Belgium) as well as Killingholme (UK) – Rotterdam (the Netherlands). DFDS Seaways vessels were on routes Immingham (UK) – Cuxhaven (Germany) and Immingham (UK) – Vlaardingen (the Netherlands). No Ro-Ro vessel or route passed within the ORCP area with all vessels noted to the east and north-east of the sites.

10.3.2.2 Tankers

356. Figure 10.62 presents a plot of tankers recorded within the ORCP area study area during the 14-day winter survey period.

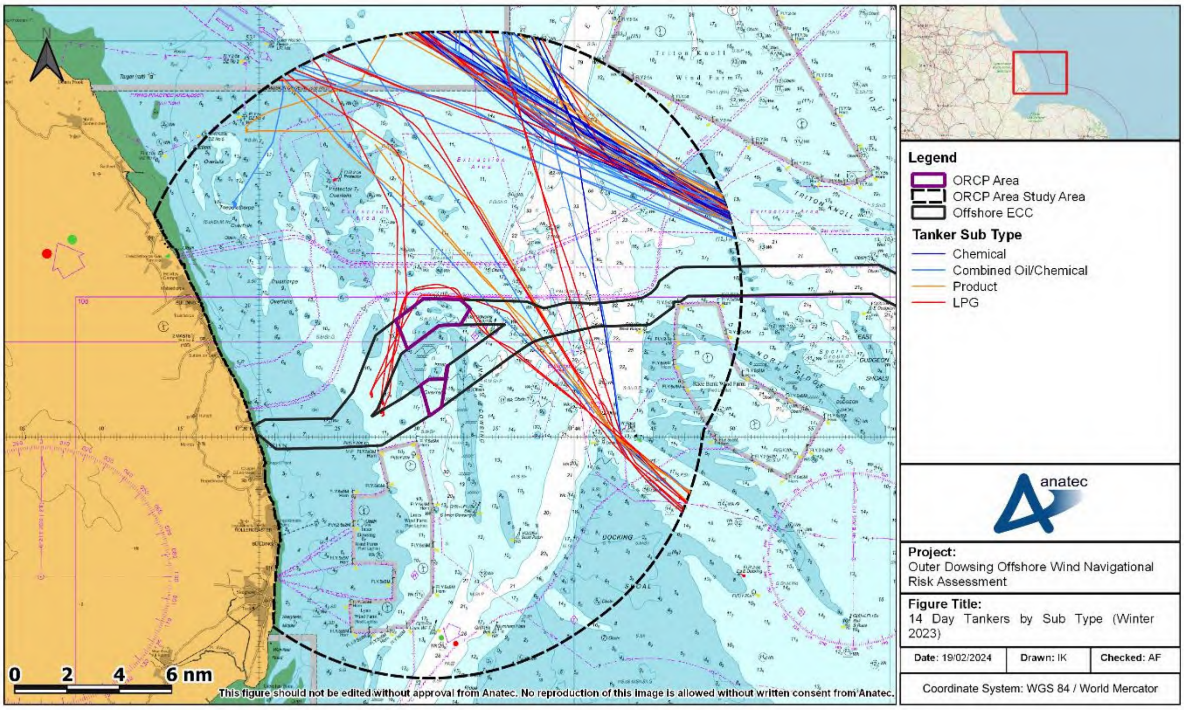

Figure 10.62 Tankers within the ORCP Area Study Area by Sub Type (14-Days, Winter 2023)

357. Throughout the winter survey period, an average of five unique tankers per day were recorded within the ORCP area study area with the most common tanker sub-types being combined oil/chemical (42%), LPG (21%), product tankers (19%), and chemical tankers (18%).

358. Three unique instances of tankers anchoring in the shallower waters to the west of the ORCP area, between the banks, was noted by two unique vessels. These vessels were routeing to Immingham (UK) and passed to the immediate north of the ORCP area with some instances of intersecting the boundary corners before anchoring at the west. These vessels were discussed at the second hazard workshop, with general consensus being that the vessels were likely performing waiting manoeuvres.

359. Figure 10.63 presents a plot of tankers recorded within the ORCP area study area during the 14-day summer survey period.

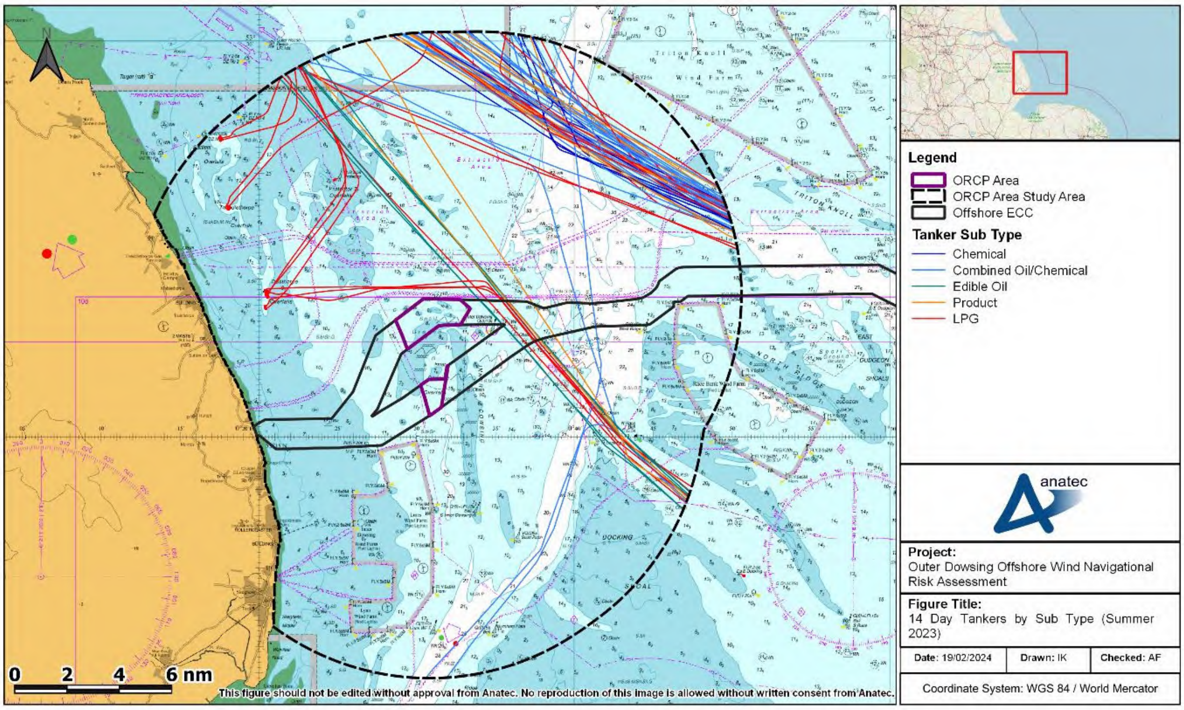

Figure 10.63 Tankers within the ORCP Area Study Area by Sub Type (14-Days, Summer 2023)

360. Throughout the summer survey period, an average of five to six unique tankers per day were recorded within the ORCP area study area with the most common tanker sub-types being combined oil/chemical (34%), LPG (33%), and product (16%).

10.3.2.3 Passenger Vessels

361. Figure 10.64 presents a plot of passenger vessels recorded within the ORCP area study area during the 14-day winter survey period. It is noted that all passenger vessels recorded within the ORCP area study area were RoPax.

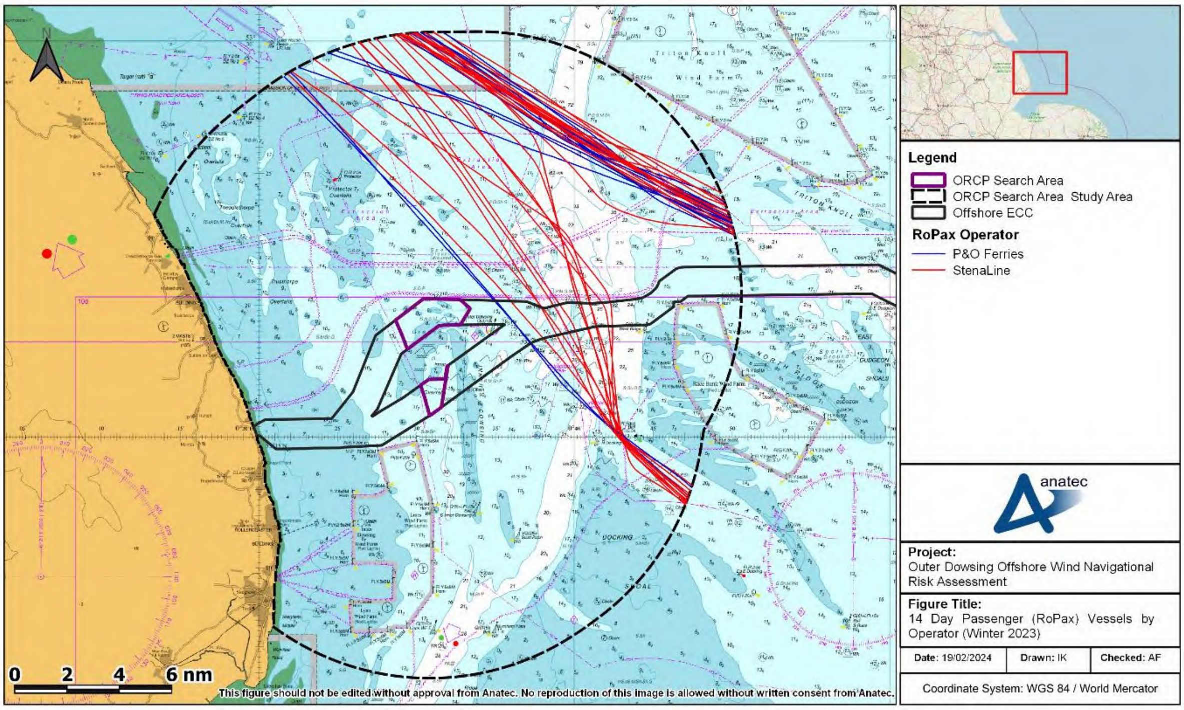

Figure 10.64 Passenger (RoPax) Vessels within the ORCP Area Study Area by Vessel Operator (14-Days, Winter 2023)

362. An average of one to two unique RoPax vessels per day were recorded within the ORCP area study area. No vessels were recorded routeing through the ORCP area.

363. RoPax vessels were operated by StenaLine (65%) and P&O Ferries (35%). Roueting of RoPax during the winter period was noted between Killingholme (UK) – Hoek Van Holland (the Netherlands) for StenaLine vessels, and Hull (UK) – Rotterdam (the Netherlands) for P&O Ferries.

364. Figure 10.65 presents a plot of passenger vessels recorded within the ORCP area study area during the 14-day summer survey period. As with the winter survey period, all passenger vessels recorded within the ORCP area study area were RoPax.

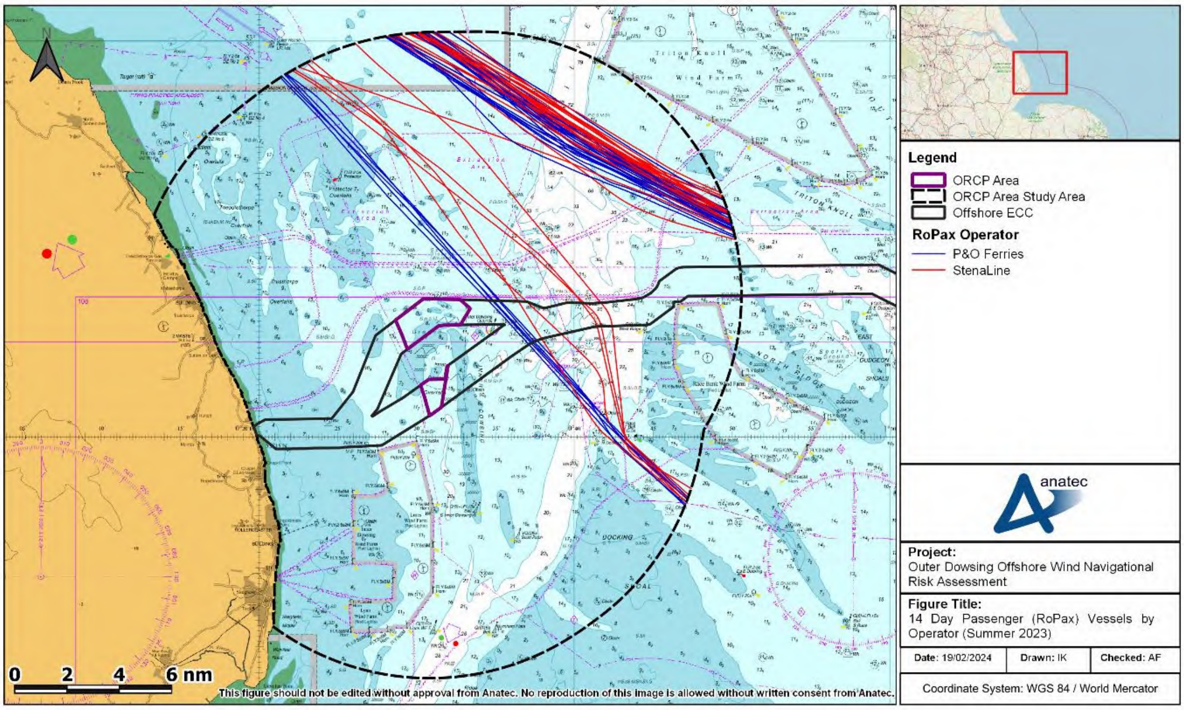

Figure 10.65 Passenger (RoPax) Vessels within the ORCP Area Study Area by Vessel Operator (14-Days, Summer 2023)

365. An average of two unique RoPax vessels per day were recorded within the ORCP area study area. No vessels were recorded routeing through the ORCP area.

366. RoPax vessels were operated by StenaLine (50%) and P&O Ferries (50%). Roueting of RoPax during the summer period was again between Killingholme (UK) – Hoek Van Holland (the Netherlands) for StenaLine vessels, and Hull (UK) – Rotterdam (the Netherlands) for P&O Ferries.

10.3.2.4 Windfarm Vessels

367. Figure 10.66 presents a plot of windfarm vessels recorded within the ORCP area study area during the 14-data winter survey period.

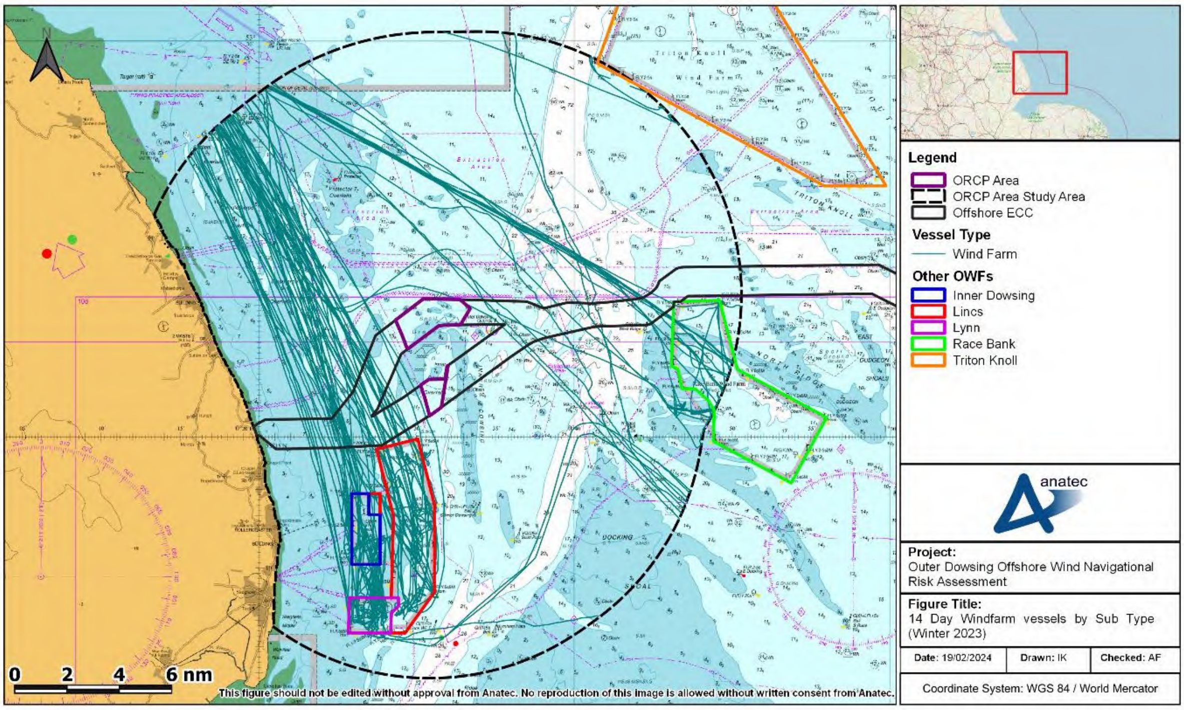

Figure 10.66 Windfarm Vessels within the ORCP Area Study Area (14-Days, Winter 2023)

368. Throughout the winter survey period, an average of four unique windfarm vessels per day were recorded within the ORCP area study area.

369. Vessels were mostly associated with the Lincs, Lynn and Inner Dowsing OWFs in the south-west of the study area. Several vessels were also noted attending Race Bank OWF at the eastern extent of the ORCP area study area. Vessels routeing to/from OWFs were noted utilising Grimsby and Great Yarmouth ports.

370. Figure 10.67 presents a plot of windfarm vessels recorded within the ORCP area study area during the 14-data summer survey period.

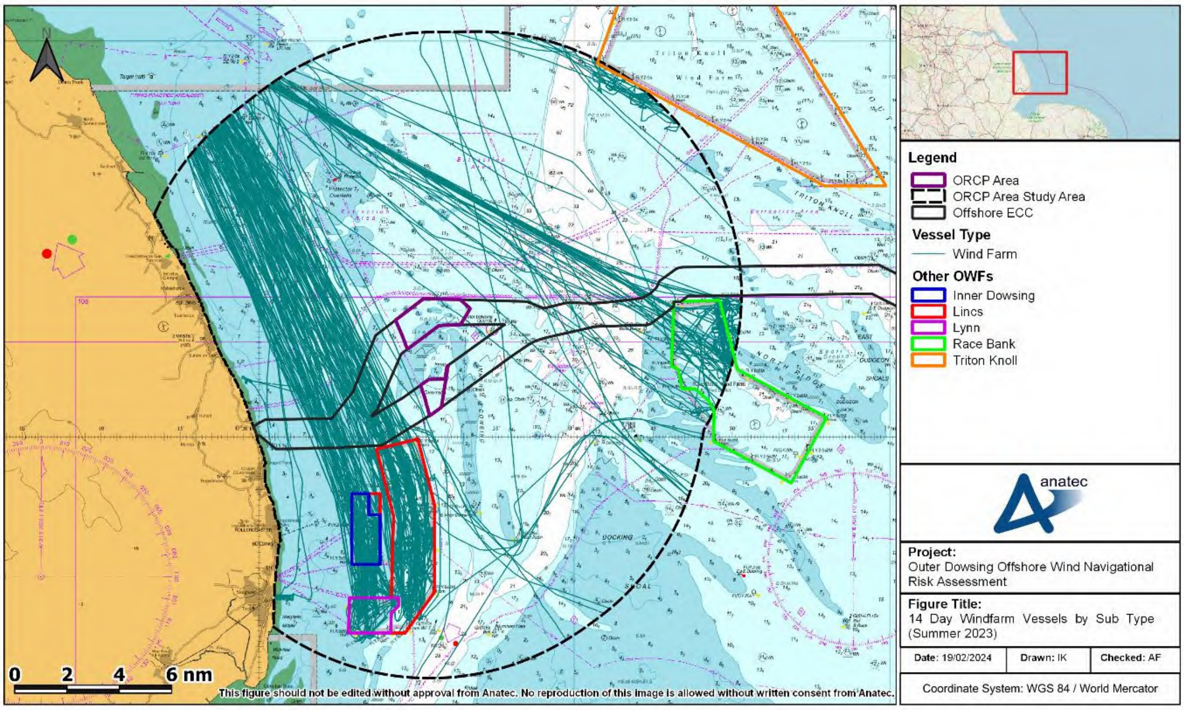

Figure 10.67 Windfarm Vessels within the ORCP Area Study Area (14-Days, Summer 2023)

371. Throughout the summer survey period, an average of ten unique windfarm vessels per day were recorded within the ORCP area study area.

372. Vessels were again mainly associated with the Lincs, Lynn and Inner Dowsing OWFs, with vessels noted transiting to Race Bank OWF. Vessels routeing to/from OWFs were noted utilising Grimsby and Great Yarmouth ports.

10.3.2.5 Fishing Vessels

373. Figure 10.68 presents a plot of fishing vessels recorded within the ORCP area study area during the 14-day winter survey period. Approximately 69% of fishing vessel tracks were recorded via AIS with the remaining 31% via Radar.

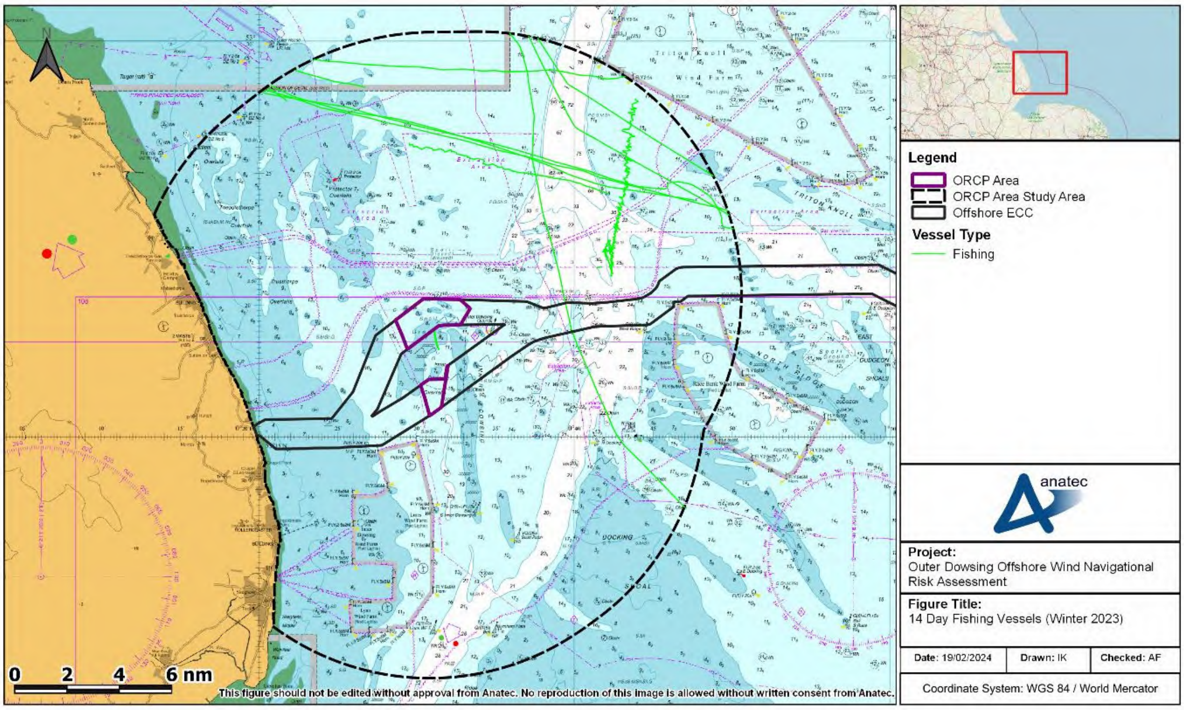

Figure 10.68 Fishing Vessels within the ORCP Area Study Area (14-Days, Winter 2023)

374. Throughout the winter survey period there was an average of one unique fishing vessel per day recorded within the ORCP area study area. All fishing vessels were recorded on transit as opposed to being engaged in fishing activity, with most vessels to the north of the ORCP. Only one small fishing vessel, recorded via Radar, intersected the northern site of the ORCP area.

375. Figure 10.69 presents a plot of fishing vessels recorded within the ORCP area study area during the summer survey period. Approximately 71% of fishing vessel tracks were recorded via AIS with the remaining 29% via Radar.

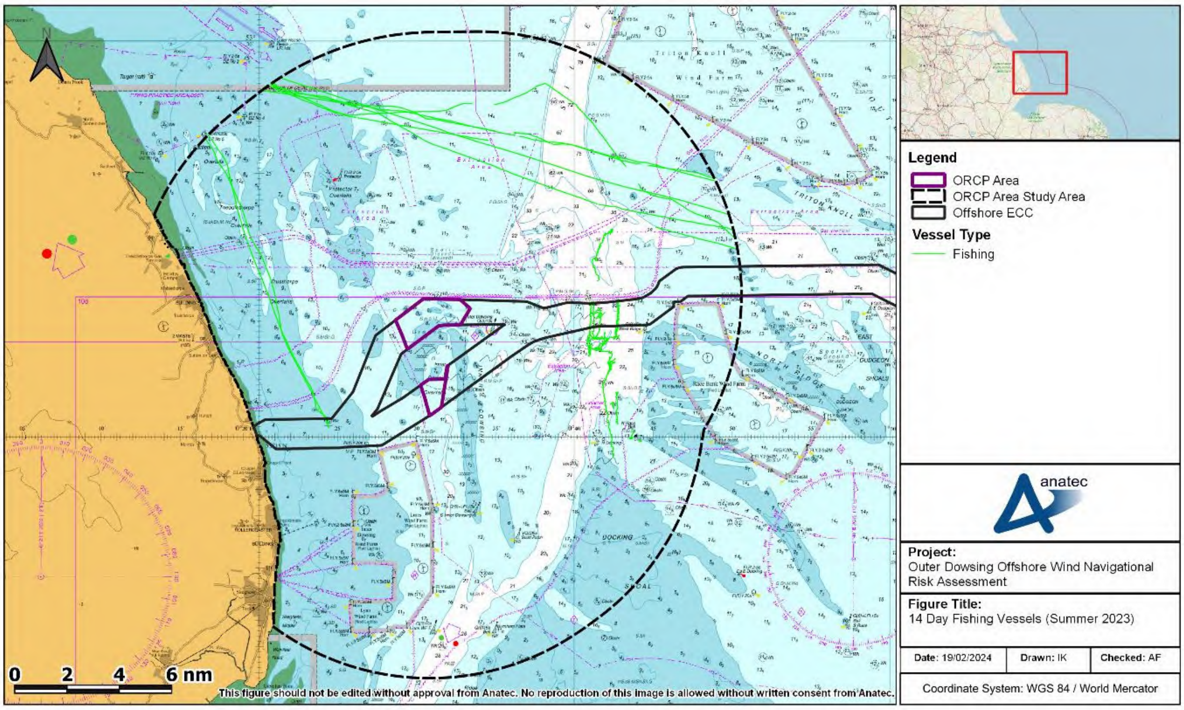

Figure 10.69 Fishing Vessels within the ORCP Area Study Area (14-Days, Summer 2023)

376. Throughout the summer survey period there was an average of one unique fishing vessel per day recorded within the ORCP area study area. Fishing vessels were primarily recorded on transit, with vessels likely to be engaged in fishing activity based on speed and behaviour noted east of the ORCP area. No fishing vessels were recorded within the ORCP area.

10.3.2.6 Recreational Vessels

377. Figure 10.70 presents a plot of recreational vessels recorded within the ORCP area study area during the summer survey period. It is noted that no recreational vessels were recorded within the ORCP area study area during the winter survey period.

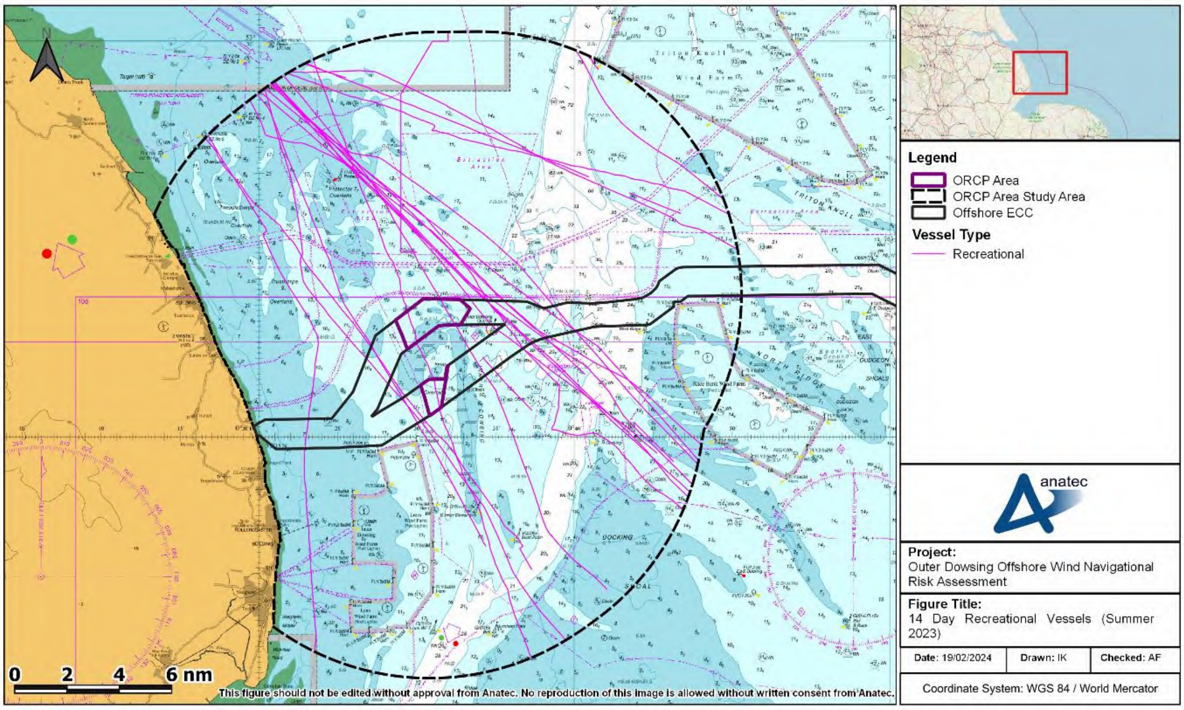

Figure 10.70 Recreational Vessels within the ORCP Area Study Area (14-Days, Summer 2023)

378. Throughout the summer survey period there was an average of two unique recreational vessels per day recorded within the ORCP area study area. Recreational vessels were noted primarily on northwest-southeast bearings following the coast.

379. Further information on recreational traffic in proximity to the array area from the RYA Coastal Atlas is provided in section 10.4.

10.3.3 Vessel Size

10.3.3.1 Vessel Length

380. Vessel length information was available for over 99% of all vessels recorded within the ORCP area study throughout the winter survey period. Of those vessels that had unspecified vessel lengths, all were recorded via Radar. Figure 10.71 illustrates the distribution of vessel length recorded throughout the survey period.

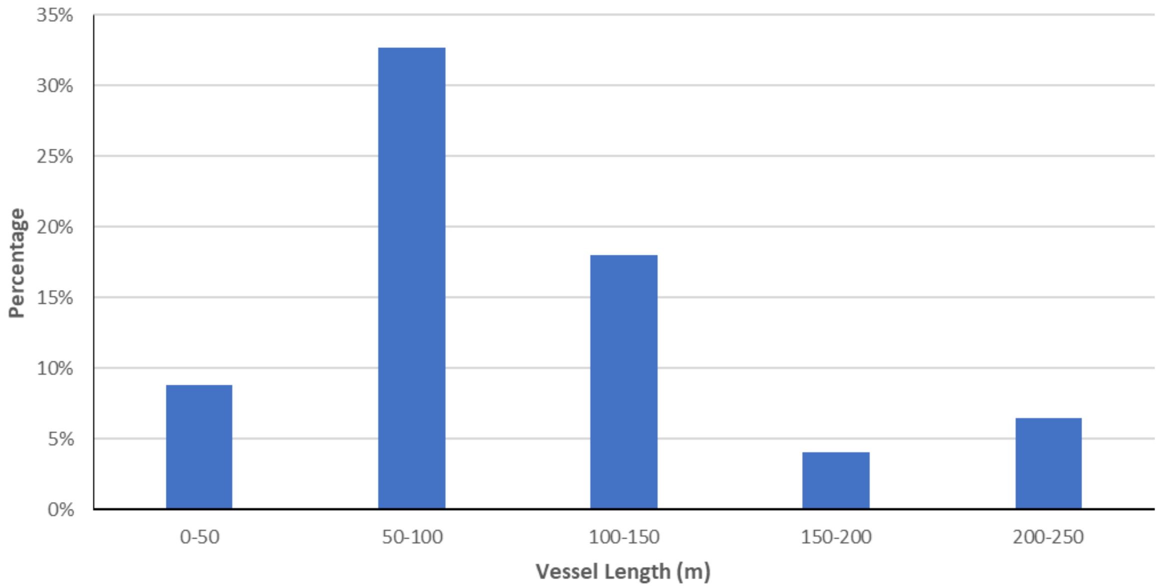

Figure 10.71 Vessel Length Distribution within the ORCP Area Study Area (14-Days, Winter 2023)

381. Excluding the proportion of vessels for which a length was not available, the average length of vessels within the ORCP area study area throughout the winter survey period was 102m. The largest vessels recorded were two unique Ro-Ro vessels at 238m.

382. The vessel tracks recorded during the winter survey period, colour-coded by vessel length, are presented in Figure 10.72.

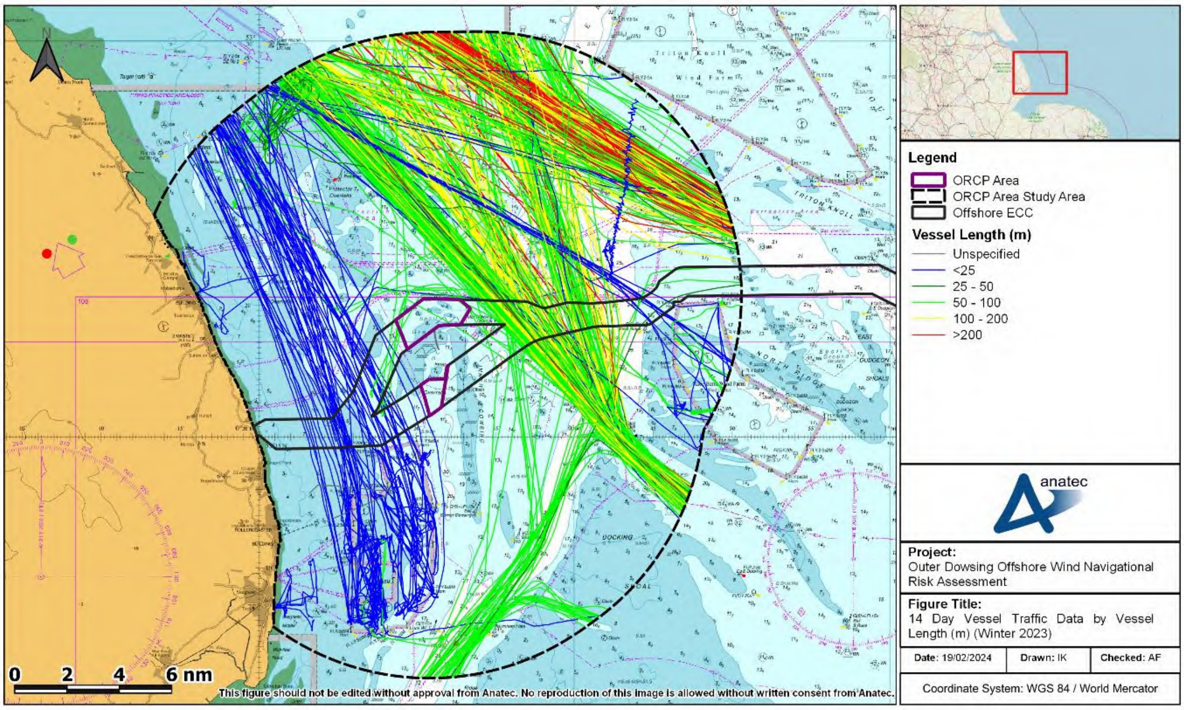

Figure 10.72 Vessel Traffic Survey Data within the ORCP Area Study Area by Vessel Length (14-Days, Winter 2023)

383. Vessels of greater lengths were primarily cargo vessels and passenger vessels (Ro-Ro and RoPax, respectively) noted to the north-east of the ORCP area study area. Vessels of smaller lengths were typically windfarm vessels, fishing vessels, and inshore SAR vessels.

384. Vessel length information was available for 98% of vessels recorded within the ORCP area study throughout the summer survey period. Figure 10.73 illustrates the distribution of vessel length recorded throughout the summer survey period.

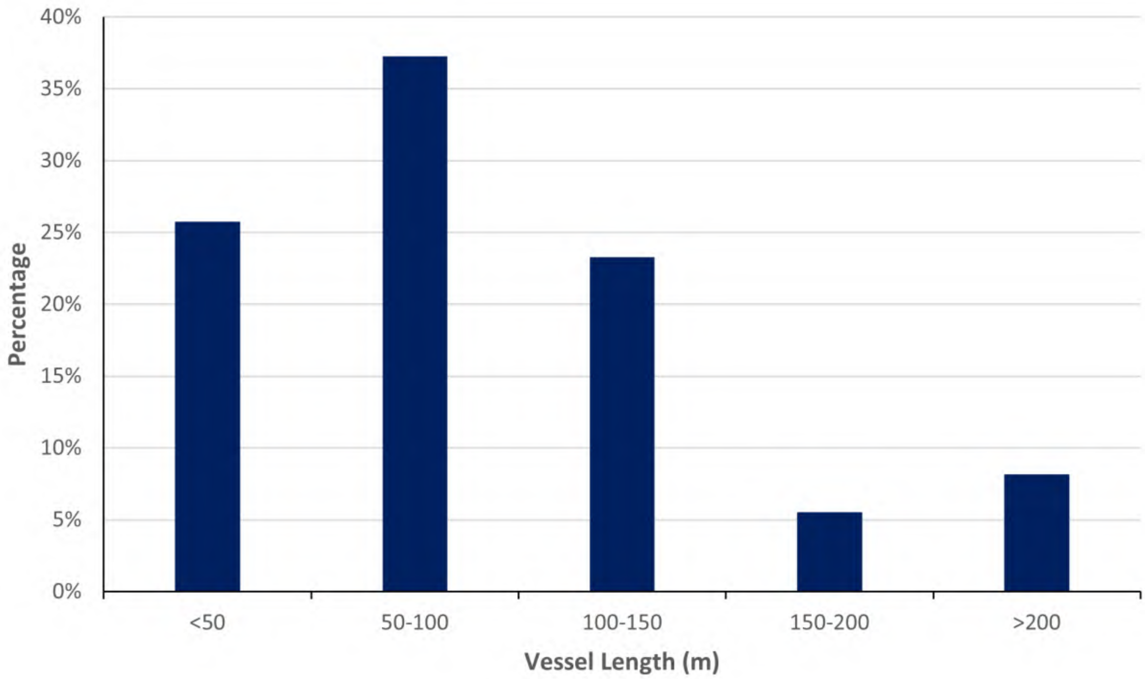

Figure 10.73 Vessel Length Distribution within the ORCP Area Study Area (14-Days, Summer 2023)

385. Excluding the proportion of vessels for which a length was not available, the average length of vessels within the ORCP area study area throughout the summer survey period was 92m. The largest vessels recorded were the two Ro-Ro vessels at 238m.

386. The vessel tracks recorded during the summer survey period, colour-coded by vessel length, are presented in Figure 10.74.

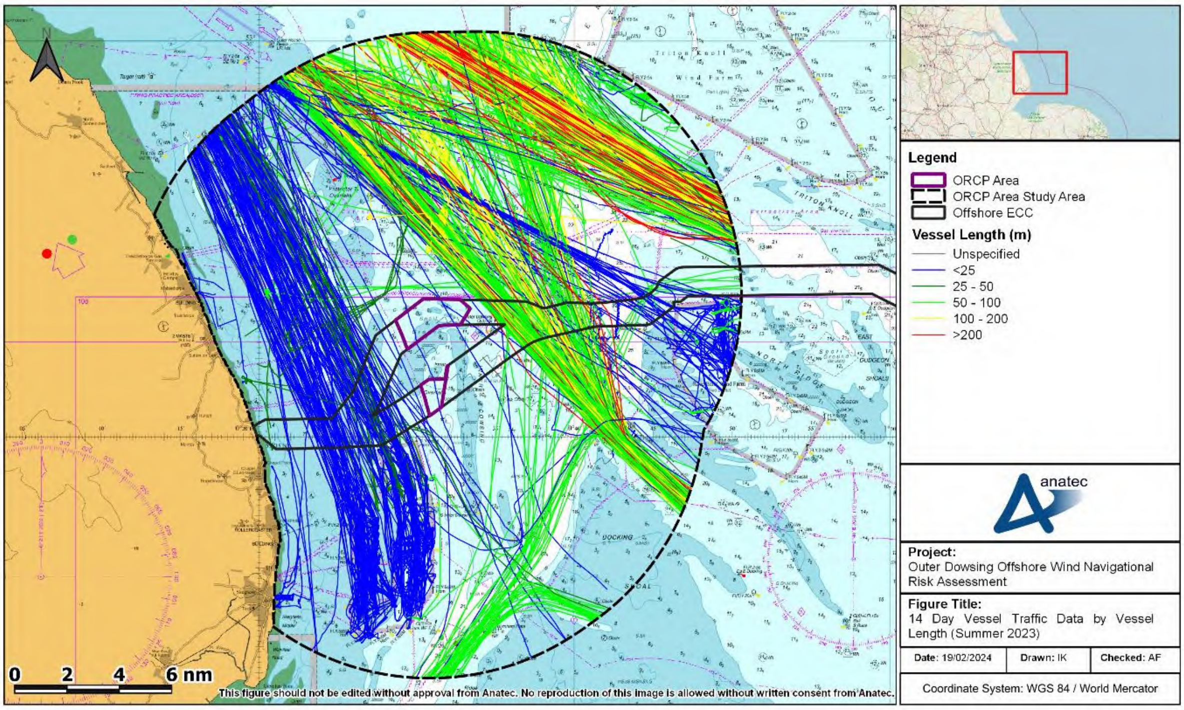

Figure 10.74 Vessel Traffic Survey Data within the ORCP Area Study Area by Vessel Length (14-Days, Summer 2023)

10.3.3.2 Vessel Draught

387. Vessel draught information was available for approximately 94% of all vessels recorded during the 14-day winter survey period. Of those vessels with unspecified vessel draughts, vessel types included windfarm, fishing, dredging/subsea operations, and ‘other’. Figure 10.75 illustrates the distribution of vessel draught recorded throughout the survey period.

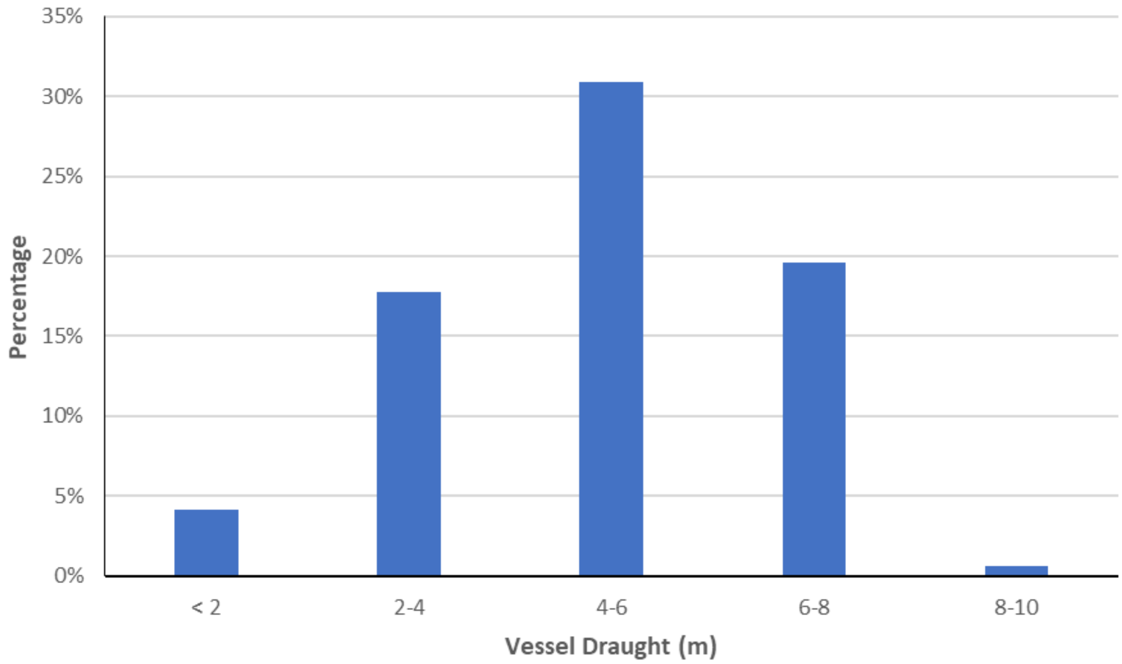

Figure 10.75 Vessel Draught Distribution within the ORCP Area Study Area (14-Days, Winter 2023)

388. Excluding the proportion of vessels for which a draught was not available, the average draught of vessels within the ORCP area study area throughout the winter survey period was 4.7m. The largest vessel draught recorded was 9.6m for a general cargo vessel.

389. The vessel tracks recorded during the winter survey period, colour-coded by vessel draught, are presented in Figure 10.76.

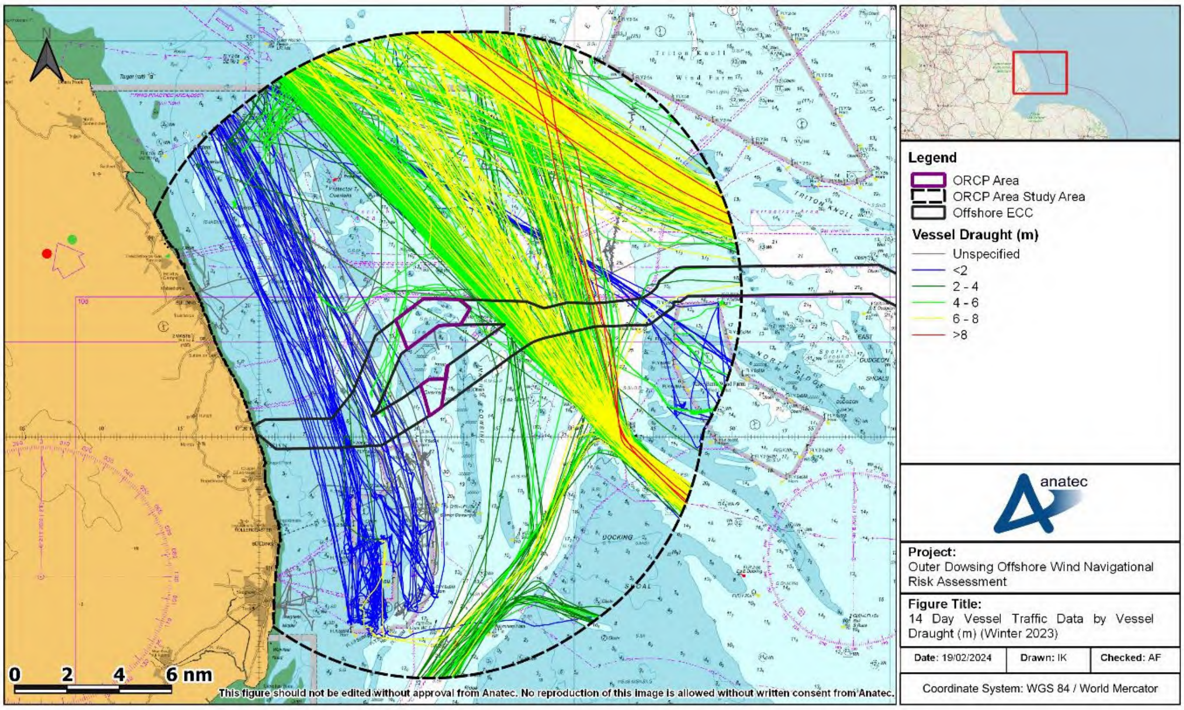

Figure 10.76 Vessel Traffic Survey Data within the ORCP Area Study Area by Vessel Draught (14-Days, Winter 2023)

390. Vessels with the largest draughts were primarily cargo vessels. These vessels were recorded to the east and north-east of the ORCP area.

391. Vessel draught information was available for approximately 91% of all vessels recorded during the summer survey period. Of those vessels with unspecified vessel draughts, vessel types included windfarm, fishing, cargo, recreational, and ‘other’. Figure 10.77 illustrates the distribution of vessel draught recorded throughout the survey period.

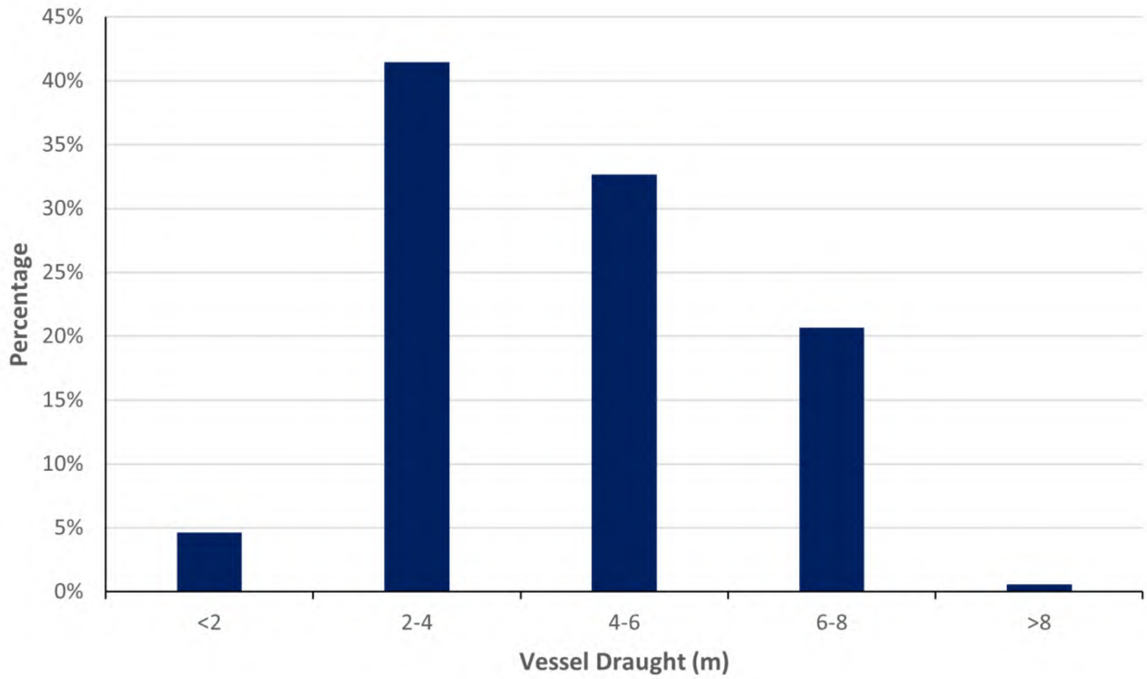

Figure 10.77 Vessel Draught Distribution within the ORCP Area Study Area (14-Days, Summer 2023)

392. Excluding the proportion of vessels for which a draught was not available, the average draught of vessels within the ORCP area study area throughout the summer survey period was 4.2m. The largest vessel draught recorded was 10.1m for a bulk carrier.

393. The vessel tracks recorded during the summer survey period, colour-coded by vessel draught, are presented in Figure 10.78.

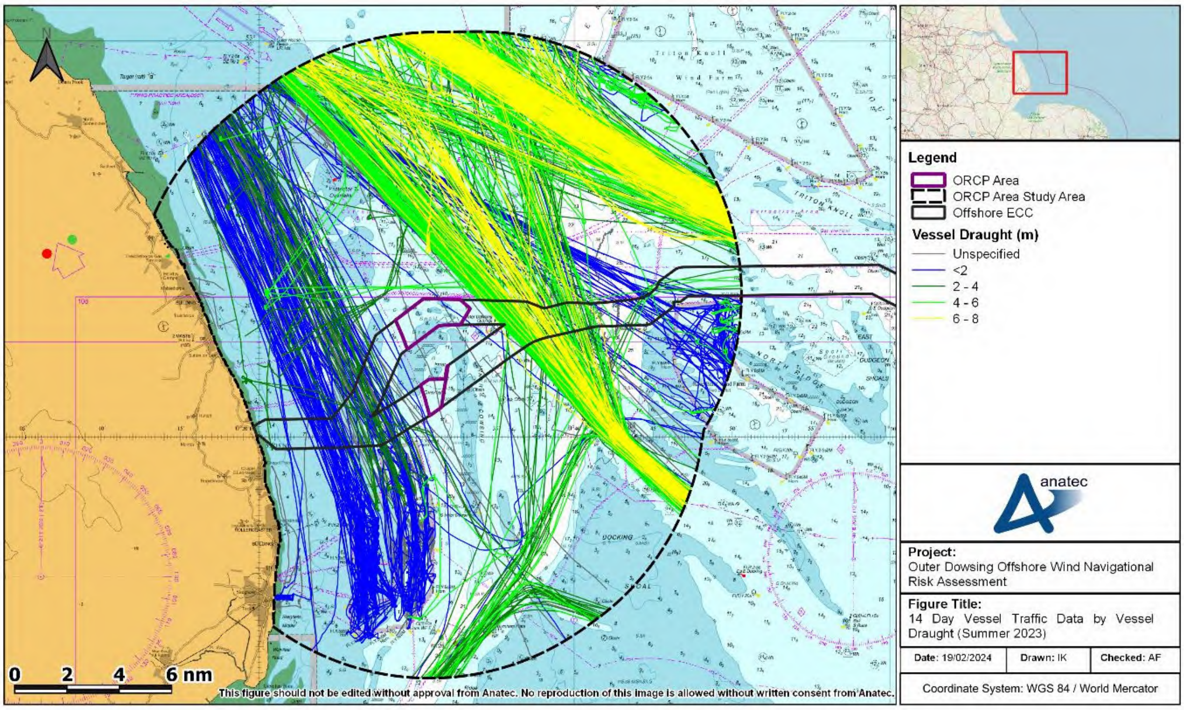

Figure 10.78 Vessel Traffic Survey Data within the ORCP Area Study Area by Vessel Draught (14-Days, Summer 2023)

10.4 RYA Coastal Atlas

394. In addition to the vessel traffic survey data, the RYA Coastal Atlas of Recreational Boating (RYA, 2019) has been reviewed for the region. The RYA Coastal Atlas may be used to “help identify and protect areas of importance to recreational boaters, to advise on new development proposals and in discussions over navigational safety”. The RYA Coastal Atlas includes a heat map indicating the density of recreational activity around the UK coast as well as features relevant to recreational boating such as general boating areas, clubs, training centres and marinas.

395. Figure 10.79 presents a plot of the RYA Coastal Atlas heat map relative to the Project. Following this, Figure 10.80 presents a plot of features relevant to recreational boating areas.

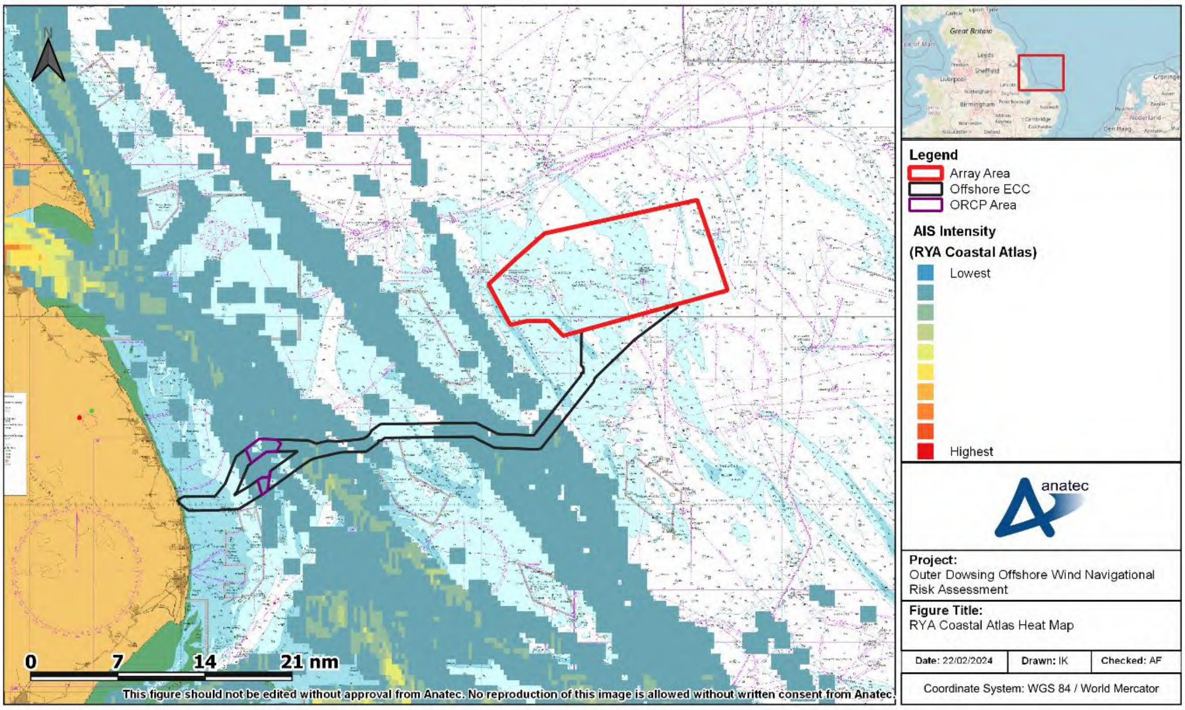

Figure 10.79 RYA Coastal Atlas Heat Map

Recreational traffic densities were noted to be low between the array area and coast, with higher densities observed in proximity to the Humber and the Wash. Recreational traffic from the Humber further south was observed intersecting the offshore ECC to the east of the ORCP area.

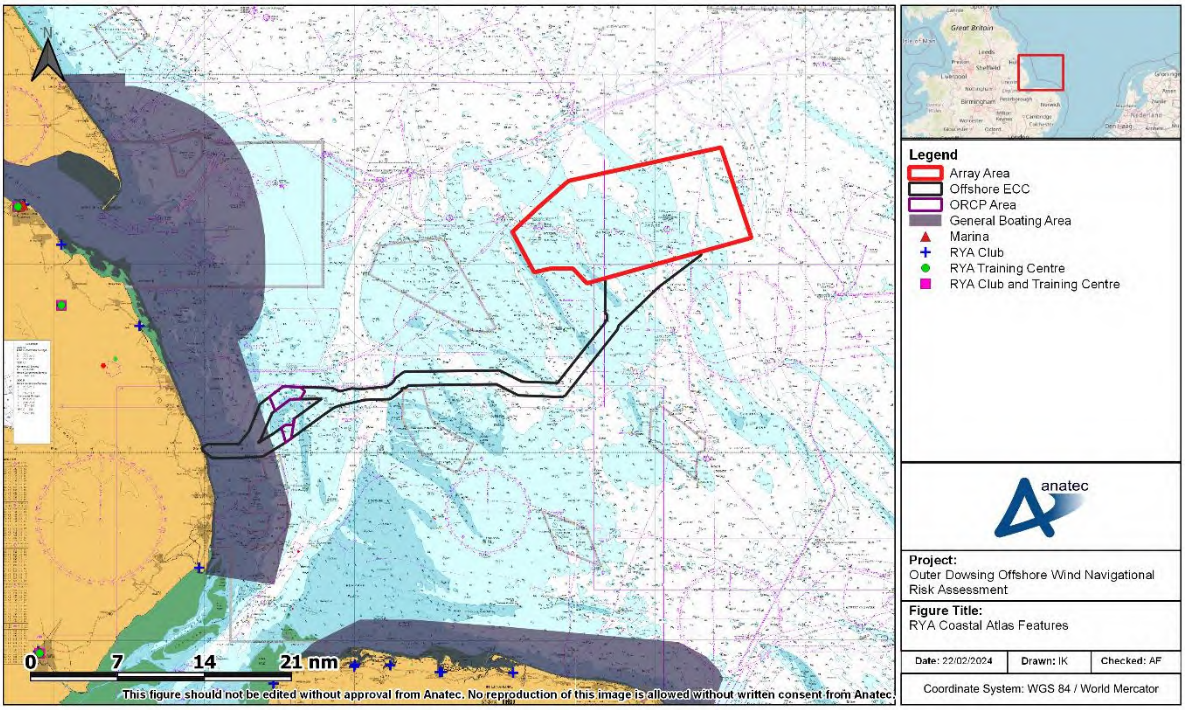

Figure 10.80 RYA Coastal Atlas Features

396. There are a number of facilities along the coast to the south of the Project, as well as the mouth of the Humber. The closest facility to the offshore ECC is an RYA club approximately 10nm south of landfall. The offshore ECC intersects a general boating area, which lies approximately 1.2nm west of the ORCP area. This indicates recreational traffic may occur in and around the landfall and general nearshore area.

10.5 Anchoring Activity

397. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

398. For this reason, those vessels which travelled at a speed of less than 1kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity.

399. No vessels were deemed to be an anchor within the shipping and navigation study area (i.e., within 10nm of the array area) on this basis.

400. The vessels deemed to be anchored within the offshore ECC study area (i.e., within 2nm of the offshore ECC) are presented in Figure 10.81.

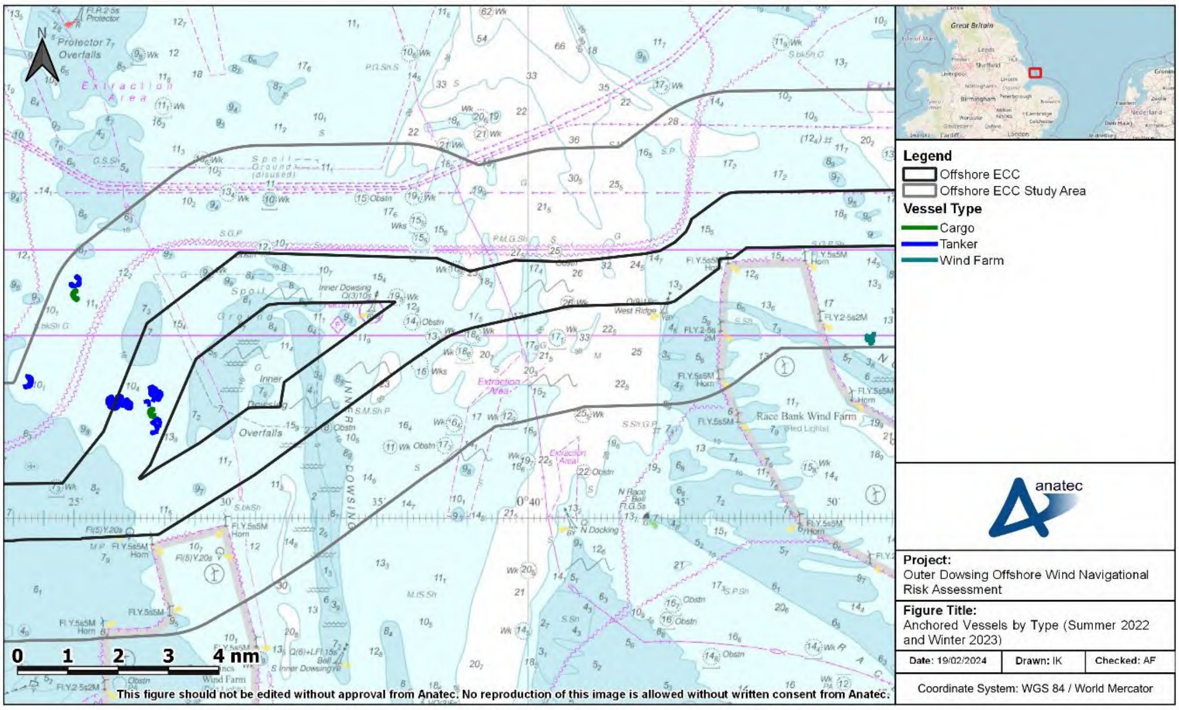

Figure 10.81 Anchored Vessels within the ECC Study Area by Vessel Type (Summer 2022 and Winter 2023)

401. One unique tanker and one windfarm vessel were recorded at anchor within the ECC study area within the summer 2022 survey period. The tanker spent a total of seven-days at anchor whilst the windfarm vessel was anchored for a total of three-days. Three tankers and two cargo vessels were recorded at anchor within the winter 2023 survey period.

402. The vessels deemed to be anchored within the ORCP area study area (i.e., within 10nm of the ORCP area) are presented in Figure 10.82.

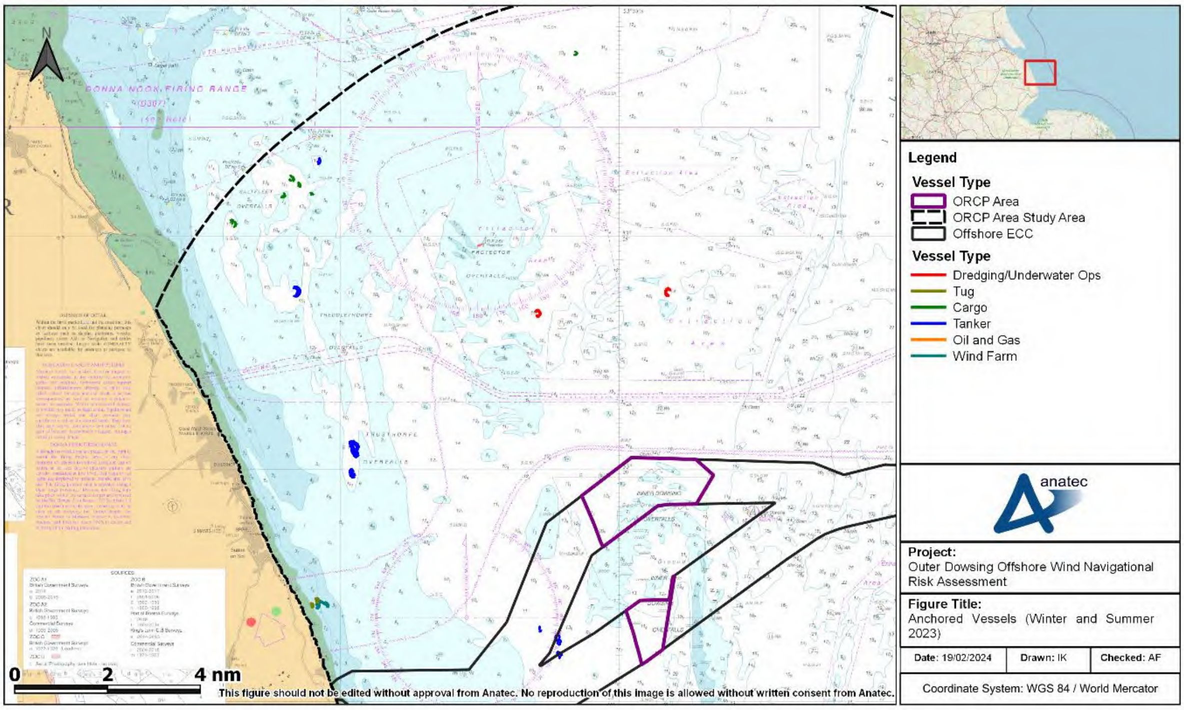

Figure 10.82 Anchored Vessels within the ORCP Area Study Area by Vessel Type (Winter and Summer 2023)

403. There were 11 unique instances of anchoring recorded within the ORCP area study area over the 14-day winter survey period. These instances of anchoring were recorded by six unique cargo vessels and four unique tankers, one of which anchored on two separate occasions. Most of these vessels at anchor were positioned at the north-west of the ORCP area study area, just south of the Donna Nook firing practice area and west of the Humber Overfalls (area 493) marine aggregate dredging area. These vessels were likely waiting berth at Humber ports as implied by their AIS broadcast destinations.

404. There were five unique vessels identified as at anchor within the ORCP area study area during the summer survey period. Two dredgers were identified as anchored north of the ORCP area, with a tanker identified to the northwest (anchored on two separate occasions), and a tug and windfarm vessel noted close to the coast.

11 Base Case Vessel Routeing

11.1 Definition of a Main Commercial Route

405. Main commercial routes have been identified using the principles set out in MGN 654 (MCA, 2021). Vessel traffic data are assessed and vessels transiting at similar headings and locations are identified as a main route. To help identify main routes, vessel traffic data can also be interrogated to show vessels (by name and/or operator) that frequently transit those routes. The route width is then calculated using the 90th percentile rule from the median line of the potential shipping route as shown in Figure 11.1.

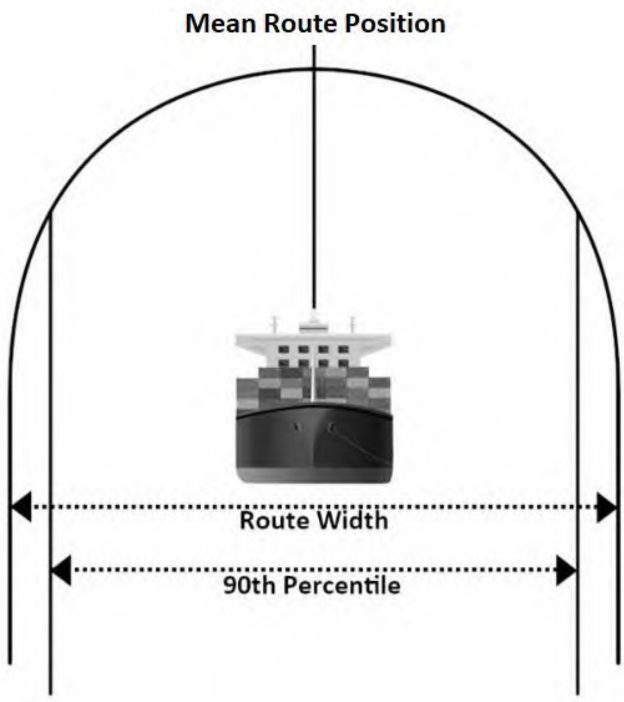

Figure 11.1 Illustration of Main Route Calculation

11.2 Pre Windfarm Main Commercial Routes

11.2.1 Array Area

406. A total of 13 main commercial routes were identified from the vessel traffic survey data. These main commercial routes and corresponding 90th percentiles within the shipping and navigation study area are shown relative to the array area in Figure 11.2. Following this, a description of each route is provided in Table 11-1, including the average number of vessels per day, route terminus locations, and main vessel types. It is noted that the terminus points shown are based on the most common destinations transmitted via AIS by vessels on those routes.

407. To ensure all main commercial routes are captured, the long-term vessel traffic data has been used to validate the main commercial routes identified from the vessel traffic survey data. Lower use or seasonally based routes have still been captured within the modelling process via both the AIS data and Anatec's ShipRoutes database (Anatec, 2023).

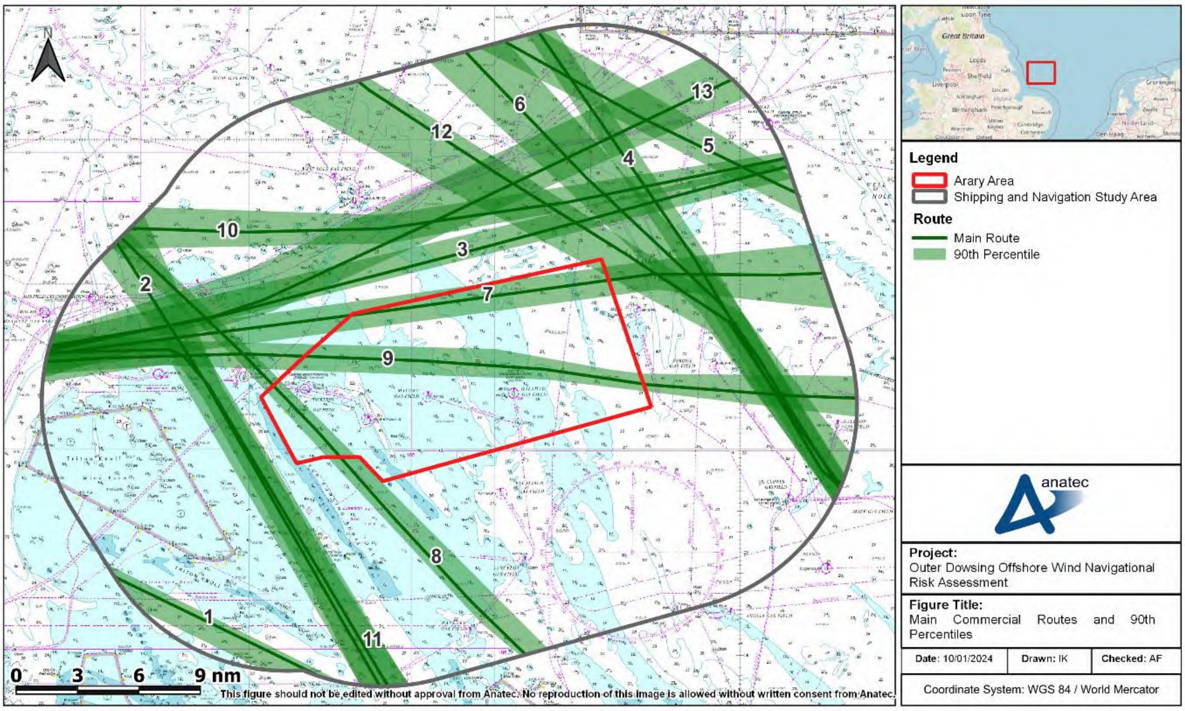

Figure 11.2 Main Commercial Routes and 90th Percentiles

Table 11-1 Description of Main Commercial Routes

Route No.	Average Vessels per Day	Description
1	16	**Humber Ports – Rotterdam (The Netherlands).** Primarily cargo vessels (59%) and tankers (29%). Includes P&O Ferries and Stena Line commercial ferry routes.
2	12	**Tees – Rotterdam (The Netherlands).** Primarily cargo vessels (53%) and tankers (34%). Used by DFDS Seaways commercial ferry operator (on the Newcastle-Amsterdam route) as an adverse weather route.
3	4	**Humber Ports – Cuxhaven (Germany).** Primarily cargo vessels (88%). Used by DFDS Seaways commercial ferry operator (on Immingham-Cuxhaven route).

Route No.	Average Vessels per Day	Description
4	2	**Tees Port – Rotterdam (The Netherlands).** Primarily cargo vessels (68%).
5	2	**Newcastle – Amsterdam (The Netherlands).** Primarily passenger vessels (79%). Used by DFDS Seaways commercial ferry operator (on the Newcastle-Amsterdam and Newcastle/North Shields-Ijmuiden routes).
6	2	**Tees – Rotterdam (The Netherlands).** Primarily cargo vessels (49%) and tankers (41%).
7	1	**Humber Ports – Cuxhaven (Germany).** Primarily cargo vessels (88%).
8	1	**Tees – Rotterdam (The Netherlands).** Primarily cargo vessels (90%).
9	<1	**Humber Ports – Bremerhaven/Hamburg (Germany).** Primarily cargo vessels (90%).
10	<1	**Humber Ports – Cuxhaven (Germany).** Primarily cargo vessels (81%).
11	<1	**Humber Ports – Rotterdam (The Netherlands).** Primarily tankers (81%).
12	<1	**Tees – Amsterdam (The Netherlands).** Cargo vessels (35%), tankers (25%), passenger vessels (19%), and oil and gas vessels (19%). Used by DFDS Seaways commercial ferry operator (the Newcastle-Amsterdam route) as an adverse weather route.
13	<1	**Humber Ports – Hornsea OWFs.** Route used by construction, O&M vessels to the Hornsea offshore wind projects from the Humber.

11.2.2 ORCP Area

408. A total of nine main commercial routes were identified for the ORCP area study area from the 28-day survey period. These main commercial routes and corresponding 90^{th} percentiles within the ORCP area study area are presented in Figure 11.3. Following this, a description of each route is provided in Table 11-2, including the average number of vessels per day, start and end locations, main vessel types, and details of commercial ferry routeing (where applicable). As per the array area routeing (section 11.2.1), it is noted that the start and end locations are based on the most common destinations transmitted via AIS by vessels on these routes.

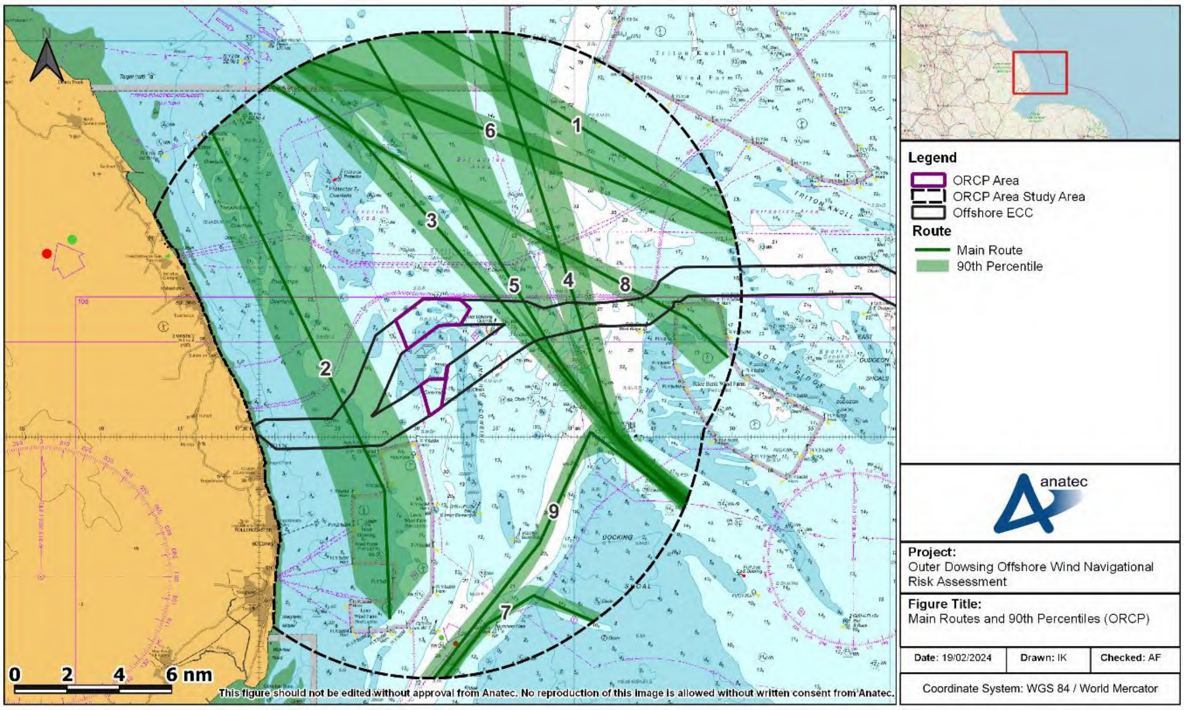

Figure 11.3 Main Commercial Routes and 90th Percentiles in Proximity to the ORCP

Table 11-2 Description of Main Commercial Routes in Proximity to the ORCP

Route No.	Average Vessels per Day	Description
1	10	**Humber Ports – Rotterdam**. Cargo vessels (62%), tankers (22%), and passenger vessels (15%). Includes the Killingholme – Zeebrugge and Killingholme – Rotterdam CLdN, as well as the Immingham – Cuxhaven and Immingham – Vlaardingen DFDS Seaways Ro-Ro routes; as well as the Killingholme – Hoek Van Holland StenaLine and Hull – Rotterdam P&O Ferries RoPax routes.
2	7-8	**Grimsby (UK) – Lincs, Inner Dowsing, and Lynn OWFs**. Entirely windfarm vessels (100%).
3	7	**Humber Ports – Amsterdam**. Primarily cargo vessels (91%). Includes alternate pathing for the Killingholme – Rotterdam CLdN, and Immingham – Vlaardingen DFDS Seaways Ro-Ro routes; as well as the Killingholme – Hoek Van Holland StenaLine and Hull – Rotterdam P&O Ferries RoPax routes.
4	3	**Tees – Rotterdam**. Primarily cargo vessels (93%).
5	3	**Humber Ports – Moerdijk**. Primarily cargo vessels (84%).

Route No.	Average Vessels per Day	Description
6	1-2	**Humber Ports – Rotterdam**. Cargo vessels (75%) and tankers (20%).
7	1	**Boston (UK) – Amsterdam**. Primarily cargo vessels (97%).
8	1	**Grimsby (UK) – Race Bank OWF**. Entirely windfarm vessels (100%).
9	1	**Boston – Dutch Ports**. Primarily cargo vessels (94%).

12 Adverse Weather Vessel Traffic Movements

409. Some vessels and vessel operators may operate alternative routes during periods of adverse weather. This section focuses on vessel movements in adverse weather given the implications if a commercial vessel is unable to make passage or a small craft is unable to access safe havens in adverse weather due to the presence of the development or activities associated with the development.

410. Adverse weather includes wind, wave and tidal conditions as well as reduced visibility due to fog that can hinder a vessel's standard route, speed of navigation and/or ability to enter the destination port. Adverse weather routes are assessed to be significant course adjustments to mitigate vessel motion in adverse weather conditions. When transiting in adverse weather conditions, a vessel is likely to encounter various types of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and/or discomfort and danger to persons on board. The sensitivity of a vessel to these phenomena will depend upon the actual stability parameters, hull geometry, vessel type, vessel size and speed.

12.1 Identification of Periods with Adverse Weather

411. Historical weather information provided by the Met Office (Met Office, 2022) has been used to identify periods of adverse weather during 2019 (the year covered by the long-term vessel traffic data) when routes in proximity to the Project could be considered most likely to be altered or cancelled. The key weather events identified are detailed in Table 12-1.

Table 12-1 Key Weather Events During 2021-2022 Relevant to the Project (Met Office)

Weather Event	Date(s)	Details
Storm Evert	29 to 30 July 2021	Strong and unusual winds for the time of year in southern England with wide gusts of over 40kt.
Storm Arwen	26 to 27 November 2021	Severe northernly winds tracking south with gusts over 60kt. Gusts of 85kt in Northumberland. This was one of the most powerful and damaging winter storms of the latest decade.
Storm Barra	7 to 8 December 2021	Deep Atlantic low pressure system which brought strong winds and heavy rain to UK with gusts up to 75kt.
Storm Malik	29 January 2022	Damaging north-westerly winds to Scotland and northeast England with gusts over 60kt and one of the most significant storms to affect the UK since 2015.
Storm Corrie	30 to 31 January 2022	Following on from Storm Malik, bringing further damaging winds with gusts reaching 80kt.
Storm Dudley	14 to 19 February 2022	Wet and windy weather for UK associated with a powerful jet stream with three consecutive storms in one week. Gusts over 60kt.

Weather Event	Date(s)	Details
Storm Eunice	18 to 21 February 2022	Wet and windy weather for UK associated with a powerful jet stream. The most severe and damaging storms to affect England and Wales since February 2014. Wind gusts over 70kt with a high of 106kt.
Storm Franklin	21 to 22 February 2022	Wet and windy weather for UK associated with a powerful jet stream with three consecutive storms in one week. Gusts over 60kt with persistent heavy rain.

12.2 Commercial Routeing Changes

412. The long-term vessel traffic data has been used to identify potential commercial routeing activity related to adverse weather conditions in proximity to the Project with the periods outlined in Table 12-1.

413. One instance of a vessel diverting from its usual route was recorded within the long-term dataset. This incident involved a DFDS Seaways-operated Ro-Ro vessel which tracked approximately 8nm south of its usual path during Storm Arwen, taking it into the shipping and navigation study area and 8nm northwest of the array area.

414. Additionally, as part of the Regular Operator consultation, Regular Operators identified from the 12-month AIS dataset (see section 4.1 and Annex C) were asked "*whether the Project poses any safety concern to the routeing of your vessels, including any adverse weather routeing*". The following relevant feedback arose from this consultation:

- Route 12 is used by DFDS Seaways vessels as an adverse weather route, however there is sufficient sea room to the north to accommodate the minor deviations required. DFDS indicated limited concern with this route during consultation.
- DFDS indicated in relation to their Immingham to Cuxhaven routes that Route 7 is preferred under certain sea state conditions as using the typical routeing (Route 3) would require longer periods in port securing cargo i.e., there is a commercial impact.
- Bore noted general concerns over adverse weather and stated masters would take additional care when transiting near or between windfarms in such conditions. In adverse conditions certain vessels may choose to pass offshore of the Outer Dowsing bank and therefore post windfarm such vessels would require to pass between Triton Knoll OWF and the array area, and therefore it was considered important that the existing width between the Outer Dowsing bank and Triton Knoll OWF was not reduced.

13 ANS

415. As per section 6.6, the Project may construct a maximum of up to two ANS offshore to provide a nesting location for certain bird species. This section outlines data assessment undertaken for the ANS based on 12 months AIS collected for the entirety of 2023 within 5nm of the two ANS areas. The MCA confirmed during consultation that assessment of 12 months of AIS data would suffice to assess the ANS (section 4).

416. Figure 13.1 presents a plot showing density of commercial routed vessels (based on the 12 months AIS) within minimum 5nm buffers of the ANS. The locations of existing and proposed offshore windfarms and oil and gas platforms have been included for reference.

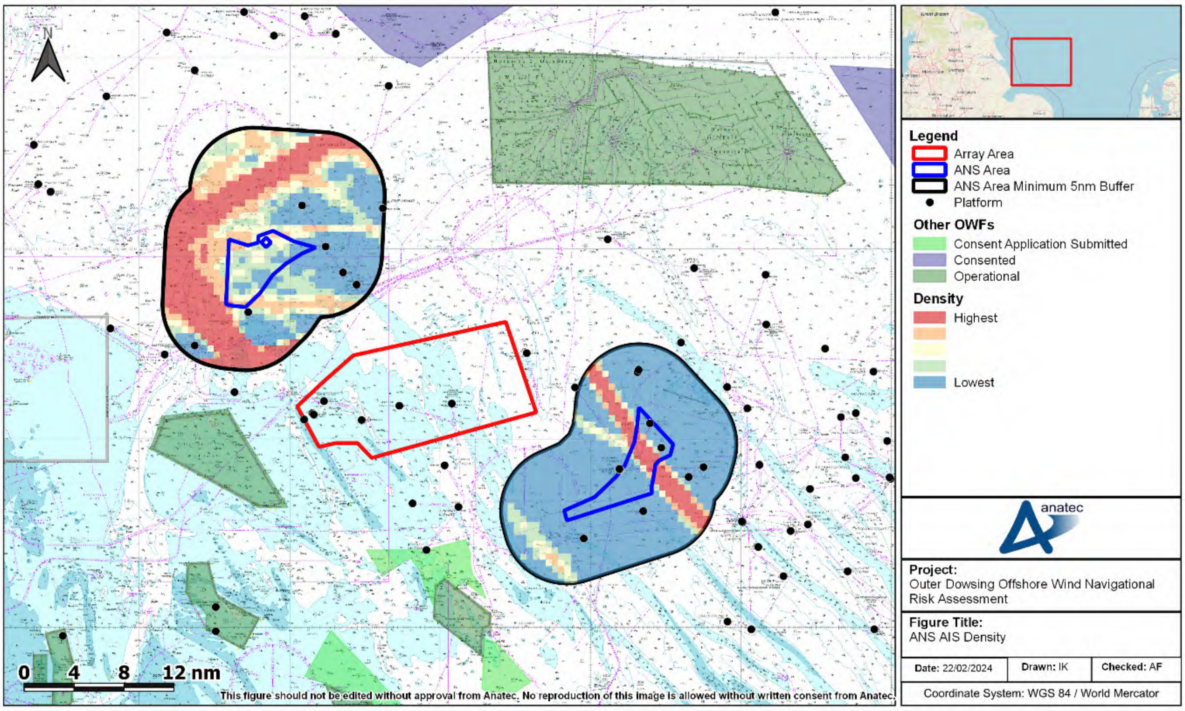

Figure 13.1 ANS AIS Density

417. A high density route was observed intersecting the southern ANS area. This route passes between the Broken Bank and Well Bank to the south, and as such is well defined.

418. Within the northern ANS area 5nm buffer, the highest density routes avoided the ANS area, however lower use routeing was observed intersecting.

419. High level assessment has been undertaken within this NRA of the ANS, noting a dedicated NRA process will be undertaken separately on specific platform locations within the ANS areas once selected. This will include full baseline assessment, vessel

traffic assessment, allision and collision modelling, consultation, and cumulative assessment.

420. The Applicant has committed to not siting an ANS in the area intersecting the high density route identified in in the southern ANS area plus a 0.5nm setback. This area is illustrated in Figure 13.2. Consultation from the MCA during the ANS NRA process indicated their view that the southwest corner was likely the areas of highest risk due to proximity to high-density traffic. The Applicant has therefore also committed to not siting an ANS in this area, as highlighted in Figure 13.3.

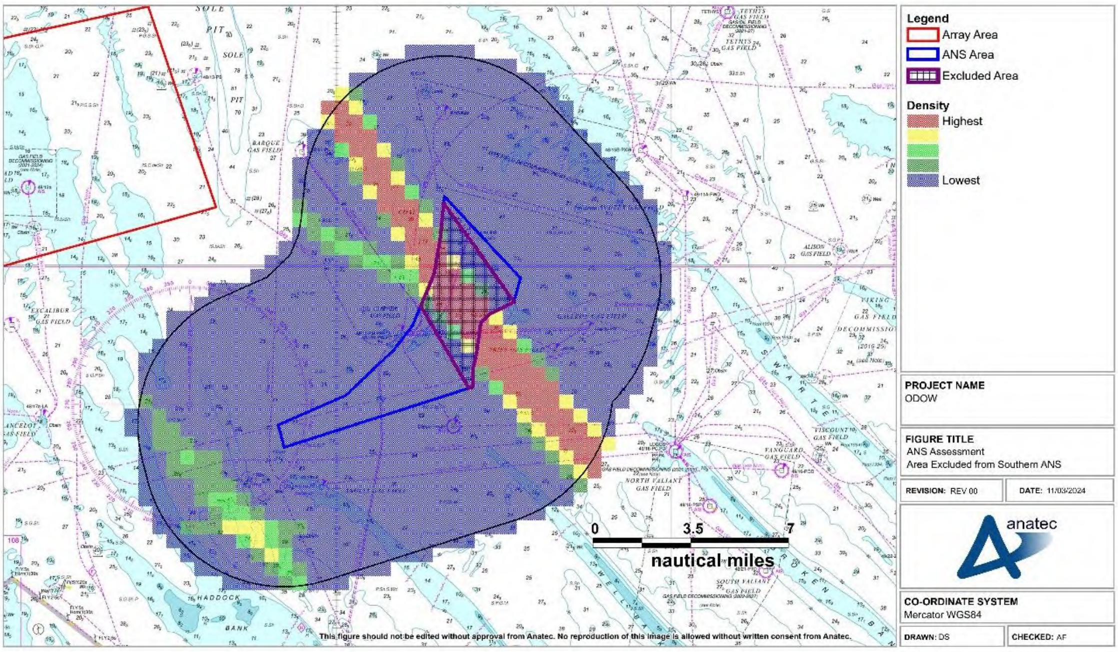

Figure 13.2 Area where no ANSs will be sited in Southern ANS area

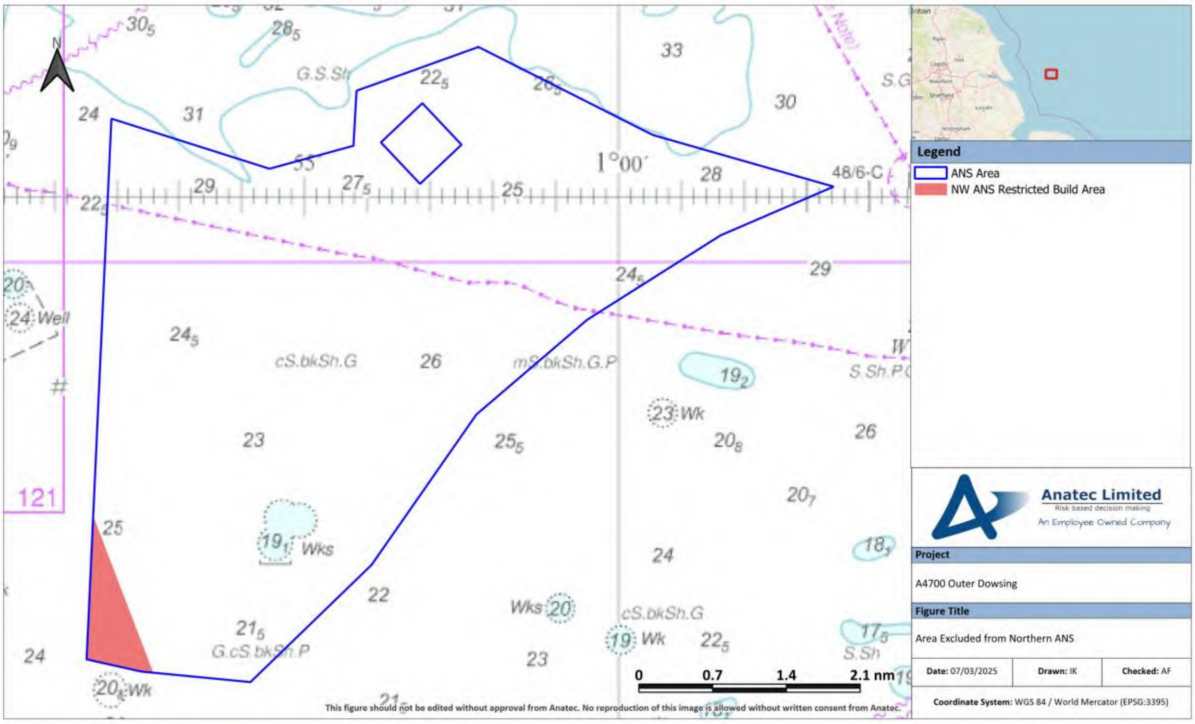

Figure 13.3 Area where no ANSs will be sited in Northern ANS area

14 Navigation, Communication, and Position Fixing Equipment

421. This section discusses the potential effects on the use of navigation, communication and position fixing equipment of vessels that may arise due to the infrastructure associated with the Project.

14.1 Very High Frequency Communications (Including Digital Selective Calling)

422. In 2004, trials were undertaken at the North Hoyle OWF, located off the coast of North Wales. As part of these trials, tests were undertaken to evaluate the operational use of typical small vessel VHF transceivers (including Digital Selective Calling (DSC)) when operated close to WTGs.

423. The WTGs had no noticeable effect on voice communications within the array or ashore. It was noted that if small craft vessel to vessel and vessel to shore communications were not affected significantly by the presence of WTGs, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

424. During this trial, a number of telephone calls were made from ashore, both within and offshore of the array area. No effects were recorded using any system provider (MCA and QinetiQ, 2004).

425. Furthermore, as part of SAR trials carried out at the North Hoyle in 2005, radio checks were undertaken between the Sea King helicopter and both Holyhead and Liverpool coastguards. The aircraft was positioned offshore of the array area and communications were reported as very clear, with no apparent degradation of performance. Communications with the service vessel located within the array were also fully satisfactory throughout the trial (MCA, 2005).

426. In addition to the North Hoyle trials, a desk-based study was undertaken for the Horns Rev 3 OWF in Denmark in 2014 and it was concluded that there were not expected to be any conflicts between point-to-point radio communications networks and no interference upon VHF communications (Energinet, 2014).

427. Following consideration of these reports and noting that since the trials detailed above there have been no significant issues with regards to VHF observed or reported, the presence of the Project is anticipated to have no significant impact upon VHF communications.

14.2 Very High Frequency Direction Finding

428. During the North Hoyle trials in 2004, the VHF Direction Finding (DF) equipment carried in the trial boats did not function correctly when very close to WTGs (within approximately 50m). This is deemed to be a relatively small-scale impact due to the

limited use of VHF direction finding equipment and will not impact operational or SAR activities (MCA and QinetiQ, 2004).

429. Throughout the 2005 SAR trials carried out at North Hoyle, the Sea King radio homer system was tested. The Sea King radio homer system utilises the lateral displacement of a vertical bar on an instrument to indicate the sense of a target relative to the aircraft heading. With the aircraft and the target vessel within the array, at a range of approximately 1nm, the homer system operated as expected with no apparent degradation.

430. Since the trials detailed above, no significant issues with regards to VHF DF have been observed or reported, and therefore the presence of the Project is anticipated to have no significant impact upon VHF DF equipment.

14.3 AIS

431. No significant issues with interference to AIS transmission from operational OWFs have been observed or reported to date. Such interference was also absent in the trials carried out at North Hoyle (MCA and QinetiQ, 2004).

432. In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e., blocking line of sight) of the AIS. However, given no issues have been reported to date at operational developments or during trials, no significant impact is anticipated due to the presence of the Project.

14.4 Navigational Telex System

433. The Navigational Telex (NAVTEX) system is used for the automatic broadcast of localised Maritime Safety Information (MSI) and either prints it out in hard copy or displays it on a screen, depending upon the model.

434. There are two NAVTEX frequencies. All transmissions on NAVTEX 518 Kilohertz (kHz), the international channel, are in English. NAVTEX 518 kHz provides the mariner (both recreational and commercial) with weather forecasts, severe weather warnings and navigation warnings such as obstructions or buoys off station. Depending on the user’s location, other information options may be available such as ice warnings for high latitude sailing.

435. The 490 kHz national NAVTEX service may be transmitted in the local language. In the UK full use is made of this secondary frequency including useful information for smaller craft, such as the inshore waters forecast and actual weather observations from weather stations around the coast.

436. Although no specific trials have been undertaken, no significant effect on NAVTEX has been reported to date at operational developments, and therefore no significant impact is anticipated due to the presence of the Project.

14.5 Global Positioning System

437. Global Positioning System (GPS) is a satellite based navigational system. GPS trials were also undertaken throughout the 2004 trials at North Hoyle, and it was stated that "*no problems with basic GPS reception or positional accuracy were reported during the trials*".

438. The additional tests showed that "*even with a very close proximity of a wind turbine to the GPS antenna, there were always enough satellites elsewhere in the sky to cover for any that might be shadowed by the wind turbine tower*" (MCA and QinetiQ, 2004).

439. Therefore, there are not expected to be any significant impacts associated with the use of GPS systems within or in proximity to the Project, noting that there have been no reported issues relating to GPS within or in proximity to any operational OWFs to date.

14.6 Electromagnetic Interference

440. A compass, magnetic compass or mariner's compass is a navigational instrument for determining direction relative to the earth's magnetic poles. It consists of a magnetised pointer (usually marked on the north end) free to align itself with the Earth's magnetic field. A compass can be used to calculate heading, used with a sextant to calculate latitude, and with a marine chronometer to calculate longitude.

441. Like any magnetic device, compasses are affected by nearby ferrous materials as well as by strong local electromagnetic forces, such as magnetic fields emitted from power cables. As the compass still serves as an essential means of navigation in the event of power loss or as a secondary source, it is important that potential impacts from Electromagnetic Field (EMF) are minimised to ensure continued safe navigation.

442. The vast majority of commercial traffic uses non-magnetic gyrocompasses as the primary means of navigation, which are unaffected by EMF. Therefore, it is considered highly unlikely that any interference from EMF as a result of the presence the Project will have a significant impact on vessel navigation. However, some smaller craft (fishing or leisure) may rely on it as their sole means of navigation.

14.6.1 Subsea Cables

443. The export and inter-array cables for the Project will be Alternating Current (AC). Studies indicate that AC does not emit an EMF significant enough to impact marine magnetic compasses (Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), 2008).

14.6.2 Wind Turbine Generators (WTGs)

444. MGN 654 (MCA, 2021) notes that small vessels with simple magnetic steering and hand bearing compasses should be wary of using these close to WTGs as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ, 2004). Potential effects are deemed to be within acceptable levels when considered alongside other mitigation such as the mariner being able to make visual observations (not wholly reliant on the magnetic compass), lighting, sound signals and identification marking in line with MGN 654.

14.6.3 Experience at Operational Windfarms

445. No issues with respect to magnetic compasses have been reported to date in any of the trials (MCA and QinetiQ, 2004) undertaken (inclusive of SAR helicopters) nor in any published reports from operational OWFs.

14.7 Marine Radar

446. This section summarises the results of trials and studies undertaken in relation to Radar effects from OWFs in the UK. It is important to note that since the time of the trials and studies discussed, WTG technology has advanced significantly, most notably in terms of the size of WTGs available to be installed and utilised. The use of these larger WTGs allows for a greater spacing between WTGs than was achievable at the time of the studies being undertaken, which is beneficial in terms of Radar interference effects (and surface navigation in general) as detailed below.

14.7.1 Trials

447. During the early years of offshore renewables within the UK, maritime regulators undertook a number of trials (both shore-based and vessel-based) into the effects of WTGs on the use and effectiveness of marine Radar.

448. In 2004 trials undertaken at North Hoyle (MCA, 2004) areas of concern were identified regarding the potential impact on marine- and shore-based Radar systems due to the large vertical extents of the WTGs (based on the technology at that time). This resulted in Radar responses strong enough to produce interfering side lobes and reflected echoes (often referred to as false targets or ghosts).

449. Side lobe patterns are produced by small amounts of energy from the transmitted pulses that are radiated outside of the narrow main beam. The effects of side lobes are most noticeable within targets at short range (below 1.5nm) and with large objects. Side lobe echoes form either an arc on the Radar screen similar to range rings, or a series of echoes forming a broken arc, as illustrated in Figure 14.1.

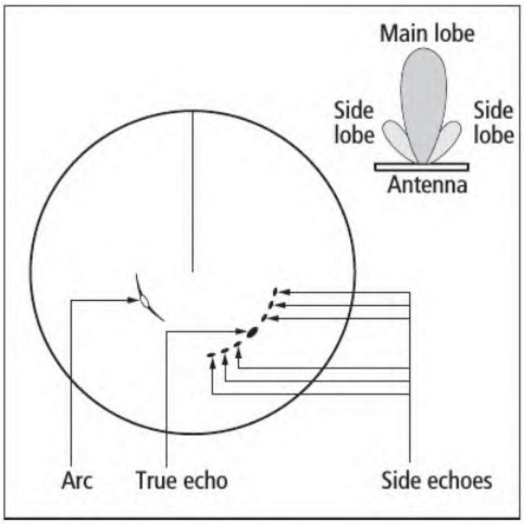

Figure 14.1 Illustration of Side Lobes on Radar Screen

450. Multiple reflected echoes are returned from a real target by reflection from some object in the Radar beam. Indirect echoes or 'ghost' images have the appearance of true echoes but are usually intermittent or poorly defined; such echoes appear at a false bearing and false range, as illustrated in Figure 14.2.

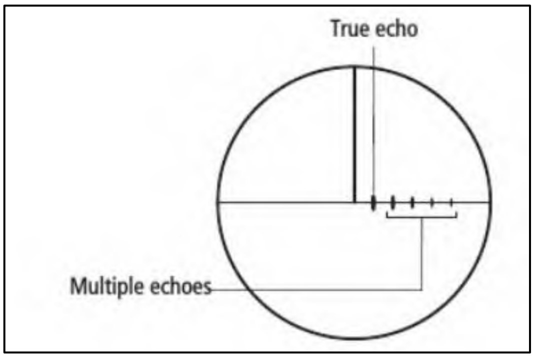

Figure 14.2 Illustration of Multiple Reflected Echoes on Radar Screen

451. Based on the results of the North Hoyle trials, the MCA produced a Shipping Route Template designed to give guidance to mariners on the distances which should be established between shipping routes and OWFs. However, as experience of effects associated with use of marine Radar in proximity to OWFs grew, the MCA refined their guidance, offering more flexibility within the more recent Shipping Route Templates, including the most recent contained within MGN 654 (MCA, 2021).

452. A second set of trials conducted at Kentish Flats OWF in 2006 on behalf of the British Wind Energy Association (BWEA) – now called RenewableUK (BWEA, 2007) – also found that Radar antennas which are sited unfavourably with respect to components of the vessel's structure can exacerbate effects such as side lobes and reflected echoes. Careful adjustment of Radar controls suppressed these spurious

Radar returns, but mariners were warned that there is a consequent risk of losing targets with a small Radar cross section, which may include buoys or small craft, particularly yachts or Glass Reinforced Plastic (GRP) constructed craft; therefore, due care should be taken in making such adjustments.

453. Theoretical modelling of the effects of the development of the proposed Atlantic Array OWF, which was to be located off the south coast of Wales, on marine Radar systems was undertaken by the Atlantic Array project (Atlantic Array, 2012) and considered a wider spacing of WTGs than that considered within the early trials[7]. The main outcomes of the modelling were the following:

- Multiple and indirect echoes were detected under all modelled parameters;
- The main effects noticed were stretching of targets in azimuth (horizontal) and appearance of ghost targets;
- There was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the WTGs and safe navigation;
- Even in the worst case with Radar operator settings artificially set to be poor, there is significant clear space around each WTG that does not contain any multipath or side lobe ambiguities to ensure safe navigation and allow differentiation between false and real (both static and moving) targets;
- Overall, it was concluded that the amount of shadowing observed was very little (noting that the model considered lattice-type foundations which are sufficiently sparse to allow Radar energy to pass through);
- The lower the density of WTGs the easier it is to interpret the Radar returns and fewer multipath ambiguities are present;
- In dense, target rich environments S-Band Radar scanners suffer more severely from multipath effects in comparison to X-Band Radar scanners;
- It is important for passing vessels to keep a reasonable separation distance between the WTGs in order to minimise the effect of multipath and other ambiguities;
- The Atlantic Array study undertaken in 2012 noted that the potential for Radar interference was mainly a problem during periods of reduced visibility when mariners may not be able to visually confirm the presence of other vessels in proximity (those without AIS installed which are usually fishing and recreational craft). It is noted that this situation would arise with or without WTGs in place; and
- There is potential for the performance of a vessel's ARPA to be affected when tracking targets in or near the array. Although greater vigilance is required, during the Kentish Flats trials it was shown that false targets were quickly identified as such by the mariners and then by the equipment itself.

[7] It is acknowledged that other theoretical analysis has been undertaken.

454. In summary, experience in UK waters has shown that mariners have become increasingly aware of any Radar effects as more OWFs become operational. Based on this experience, the mariner can interpret the effects correctly, noting that effects are the same as those experienced by mariners in other environments such as in close proximity to other vessels or structures. Effects can be effectively mitigated by "*careful adjustment of Radar controls*".

455. The MCA has also produced guidance to mariners operating in proximity to OREIs in the UK which highlights Radar issues amongst others to be taken into account when planning and undertaking voyages in proximity to OREIs (MCA, 2008). The interference buffers presented in Table 14-1 are based on MGN 654 (MCA, 2021), MGN 371 (MCA, 2008), MGN 543 (MCA, 2016) and MGN 372 (MCA, 2022).

Table 14-1 Distances at which Impacts on Marine Radar Occur

Distance at Which Effect Occurs (nm)	Identified Effects
0.5	▪ Intolerable impacts can be experienced. ▪ X-Band Radar interference is intolerable under 0.25nm. ▪ Vessels may generate multiple echoes on shore-based Radars under 0.45nm.
1.5	▪ Under MGN 654, impacts on Radar are considered to be tolerable with mitigation between 0.5 and 3.5nm. ▪ S-band Radar interference starts at 1.5nm. ▪ Echoes develop at approximately 1.5nm, with progressive deterioration in the Radar display as the range closes. Where a main vessel route passes within this range considerable interference may be expected along a line of WTGs. ▪ The WTGs produce strong Radar echoes giving early warning of their presence. ▪ Target size of the WTG echo increases close to the WTG with a consequent degradation on both X and S-Band Radars.

456. As noted in Table 14-1, the onset range from the WTGs of false returns is approximately 1.5nm, with progressive deterioration in the Radar display as the range closes. If interfering echoes develop, the requirements of the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) Rule 6 Safe Speed are particularly applicable and must be observed with due regard to the prevailing circumstances (IMO, 1972/77). In restricted visibility, Rule 19 Conduct of Vessels in Restricted Visibility applies and compliance with Rule 6 becomes especially relevant. In such conditions mariners are required, under Rule 5 Look-out to take into account

information from other sources which may include sound signals and VHF information, for example from a VTS or AIS (MCA, 2016).

14.7.2 Experience from Operational Developments

457. The evidence from mariners operating in proximity to existing OWFs is that they quickly learn to adapt to any effects. Figure 14.3 presents the example of the Galloper and Greater Gabbard OWF, which are located in proximity to IMO routeing measures. Despite this proximity to heavily trafficked TSS lanes, there have been no reported incidents or issues raised by mariners who operate within the vicinity. The interference buffers presented in Figure 14.3 are as per Table 14-1.

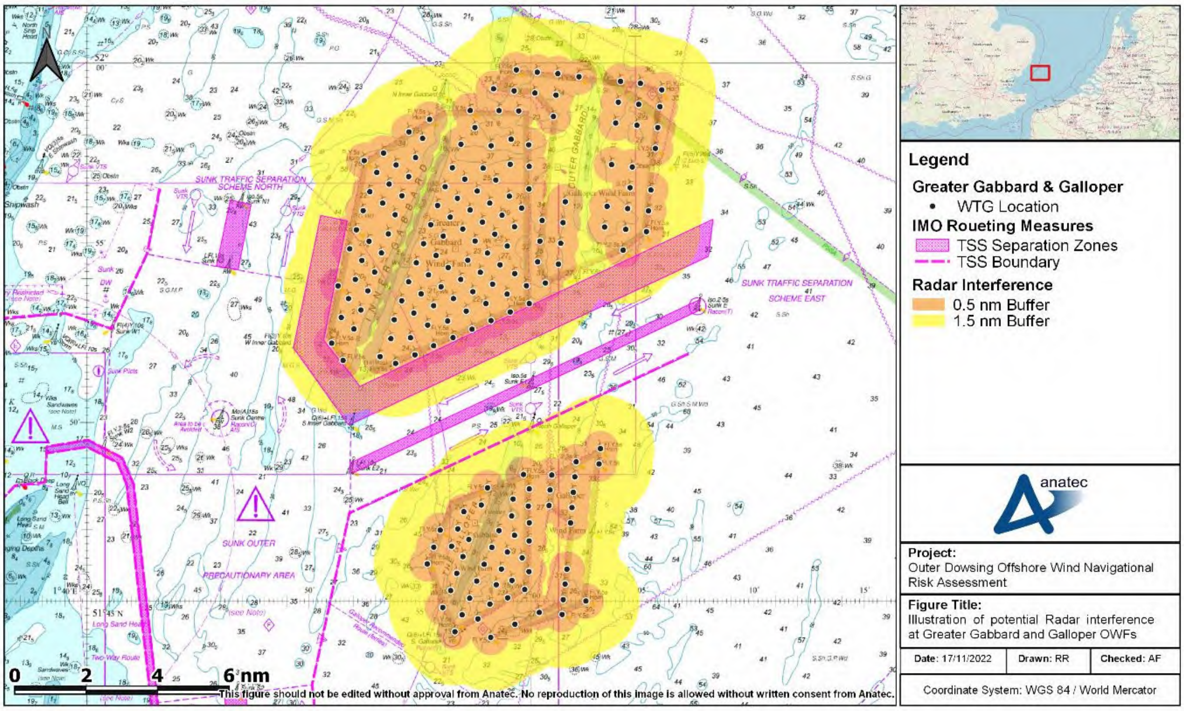

Figure 14.3 Illustration of Potential Radar Interference at Greater Gabbard and Galloper OWFs

458. As indicated by Figure 14.3, vessels utilising these TSS lanes will experience some Radar interference based on the available guidance. Both developments are operational, and each of the lanes is used by a minimum of five vessels per day on average. However, to date, there have been no incidents recorded (including any related to Radar use) or concerns raised by other users.

459. AIS information can also be used to verify the targets of larger vessels (generally vessels over 15m LOA – the minimum threshold for fishing vessel AIS carriage requirements). Approximately 3% of the vessel traffic recorded within the shipping and navigation study area was under 15m LOA in both survey periods, although throughout the vessel traffic surveys approximately 97% of vessel tracks were

recorded on AIS, indicating a low level of AIS take-up among vessels for which AIS carriage is not mandatory.

460. For any smaller vessels, particularly fishing vessels and recreational vessels, AIS Class B devices are becoming increasingly popular and allow the position of these small craft to be verified when in proximity to an OWF.

14.7.3 Increased Radar Returns

461. Beam width is the angular width, horizontal or vertical, of the path taken by the Radar pulse. Horizontal beam width ranges from 0.75° to 5°, and vertical beam width from 20° to 25°. How well an object reflects energy back towards the Radar depends upon its size, shape and aspect angle.

462. Larger WTGs (either in height or width) will return greater target sizes and/or stronger false targets. However, there is a limit to which the vertical beam width would be affected (20° to 25°) dependent upon the distance from the target. Therefore, increased WTG height in the array area will not create any effects in addition to those already identified from existing operational windfarms (interfering side lobes, multiple and reflected echoes).

463. Again, when taking into consideration the potential options available to marine users (such as reducing gain to remove false returns) and feedback from operational experience, this shows that the effects of increased returns can be managed effectively.

14.7.4 Fixed Radar Antenna Use in Proximity to an Operational Windfarm

464. It is noted that there are multiple operational windfarms including Galloper that successfully operate fixed Radar antenna from locations on the periphery of the array. These antennas are able to provide accurate and useful information to onshore coordination centres.

14.7.5 Application to the Project

465. Upon development of the Project, some commercial vessels may pass within 1.5nm of structures within the array area and therefore may be subject to a minor level of Radar interference. Trials, modelling, and experience from existing developments note that any impact can be mitigated by adjustment of Radar controls.

466. Vessels passing within the array will be subject to a greater level of interference with impacts becoming more substantial in close proximity to WTGs. This will require additional mitigation by any vessels including consideration of the navigational conditions (visibility) when passage planning and compliance with the COLREGs (IMO, 1972/77) will be essential.

467. Figure 14.4 presents an illustration of potential Radar interference due to the Project. The Radar effects have been applied to the indicative full build out array layout introduced in section 6.3.1.

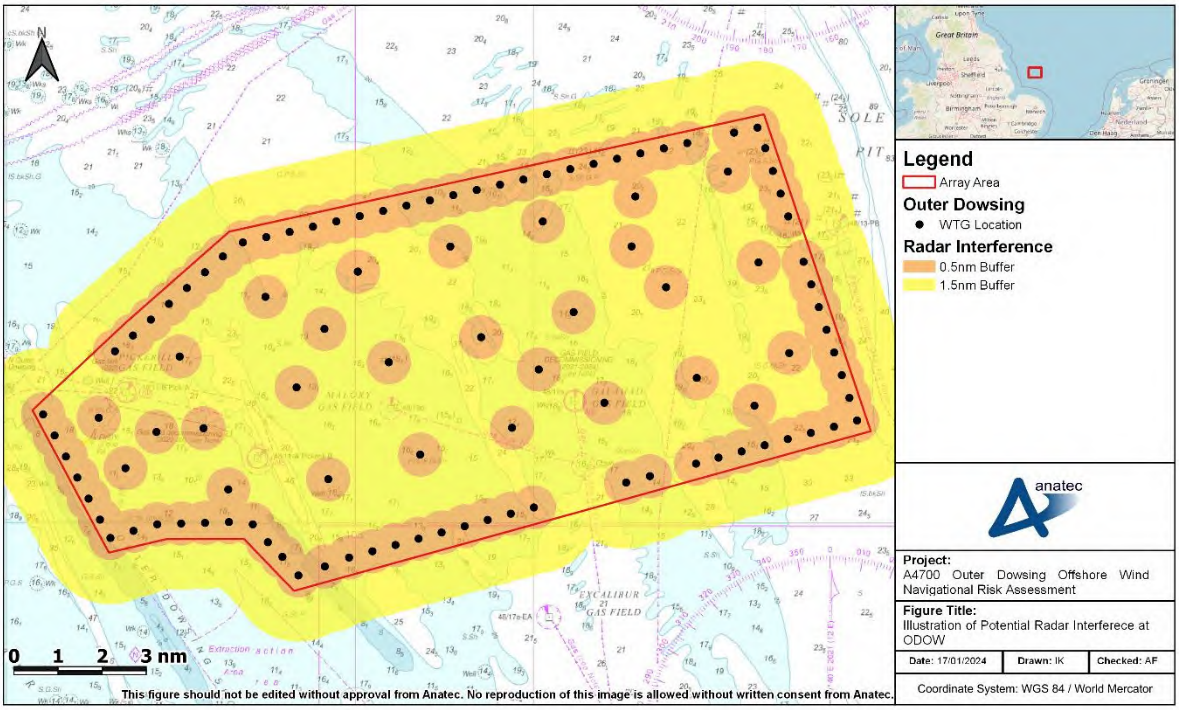

Figure 14.4 Illustration of Potential Radar Interference at the Project

468. It is noted that the reduction of the array area on the western boundary decreases any minor potential of radar impacts within the Outer Dowsing Channel.

469. Overall, the impact on marine Radar is expected to be low and no further impact upon navigational safety is anticipated outside the parameters which can be mitigated by operational controls.

14.8 Sound Navigation Ranging System

470. No evidence has been found to date with regard to existing OWFs to suggest that Sound Navigation Ranging (SONAR) systems produce any kind of SONAR interference which is detrimental to the fishing industry, or to military systems. No impact is therefore anticipated in relation to the presence of the Project.

14.9 Noise

471. No evidence has been found to date with regard to existing OWFs to suggest that prescribed sound signals are in any way impacted by acoustic noise produced by the windfarm.

14.10 Summary of Potential Effects on Use

472. Based on the detailed technical assessment of the effects from the presence of the Project on navigation, communication, and position fixing equipment in the previous subsections, Table 14-2 summarises the assessment of frequency and consequence and the resulting risk for each component of this impact. On the basis of these findings, associated risks are screened out of the risk assessment undertaken in section 19.

Table 14-2 Summary of Risks, Communication and Position Fixing Equipment

Topic	Frequency	Consequence	Significance of Risk
VHF	Negligible	Minor	Broadly Acceptable
VHF direction finding	Extremely Unlikely	Minor	Broadly Acceptable
AIS	Negligible	Minor	Broadly Acceptable
NAVTEX	Negligible	Minor	Broadly Acceptable
GPS	Negligible	Minor	Broadly Acceptable
EMF	Extremely Unlikely	Negligible	Broadly Acceptable
Marine Radar	Remote	Minor	Broadly Acceptable
SONAR	Negligible	Minor	Broadly Acceptable
Noise	Negligible	Minor	Broadly Acceptable

15 Future Case Vessel Traffic

473. The characterisation of vessel traffic established in the baseline (see section 10 and section 11) is used as input to the risk assessment (see section 19). However, it is also necessary to consider potential future case vessel traffic, in terms of general volume and size changes, port developments which may influence movements, and changes to movements associated with the presence of the Project (the post windfarm scenario).

474. The following subsections provide details of high-level future case scenarios which have been used to inform the risk assessment.

15.1 Increases in Commercial Vessel Activity

475. There is uncertainty associated with long-term predictions of vessel traffic growth including the potential for any other new developments in UK or transboundary ports and the long-term effects of Brexit on vessel access.

476. Therefore, to account for variation two independent scenarios of potential growth in commercial vessel movements of 10% and 20% have been estimated throughout the lifetime of the Project.

15.2 Increases in Commercial Fishing Vessel and Recreational Vessel Activity

477. There is similar uncertainty associated with long-term predictions for commercial fishing vessel and recreational vessel transits given the limited reliable information on future trends upon which any firm assumption could be made.

478. Therefore, two independent scenarios of potential growth in commercial fishing vessel and recreational vessel movements of 10% and 20% has been estimated throughout the lifetime of the Project.

15.3 Increases in Traffic Associated with Offshore Windfarm Operations

479. Up to 2,480 annual round trips to port would be made by vessels involved in the operation and maintenance of the Project (see section 6.5.2).

480. Noting the low data confidence associated with a number of the other cumulative developments (see section 16) and uncertainty over base ports which will be used, it is only possible to qualitatively consider future case vessel movements associated with OWF operations.

15.4 Methodology

481. It is not possible to consider all potential alternative routeing options for commercial traffic and therefore worst-case alternatives have been considered. Assumptions for re-routeing include:

- All alternative routes maintain a minimum mean distance of 1nm from offshore installations and existing OWF boundaries in line with industry experience. This distance is considered for shipping and navigation from a safety perspective as explained below; and
- All mean routes take into account sandbanks, AtoNs and known routeing preferences.

482. Annex 2 of MGN 654 defines a methodology for assessing passing distance from OWF boundaries (the Shipping Route Template) but states that it is "not a prescriptive tool but needs intelligent application".

483. To date, internal and external studies undertaken by Anatec on behalf of the UK Government and individual clients show that vessels do pass consistently and safely within 1nm of established OWFs (including between distinct developments) and these distances vary depending upon the sea room available as well as the prevailing conditions. This evidence also demonstrates that the Mariner defines their own safe passing distance based upon the conditions and nature of the traffic at the time, but they are shown to frequently pass 1nm off established developments. Evidence also demonstrates that commercial vessels do not transit through arrays.

484. The NRA also aims to establish the MDS based on navigational safety parameters, and when considering this the most conservative realistic scenario for vessel routeing is considered to be when main commercial routes pass 1nm off developments. Evidence collected during numerous assessments at an industry level confirms that it is a safe and reasonable distance for vessels to pass; however, it is likely that a large number of vessels would instead choose to pass at a greater distance depending upon their own passage plan and the current conditions.

15.5 Post Windfarm Routeing

15.5.1 Array Area

485. Each of the main routes identified (see section 11.2) has been assessed for the potential to deviate considering the methodology set out in section 15.4. A total of four of the 13 main routes identified are expected to deviate on this basis. The post windfarm routeing is shown in Figure 15.1. Following this, a summary of the deviation magnitudes is provided in Table 15-1.

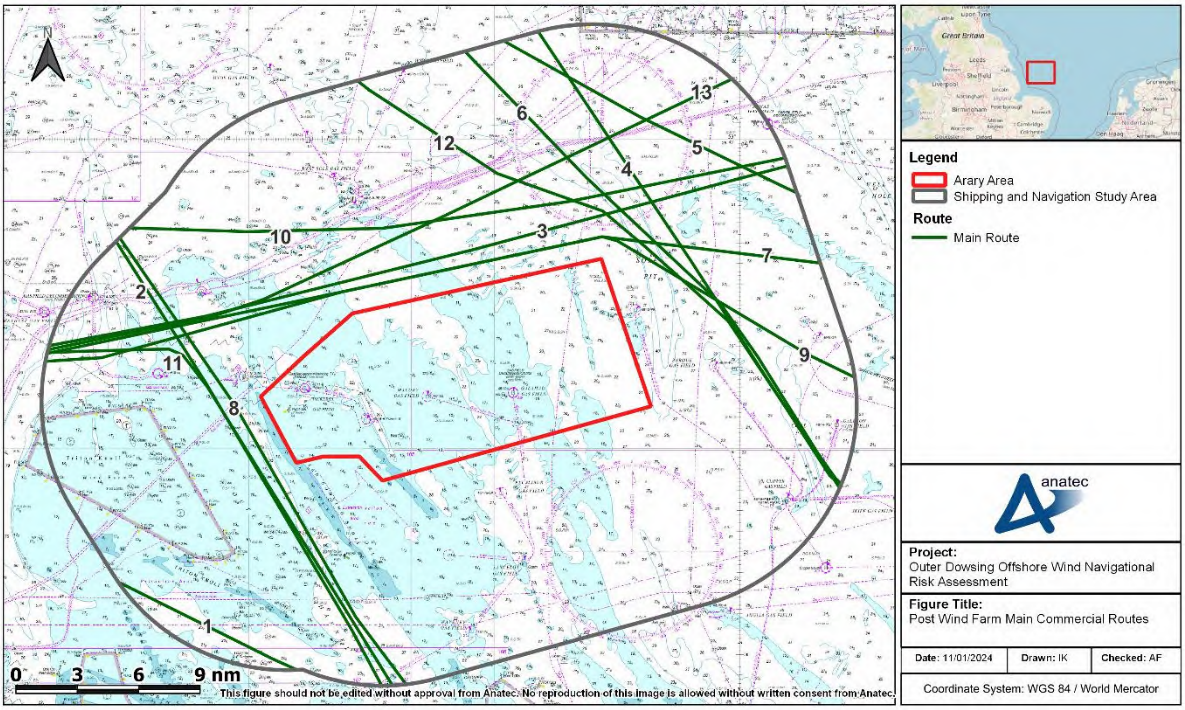

Figure 15.1 Post Windfarm Routeing

Table 15-1 Deviation Summary

Route	Vessels per Day	Distance pre Windfarm (nm)	Distance post Windfarm (nm)	Change (nm)	Percentage Change
1	16	174.3	174.3	0.00	0%
2	12	249.8	249.8	0.00	0%
3	4	286.9	286.9	0.00	0%
4	2	252.3	252.3	0.00	0%
5	2	267.8	267.8	0.00	0%
6	2	250.5	250.5	0.00	0%
7	**1**	**289.1**	**289.5**	**0.41**	**0%**
8	**1**	**247.3**	**249.7**	**2.37**	**1%**
9	**<1**	**288.3**	**290.9**	**2.61**	**1%**
10	<1	288.6	288.6	0.00	0%
11	<1	180.4	180.4	0.00	0%
12	**<1**	**250.8**	**251.1**	**0.23**	**0%**
13	<1	69.5	69.5	0.00	0%

486. The deviations of the four routes highlighted in Table 15-1 to are summarised as follows:

- **Route 7: one vessel per day**. Intersects array area, vessels anticipated to pass to the north post windfarm. Estimated journey distance increase of 0.4nm.
- **Route 8: one vessel per day**. Intersects array area, vessels anticipated to pass to the west post windfarm. Estimated journey distance increase of 2.4nm.
- **Route 9: one vessel per day**. Intersects array area, vessels anticipated to pass to the north post windfarm. Estimated journey distance increase of 2.6nm.
- **Route 12: > 1 vessel per day**. Likely vessels will pass further north (a minor deviation) to increase passing distance from array area. Estimated journey distance increase of 0.2nm.

487. Likely route deviations taking into account the implementation of the ORBA are provided in Annex F.

15.5.2 ORCP Area

488. It is noted that as per section 6.3.3, the ORCP area has been reduced since the PEIR. Due to the distance from each of the identified routes to the updated ORCP area, there are considered to be no necessary deviations of the routes due to construction of the ORCP. It is noted that there is searoom available for vessels on Route 3 (see Figure 11.3) to pass further east should they choose to do so (representing a minor deviation), however no deviation has been assumed to ensure a worst case allision risk is modelled.

16 Cumulative and Transboundary Overview

489. Cumulative effects have been considered for activities in combination and cumulatively with the Project. This section provides an overview of the baseline used to inform the cumulative risk assessment, including the proposed developments screened into the cumulative risk assessment based on the criteria outlined in section 3.3. Given the unique nature of shipping and navigation users the bespoke tiering system outlined in section 3.3 has been applied.

490. The outputs of the cumulative risk assessment are then provided in section 20.

16.1 Screened in Other Developments

491. The offshore wind farm developments screened into the cumulative assessment based on the criteria provided in section 3.3 are summarised in Table 16-1. A plot showing the locations of the developments relative to the array area is then shown in Figure 16.1, noting baseline developments have been shown for reference.

492. It is noted that three potential carbon capture areas (Southern North Sea Area 3, Southern North Sea Area 6, and CS017) are in proximity to array area or offshore ECC. Any vessel deviation associated with future development would be temporary, and limited to periods where any surface vessel activity was required. As such these areas have not been included in Table 16-1.

Table 16-1 Cumulative Tiering Summary – Offshore Wind Farms

Development	Type	Distance from Array Area (nm)	Status	Data Confidence	Interacts with Main Route	Tier
Dudgeon Extension	OWF	7.3	Consented	Medium	Yes	1
Sheringham Shoal Extension	OWF	14.1	Consented	Medium	Yes	1
Hornsea Four	OWF	21.2	Consented	Medium	Yes	1
Hornsea Three	OWF	33.9	Consented	High	Yes	1
Norfolk Vanguard West	OWF	45.2	Consented	High	Yes	1

Development	Type	Distance from Array Area (nm)	Status	Data Confidence	Interacts with Main Route	Tier
Dogger Bank South	OWF	45.0	In Planning (Application submitted)	Low	No	2

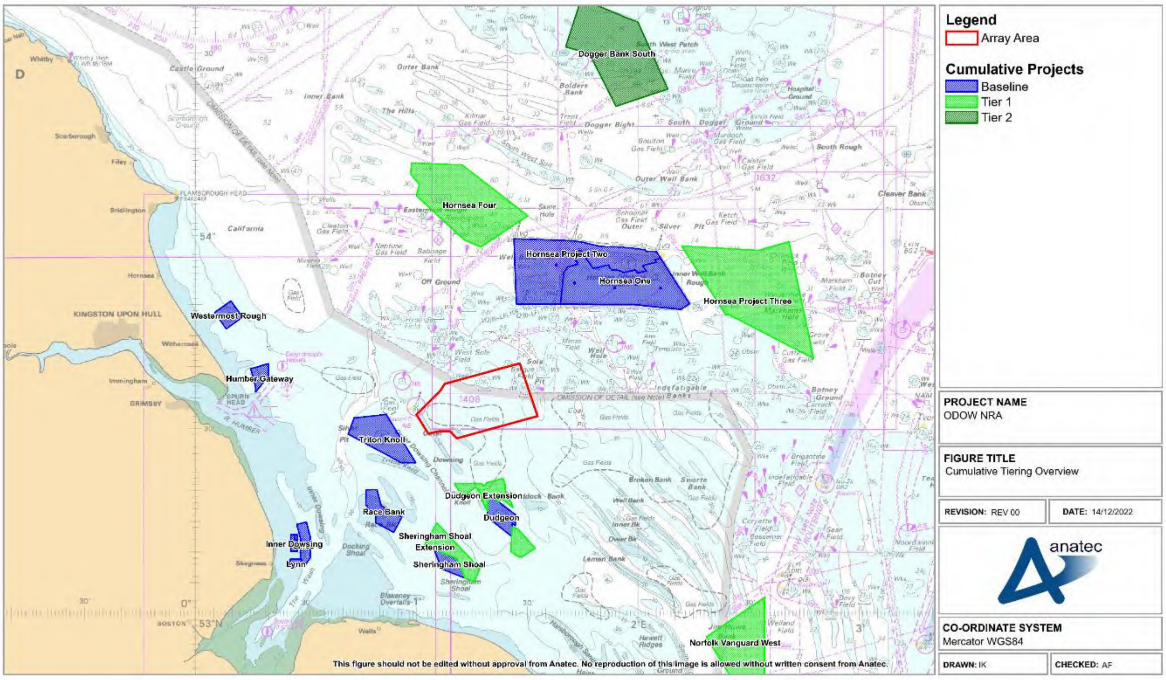

Figure 16.1 Cumulative Tiering Overview – Offshore Wind Farms

493. The MCA noted during consultation (see section 4.2.3) that it should be considered whether any of the Dutch windfarms north of the East Anglia projects may have an impact, though they added no impact was expected. These projects are all further than 50nm from the array area and are of low data confidence and as such have been screened out of detailed assessment.

494. In addition, the Eastern Green Link 3 and 4 cable developments pass within 2nm of the offshore ECC, and as such have been screened in as Tier 1 cable developments.

16.2 Cumulative Routeing Options

16.2.1 Array Area

495. Each main route identified (see section 11.2) has been assessed to determine any interactions with the screened in cumulative developments (see section 16.1). The outputs of this assessment are summarised in Table 16-2.

Table 16-2 Potential Cumulative Routeing Interactions with Cumulative Developments

Route No.	Average Vessels per Day	Description	Outer Dowsing	Hornsea Four	Hornsea Three	Dudgeon Extension	Sheringham Shoal Extension	Norfolk Vanguard West	Dogger Bank South
1	16	**Humber Ports – Rotterdam (The Netherlands)**				✓		✓	
2	12	**Tees – Rotterdam (The Netherlands)**				✓			
3	4	**Humber Ports – Cuxhaven (Germany)**	✓*		✓				
4	2	**Tees Port – Rotterdam (The Netherlands)**		✓				✓	
5	2	**Newcastle – Amsterdam (The Netherlands)**							
6	2	**Tees – Rotterdam (The Netherlands)**						✓	
7	1	**Humber Ports – Cuxhaven (Germany)**	✓		✓				
8	1	**Tees – Rotterdam (The Netherlands)**	✓			✓		✓	
9	<1	**Humber Ports – Bremerhaven/Hamburg (Germany)**	✓						
10	<1	**Humber Ports – Cuxhaven (Germany)**			✓				
11	<1	**Humber Ports – Rotterdam (The Netherlands)**				✓			

Route No.	Average Vessels per Day	Description	Outer Dowsing	Hornsea Four	Hornsea Three	Dudgeon Extension	Sheringham Shoal Extension	Norfolk Vanguard West	Dogger Bank South
12	<1	**Tees – Amsterdam (The Netherlands)**	✓					✓	
13	<1	**Humber Ports – Hornsea OWFs**							

* Route 3 does not interact with the array area in isolation, however is likely to interact when considered cumulatively with Hornsea Three.

496. A total of five routes are likely to deviate as a result of the array area and other screened in developments, namely Routes 3 7, 8, 9 and 12. Based on the potential interactions with other screened in cumulative developments as shown in Table 16-2, the likely cumulative routeing options for these four routes is summarised as follows:

- **Route 3:** vessels on this route are likely to undertake a minor deviation to the north of the array area to increase passing distance from the structures and will then pass south of Hornsea Three. It is noted that cumulative impacts to Route 3 of which DFDS is a key operator were raised as a key cumulative concern pre PEIR and at PEIR. Further discussion is provided in section 16.2.1.1.
- **Route 7:** vessels on this route are likely to deviate to the north of the array area and will then pass south of Hornsea Three.
- **Route 8:** vessels are likely to pass west of the array area, in between the Dudgeon and Sheringham Shoal extensions, and south of Norfolk Vanguard West to access the DR1 Deep Water Route (DWR).
- **Route 9:** vessels may pass either north or south of the array area, no other interactions with cumulative developments have been identified.
- **Route 12:** vessels are likely to utilise a minor deviation to the north to avoid the array area and pass north of Norfolk Vanguard West to access the DR1 DWR.

16.2.1.1 Route 3 Cumulative Deviations

497. It is noted that cumulative impacts to Route 3 of which DFDS is a key operator have been raised as a key cumulative concern, in particular the need for vessels on that route to pass north of the array area and then deviate south of Hornsea Three. The cumulative Route 3 deviation required is presented in Figure 16.2, alongside the preferred DFDS route (referred to as the ‘Pre WF Route’ in Figure 16.2), as indicated by DFDS during consultation (see section 4.2.3).

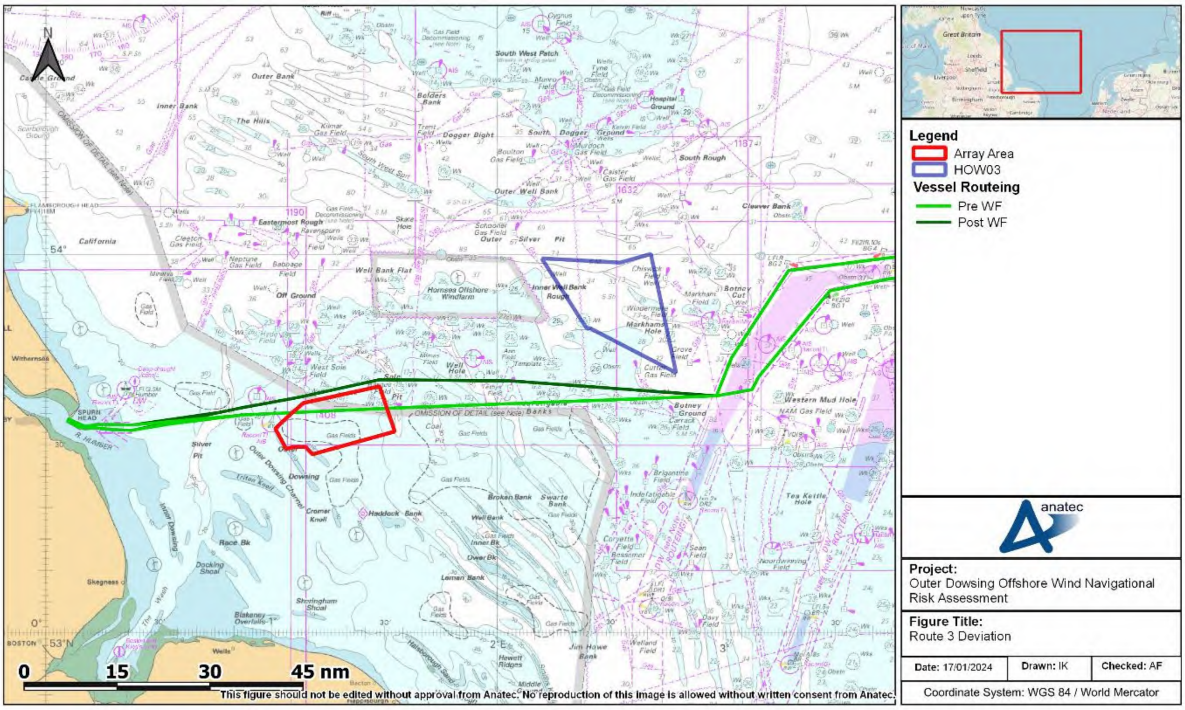

Figure 16.2 Route 3 Cumulative Deviation

498. From the post windfarm route, there will be an approximate 0.59nm (0.18%) increase to the route length due to the presence of the Project and Hornsea 3. It is noted that, compared to the array area at PEIR, this has been reduced from an approximate 0.97nm (0.30%) increase at that stage due to the updates made (see section 6.1). These values have been determined via the methodology set out in section 15.4.

499. DFDS noted during post PEIR consultation (section 4) that a deviation of around 2nm may occur cumulatively as a result of the array area and Hornsea Three, noting this was only an estimate within a meeting, and prior to the final array area being fully defined and reduced. The CoS confirmed via email response on 12 January 2023 that subsequent feedback collected from DFDS was broadly positive regarding navigational safety and the final array area updates.

16.2.2 ORCP Area

500. Given that there are no route deviations in isolation, it is not considered that the ORCP area will contribute to cumulative deviations, noting its location outside of shipping routes, and the presence of local shallow banks already dictating vessel routeing.

17 Collision and Allison Risk Modelling

501. To inform the risk assessment, a quantitative assessment of some of the major hazards associated with the Project has been undertaken, with vessel traffic in proximity to both the array area and ORCP area considered. The following subsections outline the inputs and methodology used for the collision and allision risk modelling.

17.1.1 Scenarios Under Consideration

502. For each element of the quantitative assessment, both a pre and post windfarm scenario with base and future case traffic levels have been considered. As a result, six distinct scenarios have been modelled:

- Pre windfarm with base case traffic levels;
- Pre windfarm future case with a 10% increase on base case traffic levels;
- Pre windfarm future case with a 20% increase on base case traffic levels;
- Post windfarm with base case traffic levels;
- Post windfarm future case with a 10% increase on base case traffic levels; and
- Post windfarm future case with a 20% increase on base case traffic levels.

503. The results of the base case scenarios are detailed in full in the following subsections, with the equivalent results for each future case scenario for the array area and ORCP area provided in section 17.2.3 and section 17.3.3 respectively.

17.1.2 Hazards Under Consideration

504. Hazards considered in the quantitative assessment are as follows:

- Increased vessel to vessel collision risk;
- Increased powered vessel to structure allision risk;
- Increased drifting vessel to structure allision risk; and
- Increased fishing vessel to structure allision risk.

505. The pre windfarm assessment has been informed by the array area and ORCP area vessel traffic survey data (see section 10.1 and 10.3 respectively) and other baseline data sources (such as Anatec's ShipRoutes database (Anatec, 2023). Conservative assumptions have been made with regard to route deviations and future shipping growth over the lifetime of the Project.

17.2 Array Area

17.2.1 Pre Windfarm Modelling

17.2.1.1 Vessel to Vessel Encounters

506. An assessment of current vessel to vessel encounters has been undertaken by replaying at high speed the vessel traffic data collected as part of the vessel traffic

surveys (see section 5.2). The model defines an encounter as two vessels passing within 1 nm of each other within the same minute. This helps to illustrate where existing shipping congestion is highest and therefore where offshore developments, such as an OWF, could potentially increase congestion and therefore also increase the risk of encounters and collisions. No account of whether encounters are head on or stern to head are given; only close proximity is identified for.

507. Figure 17.1 presents a heat map based upon the geographical distribution of vessel encounter tracks within a density grid. Following this, Figure 17.2 illustrates the daily number of encounters recorded within the shipping and navigation study area and array area throughout the survey periods.

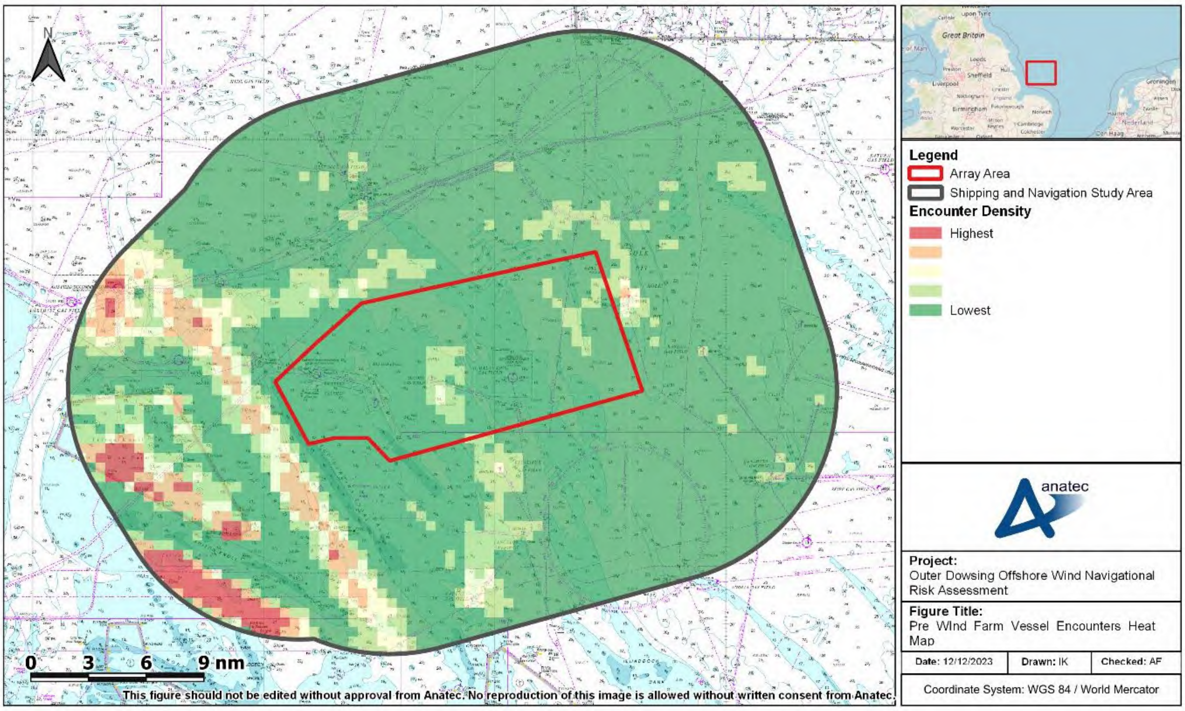

Figure 17.1 Pre Windfarm Vessel Encounters Heat Map

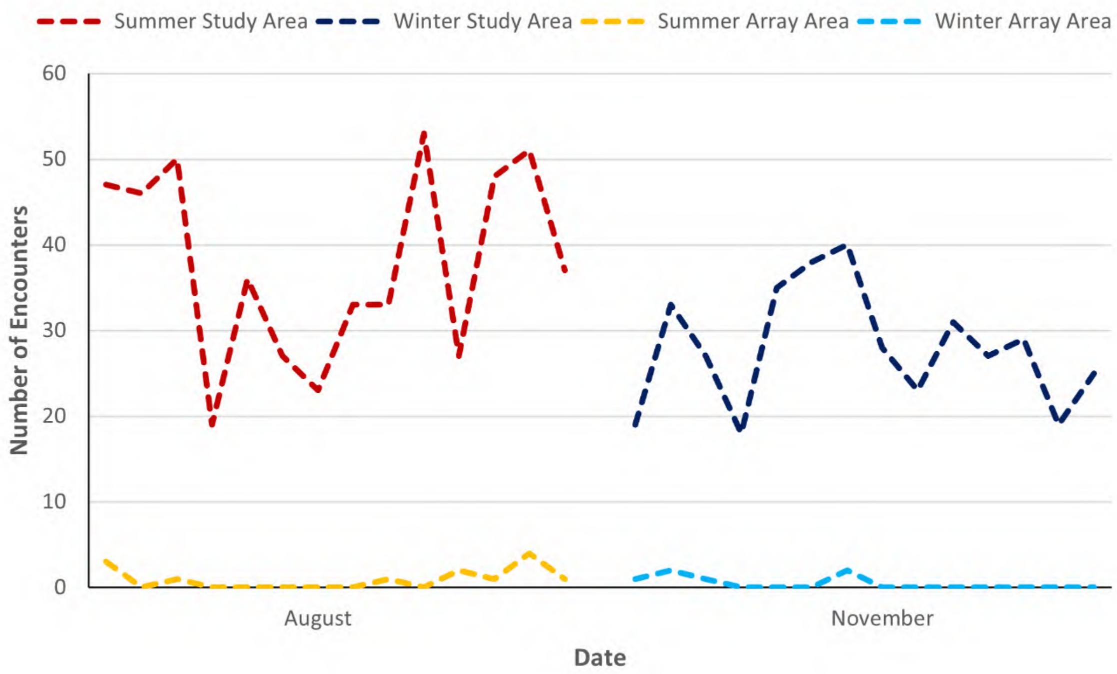

Figure 17.2 Vessel Encounters per Day

508. There was on average 33 encounters per day within the shipping and navigation study area throughout the survey periods. The greatest number of encounters recorded in one day was 53, on 11th August 2022. Encounter volumes are high relative to other assessments due to both relatively high traffic volumes and the presence of operational Triton Knoll traffic.

The most frequent vessel types involved in encounters within the shipping and navigation study area were cargo vessels (33%) and windfarm support vessels (26%).

17.2.1.2 Vessel to Vessel Collision Risk

509. Using the pre windfarm vessel routeing as input (see section 11.2), Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risk in proximity to the array area. The route positions and widths are based on the vessel traffic data sources considered (see section 5).

510. A heat map based upon the geographical distribution of collision risk within a 0.5×0.5nm grid for the base case is presented in Figure 17.3.

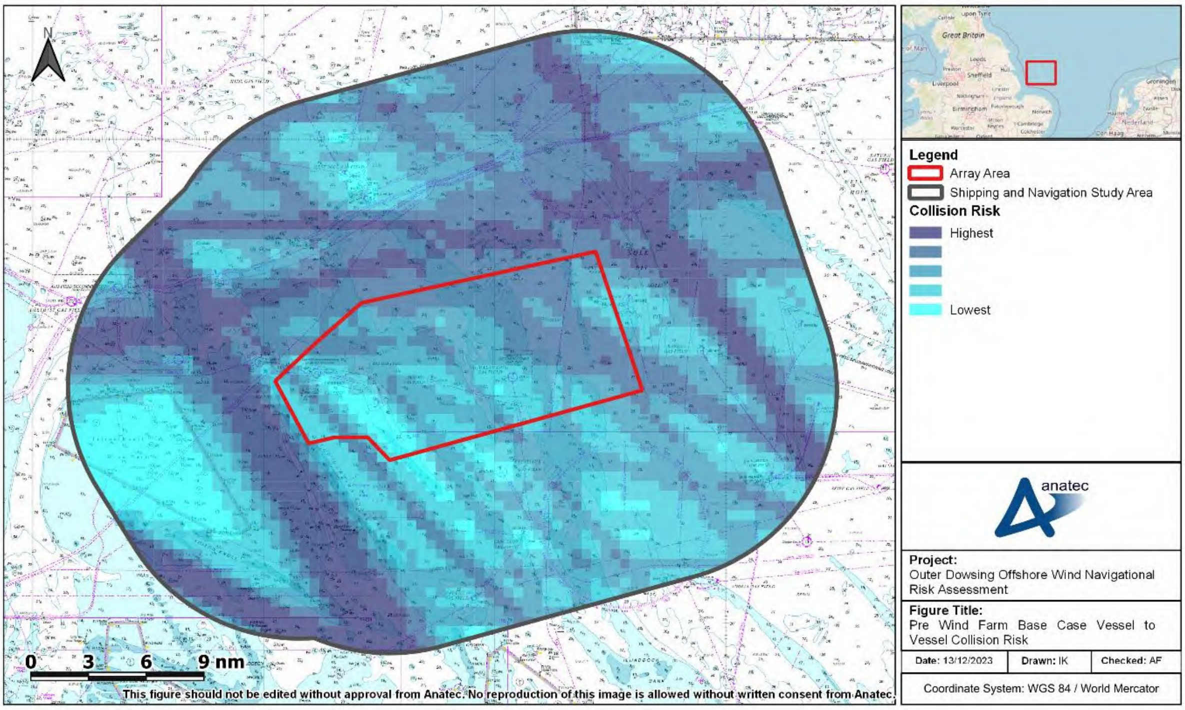

Figure 17.3 Pre Windfarm Vessel to Vessel Collision Risk

511. The annual collision frequency pre windfarm was estimated to be 3.21×10^{-2}, corresponding to a return period of approximately one in 31 years. The highest risk areas generally correspond to the busiest main routes identified in section 11.2.

512. It is noted that the model is calibrated based upon major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor impacts. Other incident data, which includes minor incidents, is presented in section 8.

17.2.2 Post Windfarm Modelling

17.2.2.1 Simulated Automatic Identification System

513. Anatec's AIS Simulator software was used to gain an insight into the potential re-routed commercial traffic following the installation of the windfarm structures within the array area. The AIS Simulator uses the mean positions of the main commercial routes identified within the shipping and navigation study area and the anticipated shift post windfarm, together with the standard deviations and average number of vessels on each main commercial route to simulate tracks.

514. A figure of 28 days of simulated AIS (matching the total duration of the vessel traffic surveys) within the shipping and navigation study area, based on the deviated main commercial routes, is presented in Figure 17.4.

515. It is noted that the simulated AIS represents an MDS based on commercial routes passing at a minimum mean distance of 1 nm from the array area.

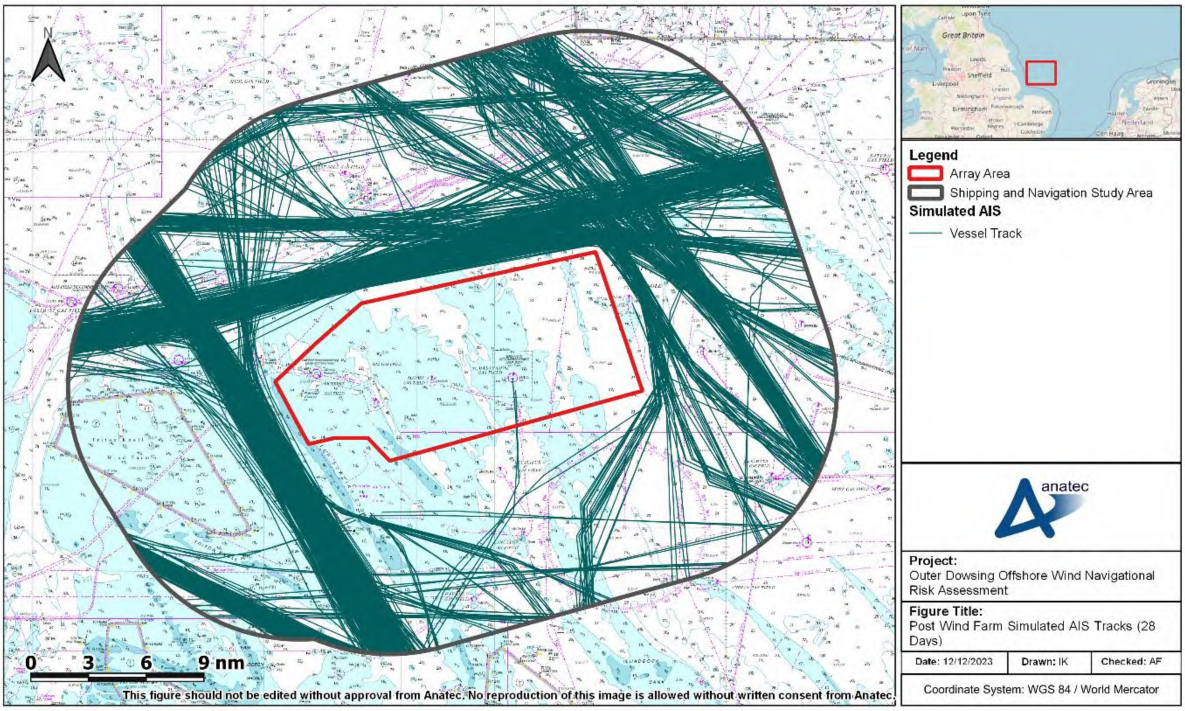

Figure 17.4 Post Windfarm Simulated AIS Tracks (28 Days)

17.2.2.2 Vessel to Vessel Collision Risk

516. Using the post windfarm routeing as input (see section 15.5), Anatec's COLLRISK model has been run to estimate the anticipated vessel to vessel collision risk in proximity to the array area.

517. A heat map based upon the geographical distribution of collision risk within a 0.5×0.5nm grid for the base case is presented in Figure 17.5.

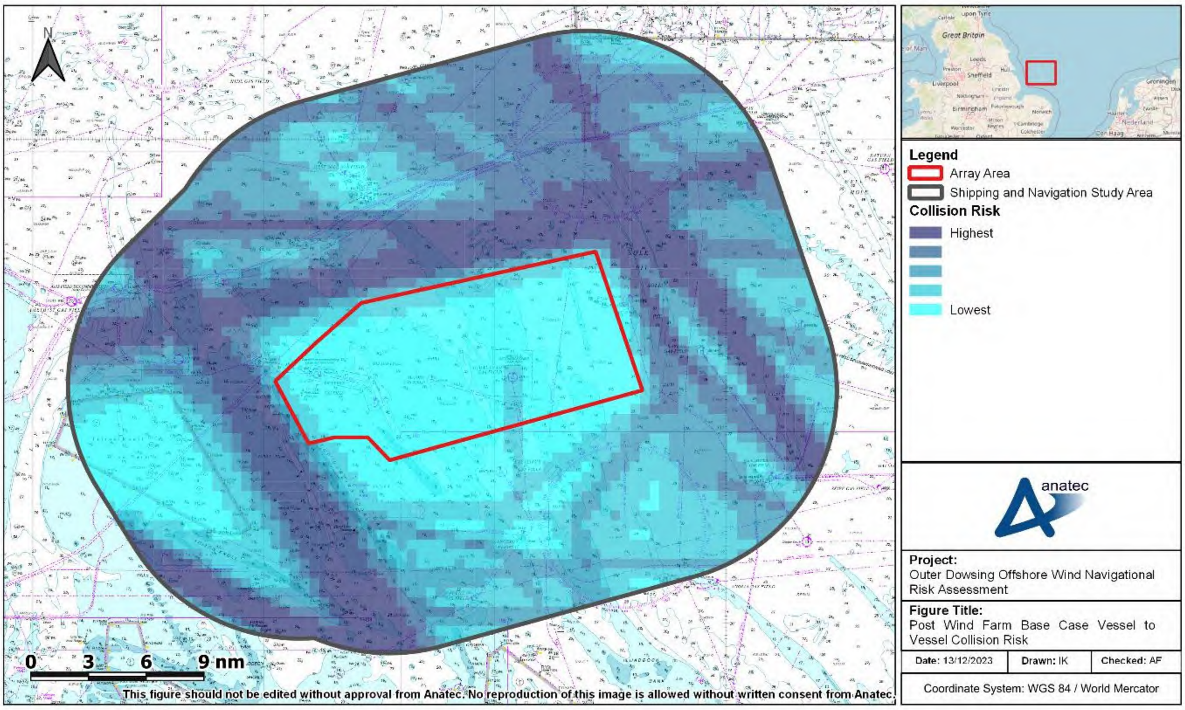

Figure 17.5 Post Windfarm Vessel to Vessel Collision Risk

518. The annual collision frequency post windfarm was estimated to be 3.59×10^{-2}, corresponding to a return period of approximately one in 28 years. This represents a 12% increase in collision frequency compared to the pre windfarm base case result.

519. It is noted that, for the array area pre PEIR, the associated collision frequency was $3.85\text{x}10^{-2}$ (one collision every 26 years), leading to an increase of approximately 19% i.e., collision risk has now been reduced due to the post PEIR array area changes (see section 6.1). This aligns with the qualitative stakeholder feedback on the array area changes (section 4) which has been positive in terms of collision risk.

520. The change in base case vessel to vessel collision risk is presented in Figure 17.6.

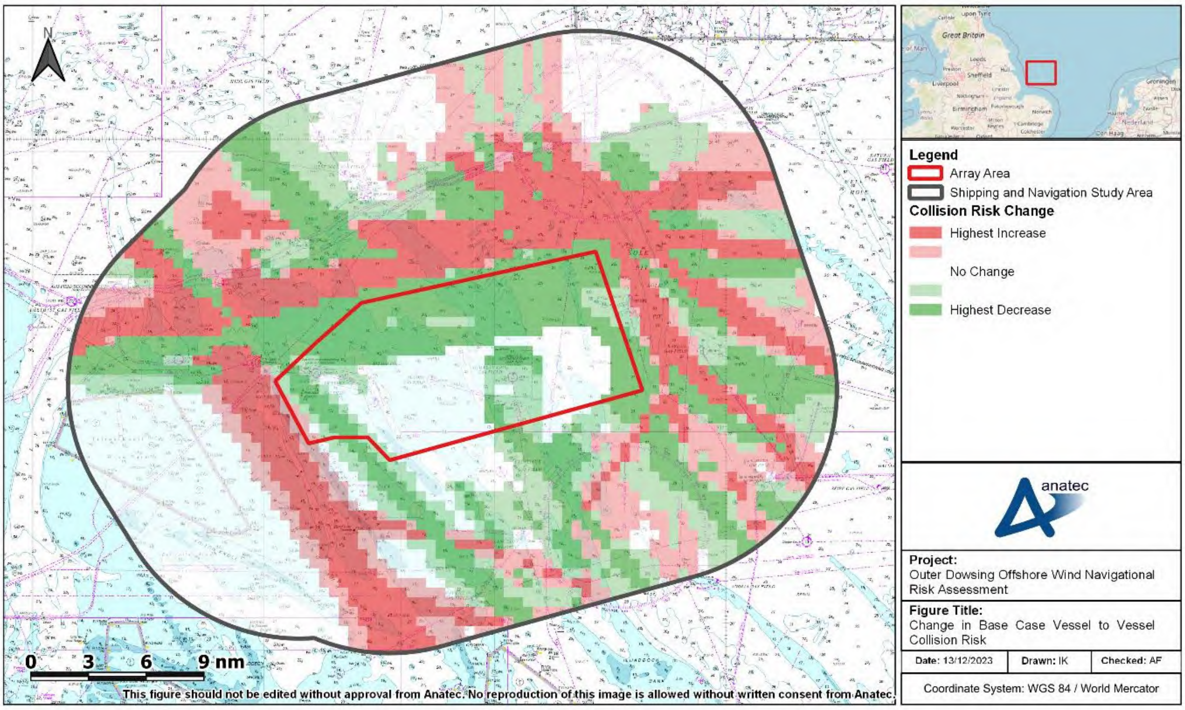

Figure 17.6 Change in Base Case Vessel to Vessel Collision Risk

521. The greatest change in risk was observed to be on the west and north peripheries of the array area, reflective of the re-routeing assumptions as per section 15.5.

522. Vessel to vessel collision risk taking into account the implementation of the ORBA is provided in Annex F.

17.2.2.3 Powered Vessel to Structure Allision Risk

523. Based upon the vessel routeing identified in the shipping and navigation study area, the anticipated re-routeing as a result of the presence of the Project, and assumptions that relevant embedded mitigation measures are in place (see section 17.2.2.4), the frequency of an errant vessel under power deviating from its route to the extent that it came into proximity with a windfarm structure associated with the Project is considered to be low.

524. From consultation with the shipping industry, it is also assumed that commercial vessels would be highly unlikely to navigate between windfarm structures due to the restricted sea room and will instead be directed by the aids to navigation located in the region and those present at the Project (noting this is observed at other UK OWFs). During the construction and decommissioning phases this will primarily consist of the buoyed construction area whilst during the operation and maintenance phase this will primarily consist of the lighting and marking of the windfarm structures.

525. Using the post windfarm routeing as input, together with the worst-case indicative array layout and local MetOcean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the windfarm structures within the array area whilst under power. In order to maintain an MDS, the model did not consider one structure shielding another, or that the presence of the Outer Dowsing shoal may lead to vessels grounding before alliding with a structure.

526. A plot of the annual powered allision frequency per structure for the base case is presented in Figure 17.7, with the chart background removed to increase the visibility of those structures with lower allision frequencies.

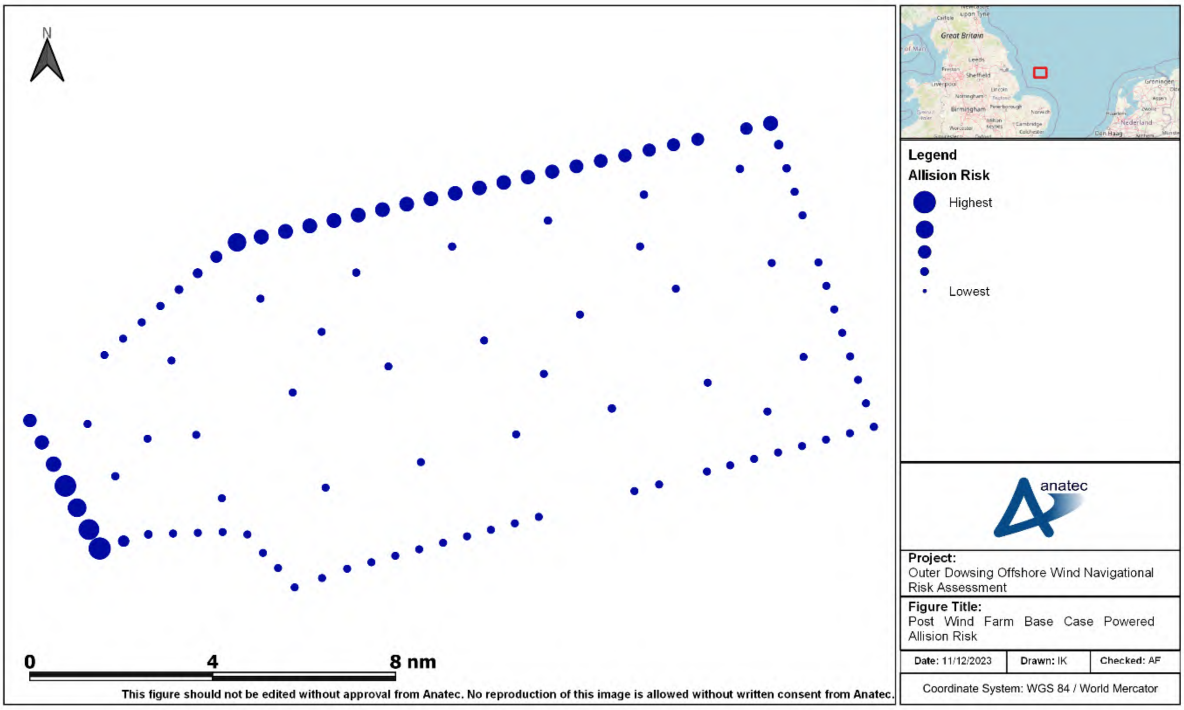

Figure 17.7 Post Windfarm Powered Vessel Allision Risk

527. Assuming base case vessel traffic levels, the annual powered allision frequency was estimated to be 5.05×10^{-3}, corresponding to a return period of approximately one in 187 years.

528. The greatest powered vessel to structure allision risk was associated with the westernmost and northernmost WTGs where high volumes of traffic from multiple main commercial routes pass. The greatest individual allision risk was associated with the southernmost structure on the western periphery of the array area (approximately 5.43×10^{-4} or one in 1,842 years). It is noted, however, that this estimate is conservative, as it makes no account for the presence of the Outer Dowsing shoal upon which a vessel may ground before alliding with a structure.

17.2.2.4 Drifting Vessel to Structure Allision Risk

529. Using the post windfarm routeing as input, together with the worst-case indicative array layout and local MetOcean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the windfarm structures within the array area. The model is based on the premise that propulsion on a vessel must fail before drifting will occur. The model takes account of the type and size of the vessel, the number of engines and the average time required to repair but does not consider navigational errors caused by human actions.

530. The exposure times for a drifting scenario are based upon the vessel hours spent in proximity to the array area (up to 10 nm from the array area). These have been estimated based on the vessel traffic levels, speeds, and revised routeing patterns. The exposure is divided by vessel type and size to ensure that these specific factors, which based upon analysis of historical incident data have been shown to influence incident rates, are taken into account for the modelling.

531. Using this information, the overall rate of mechanical failure in proximity to the array area was estimated. The probability of a vessel drifting towards a windfarm structure and the drift speed are dependent on the prevailing wind, wave, and tidal conditions at the time of the incident. Therefore, three drift scenarios were modelled, each using the MetOcean data provided in section 8:

- Wind;
- Peak spring flood tide; and
- Peak spring ebb tide.

532. After modelling the three drifting scenarios, it was established that the peak flood tide dominated scenario produced the worst-case results. A plot of the annual drifting allision frequency per structure for the base case is presented in Figure 17.8, with the chart background removed to increase the visibility of those structures with a low allision frequency.

533. It is noted that the probability of vessel recovery from drift is estimated based upon the speed of the drift and hence the time available before arriving at a windfarm structure. Vessels which do not recover within this time are assumed to allide. Conservatively, no account is made for another vessel (including a project vessel) rendering assistance, or for the likelihood that a vessel may ground on the Outer Dowsing shoal before alliding with a structure.

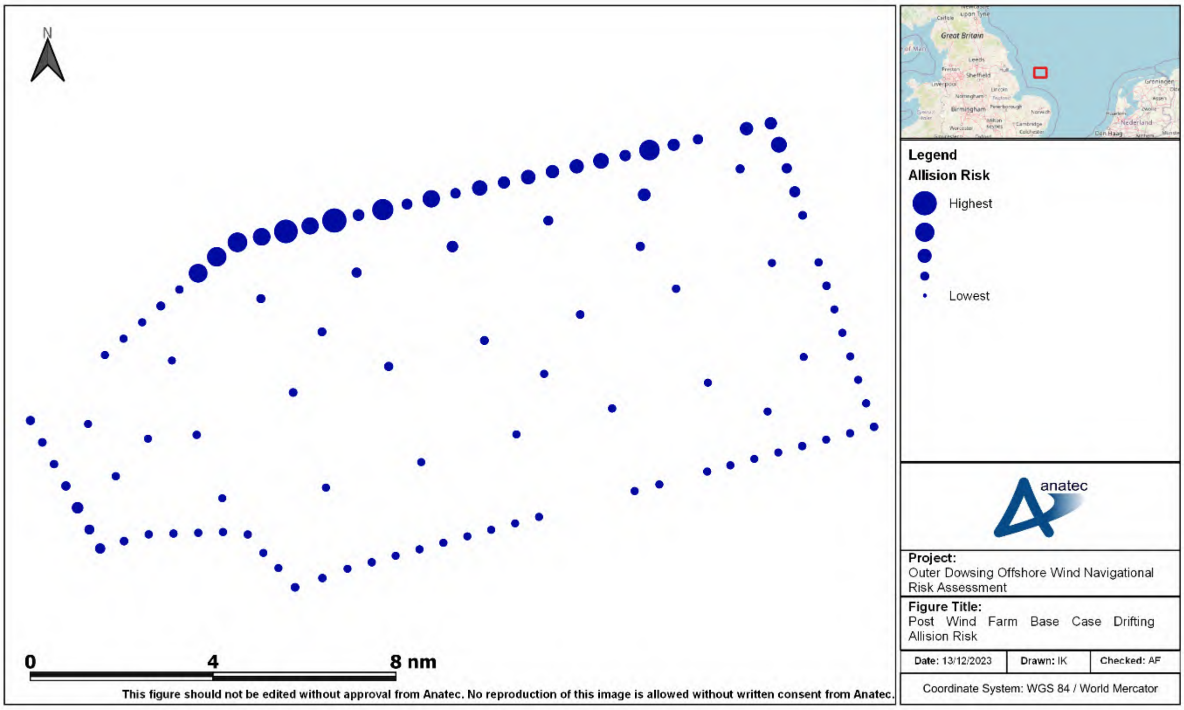

Figure 17.8 Post Windfarm Drifting Vessel Allision Risk

534. Assuming base case vessel traffic levels, the annual drifting allision frequency was estimated to be 1.04×10^{-3}, corresponding to a return period of approximately one in 958 years.

535. The greatest drifting vessel to structure allision risk was associated with structures at the northern extent of the array. The greatest individual allision risk was associated with a structure on the northern periphery (approximately 1.21×10^{-4} or one in 8,243 years).

536. It is noted that historically there have been no reported drifting allision Incidents with windfarm structures in the UK. Whilst drifting vessel scenarios do occur every year in UK waters, in most cases the vessel has been recovered prior to any allision incident occurring (such as by anchoring, restarting engines, or being taken in tow).

17.2.2.5 Fishing Vessel to Structure Allision Risk

537. Using the vessel traffic survey data as input (both AIS and Radar), Anatec's COLLRISK model was run to estimate the likelihood of a fishing vessel alluding with one of the windfarm structures within the array area.

538. A fishing vessel allision is classified separately from other allisions since fishing vessels may be located internally within the array area (unlike the transiting commercial traffic characterised by the main commercial routes). Anatec's model uses

vessel numbers, sizes (length and beam), array layout and structure dimensions. The likelihood of a major allision incident has been calibrated against historical maritime incident data and historical AIS vessel traffic data within operational OWF arrays.

539. The model assumes no change in baseline fishing activity i.e., no account is made of vessels passing over or in close proximity to structure locations choosing to increase passing distance post windfarm. This is a highly conservative assumption.

540. A plot of the annual fishing vessel allision frequency per structure for the base case is presented in Figure 17.9.

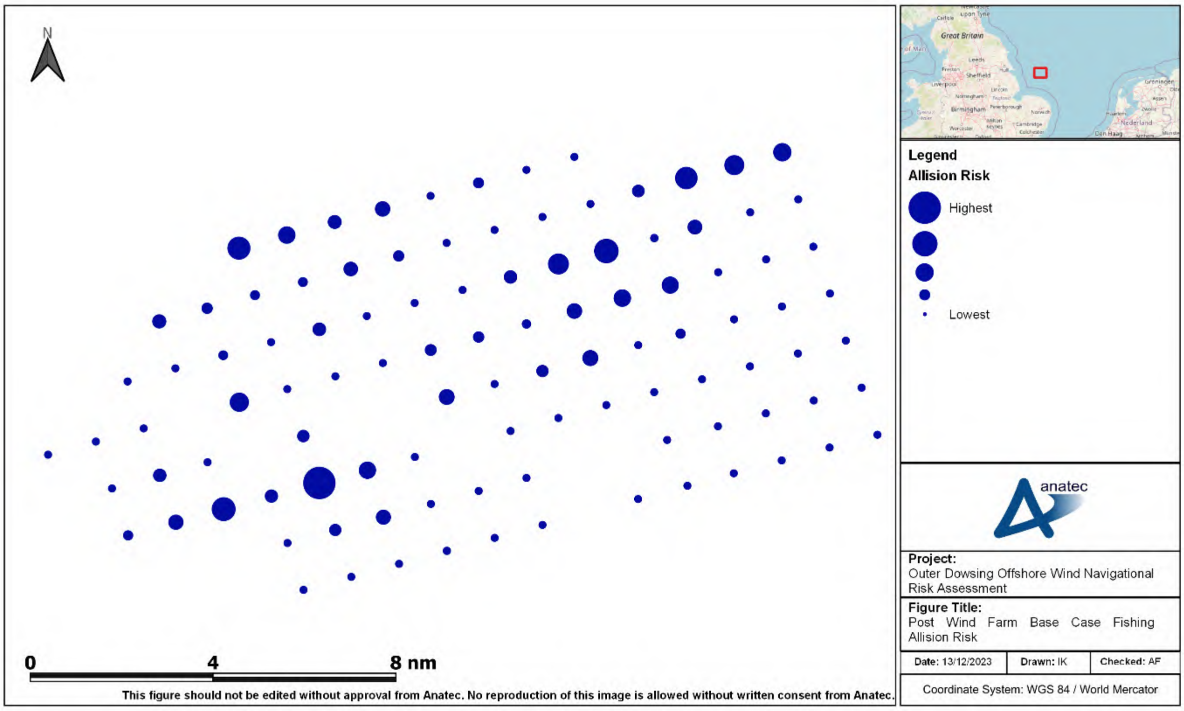

Figure 17.9 Post Windfarm Base Case Fishing Vessel Allision Risk

541. Assuming base case traffic levels, the annual fishing vessel to structure allision frequency was estimated to be 1.13×10^{-2}, corresponding to a return period of approximately one in 8.9 years.

542. The fishing vessel to structure allision risk varied throughout, reflecting the distribution of fishing vessels recorded in the vicinity. The greatest individual allision risk was associated with a WTG in the southwest of the array area (approximately $1.74\text{x}10^{-2}$ or one in 57 years).

543. The model is calibrated against known allision incidents within UK OWFs (see section 9.6). Most likely consequences will be a low impact / minor contact with no significant damage, no injuries to persons, and no pollution (in line with incident statistics to date as per section 9.6.1).

17.2.3 Risk Results Summary

544. The previous subsections modelled two scenarios, namely the pre and post windfarm scenarios with base case traffic levels. In order to incorporate the potential for future traffic growth, pre and post windfarm scenarios have also been modelled for future case traffic levels (both 10% and 20% increases). Table 17-1 summarises the results of all six scenarios for the array area.

545. Overall, the base case collision and allision frequency due to the presence of the Project was estimated to increase by approximately 1.23×10^{-1} (equating to an additional collision or allision every 8.1 years).

Table 17-1 Summary of Annual Collision and Allision Risk Results

Risk	Scenario	Annual Frequency (Return Period)		
		Pre Windfarm	Post Windfarm	Change
Vessel to vessel collision	Base case	3.21×10^{-2} (1 in 31 years)	3.59×10^{-2} (1 in 28 years)	3.76×10^{-3} (1 in 266 years)
	Future case (10%)	3.88×10^{-2} (1 in 26 years)	4.32×10^{-2} (1 in 23 years)	4.40×10^{-3} (1 in 227 years)
	Future case (20%)	4.60×10^{-2} (1 in 22 years)	5.13×10^{-2} (1 in 19 years)	5.30×10^{-3} (1 in 189 years)
Powered vessel to structure allision	Base case	-	5.35×10^{-3} (1 in 187 years)	5.35×10^{-3} (1 in 187 years)
	Future case (10%)	-	5.89×10^{-3} (1 in 170 years)	5.89×10^{-3} (1 in 170 years)
	Future case (20%)	-	6.42×10^{-3} (1 in 156 years)	6.42×10^{-3} (1 in 156 years)
Drifting vessel to structure allision	Base case	-	1.04×10^{-3} (1 in 958 years)	1.04×10^{-3} (1 in 958 years)
	Future case (10%)	-	1.15×10^{-3} (1 in 871 years)	1.15×10^{-3} (1 in 871 years)
	Future case (20%)	-	1.25×10^{-3} (1 in 798 years)	1.25×10^{-3} (1 in 798 years)
Fishing vessel to structure allision	Base case	-	1.13×10^{-1} (1 in 8.9 years)	1.13×10^{-1} (1 in 8.9 years)
	Future case (10%)	-	1.24×10^{-1} (1 in 8.0 years)	1.24×10^{-1} (1 in 8.0 years)
	Future case (20%)	-	1.36×10^{-1} (1 in 7.4 years)	1.36×10^{-1} (1 in 7.4 years)
Total	**Base case**	**3.21×10^{-2} (1 in 31 years)**	**1.55×10^{-1} (1 in 6.4 years)**	**1.23×10^{-1} (1 in 8.1 years)**

Risk	Scenario	Annual Frequency (Return Period)		
		Pre Windfarm	Post Windfarm	Change
	Future case (10%)	3.88×10^{-2} (1 in 26 years)	1.73×10^{-1} (1 in 5.8 years)	1.34×10^{-1} (1 in 7.4 years)
	Future case (20%)	4.60×10^{-2} (1 in 22 years)	1.95×10^{-1} (1 in 5.1 years)	1.49×10^{-1} (1 in 6.7 years)

17.3 ORCP Area

17.3.1 Pre Windfarm Modelling

17.3.1.1 Vessel to Vessel Encounters

546. It is noted that as no route deviations are expected due to the location of the ORCP (see section 15.5.2), and as such collision risk is not expected to increase, full encounters analysis for the ORCP area study area has not been undertaken.

17.3.1.2 Vessel to Vessel Collision Risk

547. Using the pre windfarm vessel routeing as input, Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risk with the ORCP area study area. The route positions and widths are based on the vessel traffic survey data.

548. A heat map based upon the geographical distribution of collision risk within a density grid for the pre windfarm base case is presented in Figure 17.10.

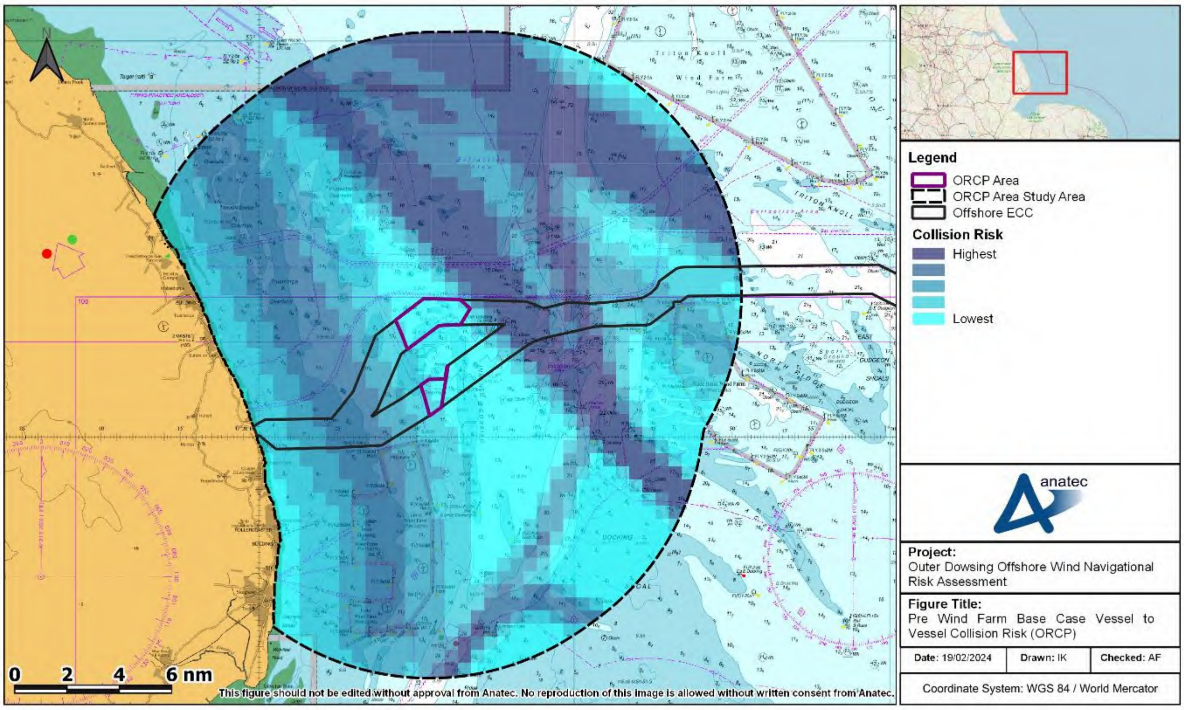

Figure 17.10 Pre Windfarm Base Case Vessel to Vessel Collision Risk (ORCP)

549. Assuming base case vessel traffic levels, the annual collision frequency pre windfarm was estimated to be 1.09×10^{-2}, corresponding to a return period of approximately one in 92 years. This is a relatively average return period for offshore structures in proximity to high-use coastal routes in the North Sea. It is noted that the model is calibrated based upon major incident data at sea which allows for benchmarking but does not cover all incidents.

17.3.2 Post Windfarm Modelling

17.3.2.1 Vessel to Vessel Collision Risk

550. As no vessel deviations are expected due to construction of the ORCP, the risk of vessel to vessel collision is considered broadly analogous to the pre windfarm scenario (see section 17.3.1.1).

17.3.2.2 Powered Vessel to Structure Allision Risk

551. Using the post windfarm routeing as input, together with the worst case indicative ORCP locations and local MetOcean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with the ORCP whilst under power.

552. Assuming base case vessel traffic levels, the annual powered allision frequency for each of the ORCPs is presented in Table 17-2.

Table 17-2 Base Case Powered Allision Risk by ORCP Location

ORCP	Annual Frequency	Return Period
Northern	2.40×10^{-3}	1 in 417 years
Southern	1.11×10^{-3}	1 in 900 years

17.3.2.3 Drifting Vessel to Structure Allision Risk

553. Using the post windfarm routeing as input, together with the worst case indicative ORCP locations and local MetOcean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with the ORCP whilst not under power.

554. After modelling the same three drifting scenarios outlined in section 17.2.2.4, it was established that the wind dominated scenario produced the worst case results.

555. Assuming base case vessel traffic levels, the annual drifting allision frequency for each of the ORCP locations is presented in Table 17-3.

Table 17-3 Base Case Drifting Allision Risk by ORCP Location

ORCP	Annual Frequency	Return Period
Northern	3.68×10^{-5}	1 in 27,177 years
Southern	2.32×10^{-7}	1 in 4,307,274 years

17.3.2.4 Fishing Vessel to Structure Allision Risk

556. Using the vessel traffic survey data as input, Anatec's COLLRISK model was run to estimate the likelihood of a fishing vessel alliding with an ORCP location.

557. Assuming base case traffic levels, the annual fishing vessel to structure allision frequency was negligible. This is due to the negligible levels of fishing vessel activity in proximity to the worst case ORCP locations.

17.3.3 Risk Results Summary

558. The previous subsections modelled two scenarios, namely the pre and post windfarm scenarios with base case traffic levels. In order to incorporate the potential for future traffic growth, pre and post windfarm scenarios have also been modelled for future case traffic levels (both 10% and 20% increases). Table 17-4 summarises the results of all six scenarios for the ORCP area.

559. Overall, the base case collision and allision frequency due to the presence of the ORCP was estimated to increase by approximately 3.55×10^{-3} (equating to an additional collision or allision every 282 years).

Table 17-4 Summary of Annual Collision and Allision Risk Results (ORCP)

Risk	Scenario	Annual Frequency (Return Period)		
		Pre Windfarm	Post Windfarm	Change
Vessel to vessel collision	Base case	1.09×10^{-2} (1 in 92 years)	1.09×10^{-2} (1 in 92 years)	-
	Future case (10%)	1.32×10^{-2} (1 in 76 years)	1.32×10^{-2} (1 in 76 years)	-
	Future case (20%)	1.57×10^{-2} (1 in 64 years)	1.57×10^{-2} (1 in 64 years)	-
Powered vessel to structure allision	Base case	-	3.51×10^{-3} (1 in 285 years)	3.51×10^{-3} (1 in 285 years)
	Future case (10%)	-	3.86×10^{-3} (1 in 259 years)	3.86×10^{-3} (1 in 259 years)
	Future case (20%)	-	4.21×10^{-3} (1 in 238 years)	4.21×10^{-3} (1 in 238 years)
Drifting vessel to structure allision	Base case	-	3.70×10^{-5} (1 in 27,006 years)	3.70×10^{-5} (1 in 27,006 years)
	Future case (10%)	-	4.07×10^{-5} (1 in 24,550 years)	4.07×10^{-5} (1 in 24,550 years)
	Future case (20%)	-	4.44×10^{-5} (1 in 22,507 years)	4.44×10^{-5} (1 in 22,507 years)
Total	**Base case**	**1.09×10^{-2} (1 in 92 years)**	**1.44×10^{-2} (1 in 69 years)**	**3.55×10^{-3} (1 in 282 years)**
	Future case (10%)	**1.32×10^{-2} (1 in 76 years)**	**1.71×10^{-2} (1 in 58 years)**	**3.90×10^{-3} (1 in 256 years)**
	Future case (20%)	**1.57×10^{-2} (1 in 64 years)**	**2.00×10^{-2} (1 in 50 years)**	**4.25×10^{-3} (1 in 235 years)**

18 Embedded Mitigation Measures

560. As part of the Project design process, a number of embedded mitigation measures have been adopted to reduce the potential for risk to shipping and navigation. These measures have and will continue to evolve over the development process as the EIA progresses and in response to consultation.

561. The identified measures include good or standard practice and include actions that would be undertaken to meet existing legislation requirements. It has been assumed for the purposes of the FSA (see section 19) that these measures will be in place.

562. The identified measures are detailed in Table 18-1.

Table 18-1 Embedded Mitigation Measures Relevant to Shipping And Navigation

Mitigation	Description	How Secured
Compliance with MGN 654	The Project will comply with MCA requirements under MGN 654 including its annexes.	dML conditions
Charting	Project infrastructure (including structures and subsea cables) will be charted.	dML conditions require provision of relevant information to the UKHO.
Promulgation of information	Circulation of relevant project information including via all usual means (e.g., Kingfisher Bulletin, Notice to Mariners).	dML conditions.
Buoyed construction area	Agreement of extent of buoyed construction area with Trinity House including buoy locations and types.	dML conditions.
Application for safety zones	Application for safety zones around structures during construction and periods of major maintenance: ▪ 500m around structures where construction is ongoing; ▪ 50m around all structures prior to commissioning of the Project; and ▪ 500m around structures where major maintenance is ongoing.	Electricity application procedures (section 95 of Energy Act 2004).
Marine Coordination	Marine coordination and communication to manage project vessel movements.	dML condition

Mitigation	Description	How Secured
Lighting and Marking	Lighting and marking in agreement with Trinity House, MCA, and Civil Aviation Authority (CAA), and in compliance with IALA G1162 (IALA, 2021).	dML conditions.
Guard vessels	Use of guard vessels where identified as necessary via risk assessment.	MGN 654
Layout Design	Ongoing consultation with MCA and Trinity House in relation to layout design, including MMO sign off on final layout in consultation with the MCA and Trinity House.	dML conditions.
Blade clearance	Blade clearance in line with RYA requirements and MGN 654 to ensure potential for recreational mast interaction with the blades is minimised.	MGN 654
Cable protection	Cable burial risk assessment process to determine required cable protection and monitoring requirements.	dML conditions.

18.1 Marine Aids to Navigation

563. Throughout all phases, AtoNs will be provided in accordance with Trinity House and MCA requirements, with consideration being given to IALA Recommendation O-139 and G1162 (IALA, 2021) and MGN 654 (MCA, 2021).

18.1.1 Construction and Decommissioning Phases

564. During the construction and decommissioning phases, buoyed construction and decommissioning areas will be established and marked, where required, in accordance with Trinity House requirements based on the IALA Maritime Buoyage System. Surface piercing structures will be marked with temporary lighting.

18.1.2 Operation and Maintenance Phase

565. Marine marking during the O&M phase will be agreed in consultation with Trinity House once the final layout has been selected post consent. Likely requirements are given in the sections 18.1.2.1 and 18.1.2.2

18.1.2.1 Marking of Individual Array Structures

566. As per IALA Guideline G1162, each surface structure within the array area will be painted yellow from the level of Highest Astronomical Tide (HAT) to at least 15m

above HAT. Each structure will also be clearly marked with a unique alphanumeric identifier which will be clearly visible from all directions. The MCA will advise post consent on the specific requirements for the identifiers, but a logical pattern with potential for additional visual marks may be considered by statutory stakeholders. Each identifier will be illuminated by a low-intensity light such that the sign is available from a vessel thus enabling the structure to be identified at a suitable distance to avoid an allision incident.

567. The identifiers will be situated such that under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer (with the naked eye), stationed 3m above sea level and at a distance of at least 150m from the WTG. The light will be either hooded or baffled so as to avoid unnecessary light pollution or confusion with navigational marks.

18.1.2.2 Marking of Array

568. The marking of the array as a whole will be agreed with Trinity House once the final array layout has been selected and will be in line with IALA Recommendation O-139 and G1162. As per the IALA guidance, and in consultation with Trinity House, it will be ensured that:

- All corner structures will be marked as an Significant Peripheral Structure (SPS) and where necessary to satisfy the spacing requirements between SPS under IALA G1162, additional periphery structures may also be marked as SPS;
- Structures designated as an SPS will exhibit a flashing yellow five second (flash yellow every five seconds) light of at least 5nm nominal range and omnidirectional fog signals as appropriate and where prescribed by Trinity House, and will be sounded when the visibility is 2nm or less;
- All lights will be visible to shipping through 360˚ and if more than one lantern is required on a structure to meet the all-round visibility requirement, then all the lanterns on that structure will be synchronised;
- All lights will be exhibited at the same height at least 6m above HAT and below the arc of the lowest WTG blades;
- Remote monitoring sensors using Supervisory Control and Data Acquisition (SCADA) will be included as part of the lighting and marking scope to ensure a high level of availability for all AtoNs; and
- Aviation lighting will be as per CAA requirements; however, will likely be synchronised Morse “W” at the request of Trinity House.

569. Consideration will also be given to the use of marking via AIS, or other electronic means (such as Radar Beacons (Racon)) to assist safe navigation particularly in reduced visibility. AIS transmitters or virtual buoys could also be considered internally to assist with safe navigation within the array area.

18.2 Design Specifications Noted in Marine Guidance Note 654

570. The individual WTGs and other structures will have functions and procedures in place for generator shut down in emergency situations, as per MGN 654 (MCA, 2021).

18.3 Safety Zones

571. The Applicant intend to submit an application to the Department of Energy, Security, and Net Zero post consent for safety zones during the construction and operational phases, with a separate application submitted for the decommissioning phase at a later date. The safety zones applied for will be determined as part of the application process, however it is expected that the following safety zones will be applied for noting that these are the industry standard:

- 500m around any structure where construction is ongoing, as denoted by the presence of a construction vessel;
- 50m around any structure where active construction is not ongoing prior to full commissioning of the windfarm; and
- 500m around any structure where major maintenance is ongoing during the operational phase, where major maintenance is as defined within the Electricity Regulations (2007).

19 Risk Assessment – In Isolation

572. This section provides a qualitative and quantitative risk assessment (using FSA) for the hazards identified due to the Project, based on baseline data, expert opinion, outputs of the Hazard Workshop, stakeholder concerns and lessons learnt from existing offshore developments. The hazards assessed are as follows:

- Displacement of vessels leading to increased collision risk between third-party vessels;
- Restriction of adverse weather routeing;
- Increased vessel-to-vessel collision risk between a third-party vessel and project vessel;
- Increased vessel to structure allision risk (powered, drifting, and internal navigation);
- Reduction of emergency response provision including SAR capability;
- Reduction of under keel clearance; and
- Increased anchor/gear interaction with subsea cables.

573. For each hazard, the full description of the hazard is provided in ***bold italicised*** text. This is followed by various subsections as appropriate to consider each component of the hazard, both for the array area and offshore ECC based on the MDS (see section 6.7).

574. For each hazard, embedded mitigation measures which have been identified as relevant to reducing risk are listed, with full descriptions provided in section 18. This is followed by statements defining the frequency of occurrence, severity of consequence, and subsequent significance of risk based on the methodology defined in section 3.2.

575. The risk control log (see section 21) summarises the risk assessment and a concluding risk statement is provided (see section 23.7).

19.1 Displacement Of Vessels Leading To Increased Collision Risk Between Third Party Vessels

576. Construction or decommissioning activities and the presence of surface piercing structures within the array area may result in the displacement of vessels from pre-existing routes and activities. This displacement may result in an increased risk of a collision between third-party vessels.

577. During the construction phase, the array area will be marked as a buoyed construction area. There will be no restriction on entry into the buoyed construction area other than through any active safety zones, noting the Cardinal Marks (buoys) do advise Mariners to avoid the area.

578. Experience at other OWF projects indicates that areas of active construction will generally be avoided by vessels observing the buoyed construction area, and therefore it is likely that the ongoing construction works will displace existing traffic from within the array area. The same scenario is likely during the decommissioning phase i.e., the array area will be marked as a buoyed decommissioning area, and it is likely that vessels will avoid the ongoing works.

579. During the operational phase, there would again be no restriction on transits into the array area assuming any active major maintenance safety zones are avoided. However, it is likely that commercial vessels will continue to avoid the array area on the deviations established during the construction phase.

580. During consultation, displacement was raised as a concern by vessel operators including DFDS and Stena. The potential for displacement leading to an increase in collision risk was also raised including by the MCA and the CoS.

19.1.1 Commercial Vessels

19.1.1.1 Commercial Vessel Routeing

581. Based on the deviations assessment undertaken in section 15.5, of the 13 main commercial routes identified, four are anticipated to deviate to avoid the structures within the array area. The deviations to these four routes are summarised as follows:

- Route 7: one vessel per day. Intersects array area, vessels anticipated to pass to the north post windfarm. Estimated journey distance increase of 0.1nm (0.4nm if the ORBA was not implemented).
- Route 8: one vessel per day. Intersects array area, vessels anticipated to pass to the west post windfarm. Estimated journey distance increase of 2.4nm.
- Route 9: less than one vessel per day. Intersects array area, vessels anticipated to pass to the north post windfarm. Estimated journey distance increase of 2.1nm (2.6nm if the ORBA was not implemented).
- Route 12: < 1 vessel per day. Used by DFDS as an adverse weather route. Likely vessels will pass further north (a minor deviation) to increase passing distance from array area. Estimated journey distance increase of 0.2nm. Any impact from this deviation will be further reduced due to the implementation of the ORBA.

582. Baseline routeing in the area is observed to be largely dictated by the numerous sand banks and the existing surface piercing infrastructure (both renewables and oil and gas). In the future case scenario routeing of vessels deviating west of the array area will be dictated by the presence of the Outer Dowsing Bank, with these vessels merging with established routes. Vessels deviating to the north will likely pass between the array area and the platforms at the West Sole field (dependent on decommissioning status), again on routes already established by other vessels. It is noted that the changes made to the AfL array area post PEIR to arrive at the array

area, as well as the implementation of the ORBA, mean that deviations to vessels passing north have been reduced.

583. The most likely consequences of vessel displacement will be increased journey times and distance for affected third-party vessels. This was highlighted by commercial ferry operators (DFDS and Stena) during consultation. As a worst case, there may be disruption to existing schedules, particularly for the commercial ferry operators using the region. However, given the size of the deviations anticipated and the ability to effectively passage plan, disruptions to schedule are expected to be minimal. DFDS confirmed via the CoS that they were “broadly positive” about the changes made to the array area (email on 12th January 2024).

584. There is not anticipated to be any notable displacement to commercial vessels arising from the ORCPs. The ORCP area has been reduced post PEIR from the ORCP area to maintain a minimum 0.5nm setback from the commercial routeing to the east, with the removal of the northern ORCP area altogether further increasing the available searoom. There is searoom available for these vessels to pass further east should they choose to do so, which would lead to a minor deviation.

585. Any displacement associated with the offshore ECC will be temporary and spatially limited to the area around the installation operation. There will be no displacement impact once the cables are laid, other than during any periods of maintenance, which would be anticipated to be a low frequency event.

19.1.1.2 Collision Risk

586. Historical incident data assessed in section 9.6 indicates that to date no collision incidents between third-party vessels have occurred directly as a result of a UK OWF. However, given vessels will be displaced, it is likely that there will be increased encounters and hence a potential for collision risk to also increase.

587. Based on the quantitative assessment of vessel to vessel collision risk undertaken in in section 17.2, the return period of a vessel being involved in a collision pre windfarm in the shipping and navigation study area was estimated at 31 years, reflective of the traffic volumes in the area. No collisions were identified within the recent incident data assessment undertaken in section 9, however it is noted that older data studied at PEIR indicated one collision incident was responded to by the RNLI prior. The collision incident occurred 9nm east of the array area and involved an oil and gas vessel (the data did not specify the other vessel involved).

588. The corresponding post windfarm return period was estimated at 28 years which represents an increase of approximately 12%. The change in collision risk was observed to be primarily associated with routeing to the north and west of the array area. It is noted that this represents a reduction from the equivalent risk estimated at PEIR, a return period of 26 years. This is reflective of the reduction in array area

increasing searoom, and minimising collision risk. This aligns with consultation feedback, with the agreed minutes of the second hazard workshop stating that "General consensus by attendees was that concerns have been generally addressed" by the array area reductions.

589. Further, from vessel to vessel collision risk modelling in the scenario considering the implementation of the ORBA, the corresponding post wind farm return period was estimated at 29 years, representing an increase of approximately 9%. The introduction of the ORBA has therefore reduced collision risk by approximately 3%.

590. In adverse weather including reduced visibility, third-party vessels may experience limitations regarding visual identification of other third-party vessels, either when passing opposing sides of the buoyed construction/decommissioning areas (with partially constructed or deconstructed WTGs) and operational array area, or when navigating internally within the operational array area (small craft only). These limitations may increase the potential for an encounter. However, this will be mitigated by the application of the COLREGs (including Rule 6 Safe Speeds and Rule 19 Conduct of Vessels in Restricted Visibility) in adverse weather conditions.

591. The most likely consequences in the event of an encounter between two or more third-party vessels is the implementation of avoidance action in line with the COLREGs, with the vessels involved able to resume their respective passages with no long-term consequences.

592. Should an encounter develop into a collision incident, it is most likely to involve minor contact resulting in minor damage to the vessels with no harm to people. As a worst case (with very low frequency of occurrence) one or both of the vessels may experience substantial damage or founder with Potential Loss of Life (PLL) and pollution, with this outcome more likely where one of the vessels is a small craft (e.g., fishing vessel, recreational vessel).

593. Vessel traffic monitoring will be undertaken throughout the construction phase to characterise changes to routeing patterns. These will be compared against the anticipated deviations determined in section 15.5 to allow a comprehensive review of the mitigation measures applied at the time.

594. Collision risk was also estimated for the ORCP Area Study Area modelling process (see section 17.3), with a return period of 92 years estimated assuming base case traffic levels. Given limited anticipated impact on deviation to commercial vessels from the ORCP, it is considered unlikely that there will be any associated notable change in collision risk.

19.1.1.3 Commercial Vessel Third Party Activities

595. As shown via the vessel traffic assessment, dredging and oil and gas activities do take place in the vicinity. Of note is the Outer Dowsing extraction area (area 515/2)

located near the south western part of the array area, and various oil and gas platforms, including Malory which is within the array area and is currently still active. Further assessment of third party activities is provided in Volume 1, Chapter 18: Marine Infrastructure and Other Users (document reference 6.1.18).

596. It was estimated that less than one marine aggregate dredger per week intersected the array area based on the long term AIS (see Annex E). It is considered likely that these vessels would deviate around the array area as opposed to transiting through, though they would be free to transit through assuming active safety zones were avoided. Feedback from Boskalis (a key marine aggregate dredger operator in the area) during the first hazard workshop was that any impact on marine aggregate dredging activity was likely to be minimal given the local dredging areas do not intersect the array area, with feedback indicating marine aggregate dredgers tend to transit from the south and as such significant deviations to vessel transits are also not expected. It was raised at the second hazard workshop that proximity should be considered during the construction phase when safety zones and construction buoyage would be deployed. Appropriate liaison procedures should therefore be put in place with Boskalis, and the presence of area 515/2 will be included in discussions with Trinity House on construction buoyage (noting buoyage locations will be as directed by Trinity House).

597. Given the presence of oil and gas infrastructure within the array area, in particular Malory for which there are no known decommissioning plans, it will be necessary for oil and gas vessels to enter into the array area to access the infrastructure. This has been assessed in the Access and Allision Report (Appendix 18.2; document reference 6.3.18.2).

598. Vessels to the Hornsea projects were observed to typically pass north of the array area and as such no impact is anticipated.

599. As for main commercial routes, the most likely consequence will be increased journey times and distances for affected third-party vessels from the array area, with limited if any deviation expected from the ORCPs.

19.1.1.4 Promulgation of Information and Passage Planning

600. All vessels operating in the area are expected to comply with national and international flag state regulations (including the COLREGs and SOLAS) and will have a raised level of awareness of construction and decommissioning activities given the promulgation of information relating to the Project. This includes the charting of the buoyed construction/decommissioning area on relevant nautical charts and the use of safety zones. The physical presence of the buoyed construction/decommissioning area itself will also serve to maximise awareness. Similarly, during the operational phase infrastructure will be appropriately marked on relevant nautical charts and by

that stage awareness of the array area will be high given its established presence over the construction phase.

601. All vessels proceeding to sea are expected to comply with flag state regulations including Regulation 34 of SOLAS Chapter V – which states that “the voyage plan shall identify a route which […] anticipates all known navigational hazards and adverse weather conditions” (IMO, 1974) – and IMO Resolution A.893(21) on the Guidelines for Voyage Planning (IMO, 1999). The promulgation of information relating to the Project will assist and facilitate such passage planning.

19.1.2 Small Craft (Fishing and Recreation)

19.1.2.1 Small Craft Displacement

602. The vessel traffic survey data shows transits from recreational vessels and fishing vessels through the array area occur (noting the survey captured both AIS and non AIS traffic). This aligns with the findings of the long term AIS analysis (see Annex E).

603. As for commercial vessels, there will be no restriction on small craft entering the array area during any phase other than through active safety zones. However, based on experience at previously under construction OWFs, commercial fishing vessels and recreational vessels may choose not to navigate internally within the buoyed construction/decommissioning area. Therefore, displacement of transits by small craft during the construction and decommissioning phases is also likely to occur.

604. For the operational phase, based on experience at existing operational OWFs, it is anticipated that commercial fishing vessels and recreational vessels may choose to navigate internally within the array area, particularly in favourable weather conditions.

605. Feedback during the first hazard workshop was that the area is commonly used by potters (i.e., vessels laying and hauling static gear pots) in particular (season dependent), and post windfarm use of the area is likely to depend on the final layout noting commercial impacts to fishing vessels are considered in Volume 1, Chapter 14: Commercial Fisheries (document reference 6.1.14). Recreational representation at the workshops indicated no initial concerns; however, it was noted that sailing vessels may be more likely to avoid the array area than motor cruisers.

606. There is unlikely to be notable displacement to small craft associated with the ORCPs, given they will be single isolated platforms, noting that small craft activity in proximity to the ORCP area was not recorded in notable volumes.

607. The most likely consequence of small craft displacement is changes to vessel’s existing routines but without any safety impact.

19.1.2.2 Collision Risk for Small Craft

608. There is anticipated to be an increase in commercial vessel density and hence collision risk around the northern and western windfarm peripheries. Given recreational and fishing transits are known to occur in both these areas based on the vessel traffic survey data, there may be increased encounters between small craft and larger commercial vessels. It is noted that feedback during the first hazard workshop was that recreational vessels would tend to avoid commercial vessel routeing; however, within this area recreational vessels do already transit with commercial vessels in the area between the Outer Dowsing Bank and Triton Knoll OWF. In this regard the Cruising Association noted in the second hazard workshop that the reduction of the western boundary of the AfL array area was a positive for recreational vessels, as it allowed space over the Outer Dowsing Bank for recreational vessels to transit outside of the main commercial routeing through the Outer Dowsing Channel.

609. In the event of a collision incident involving a small craft (with comparatively weaker structural integrity due to hull materials) compared to a larger commercial vessel, the likelihood of a worst case outcome (the small craft foundering with PLL and pollution) will be greater.

19.1.3 Embedded Mitigation Measures

610. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Buoyed construction / decommissioning area;
- Application for safety zones; and
- Lighting and marking.

19.1.4 Significance of Risk

611. The frequency of occurrence, severity of consequence, and significance of risk due to vessel displacement from the array area is presented in Table 19-1 alongside the resulting significance of risk.

Table 19-1 Risk Rankings for Displacement of Vessels Leading to Increased Collision Risk between Third Party Vessels

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	Construction	Remote	Serious	Tolerable
	O&M	Remote	Serious	Tolerable
	Decommissioning	Remote	Serious	Tolerable

Project Component	Phase	Frequency	Severity	Significance of Risk
ORCP	Construction	Extremely Unlikely	Serious	Tolerable
	O&M	Extremely Unlikely	Serious	Tolerable
	Decommissioning	Extremely Unlikely	Serious	Tolerable
Offshore ECC	Construction	Extremely Unlikely	Serious	Tolerable
	O&M	Negligible	Serious	Broadly Acceptable
	Decommissioning	Extremely Unlikely	Serious	Tolerable

612. Assuming the additional mitigation of liaison with Boskalis during construction, the impact is assessed as being Tolerable with mitigation and ALARP, and therefore not significant in EIA terms.

19.2 Restriction of Adverse Weather Routeing

613. The presence of the structures within the array area could restrict adverse weather routeing options in the study area.

614. Adverse weather including wind, wave, and tidal conditions as well as reduced visibility can hinder a vessel’s normal route and/or speed of navigation. Adverse weather routes are defined as significant course adjustments to mitigate vessel movement in adverse weather conditions. When transiting in adverse weather conditions, a vessel is likely to encounter various kinds of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and/or danger to persons on board. The sensitivity of a vessel to these phenomena will depend on the actual stability parameters, hull geometry, vessel type, vessel size and speed.

615. The presence of structures within or near to any adverse weather routes may prevent the route from being utilised during adverse conditions. Mitigations for vessels include adjusting their heading to position themselves 45° to the wind, altering or delaying sailing times, reducing speed and/or potentially cancelling journeys.

19.2.1 All Users

616. DFDS noted during consultation limited concern with the King Seaways and Princess Seaways adverse weather routeing (Route 12), however stated that routeing between Immingham and Cuxhaven would be affected, with a route preferred for use during certain adverse conditions intersecting the array area. This route is used when sea conditions further north are such that the typically used Immingham to Cuxhaven route (Route 7) would require additional time in port to secure cargo i.e., there would be a commercial impact on DFDS if Route 7 could not be used. However, the AfL array area has been reduced post PEIR to arrive at the array area in consultation with DFDS, who have confirmed they are broadly content with the changes made in terms of navigational safety.

617. Due to the nature of being single platforms, the distance to existing vessel routes, and relatively shallow water depths, it is not expected that the ORCPs will have a notable impact on any adverse weather routeing. Similarly for the offshore ECC, any displacement during construction would be temporary and spatially limited to the area around the installation vessel, with no displacement during O&M other than any periods of maintenance.

618. Lighting and marking will be defined in consultation with Trinity House as required, and this will include consideration of requirements during periods of poor visibility (e.g., sound signals) to ensure the structures within the array area and ORCPs are detectable in adverse conditions, noting the structures will also be charted. Under COLREGS (IMO, 1972), vessels are also required to take appropriate measures with regards to determining a safe speed, taking into account various factors including the state of visibility, the state of the wind, sea, and current as well as the proximity of navigational hazards.

619. The most likely consequences are considered to be displacement from existing adverse weather routeing options but with no safety risk. As a worst case, there may be effects on schedules with limited safety risk.

19.2.2 Embedded Mitigation Measures

620. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Appropriate marking on Admiralty charts;
- Promulgation of information; and
- Lighting and marking.
- Significance of Risk

621. The frequency of occurrence, severity of consequence, and significance of risk due to restriction of adverse weather routeing is presented in Table 19-2 alongside the resulting significance of risk.

Table 19-2 Risk Rankings for restriction of adverse weather routeing

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	Construction	Remote	Serious	Tolerable
	O&M	Remote	Serious	Tolerable
	Decommissioning	Remote	Serious	Tolerable
ORCP	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Extremely unlikely	Serious	Tolerable
	Decommissioning	Extremely unlikely	Serious	Tolerable
Offshore ECC	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Negligible	Serious	Broadly Acceptable
	Decommissioning	Extremely unlikely	Serious	Tolerable

622. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

19.3 Increased Vessel-to-Vessel Collision Risk between a Third-Party Vessel and Project Vessel

623. Increases in windfarm vessel activity associated with the Project could lead to increased collision rates in the area with third party vessels.

624. The construction, operation, and decommissioning of the Project will necessitate the use of various types of vessels. These vessels will increase traffic volumes within the area, which may lead to an increase in collision risk to third party vessels.

19.3.1 In Isolation – All Users

625. During construction, it is estimated that up to 174 vessels could be used with a total of up to 5,234 return trips. It is likely that vessel numbers will be similar during the decommissioning phase. During the operational phase up to 2,480 annual trips are estimated. It is likely that some project vessels will be Restricted in Ability to

Manoeuvre (RAM), noting that project vessels would likely be undertaking associated sensitive operations activities within the array area, offshore ECC, or at the ORCPs.

626. From historical incident data, there has been one instance of a third-party vessel colliding with a project vessel associated with a UK OWF, leading to moderate vessel damage reported but with no harm to persons. This collision occurred within harbour limits, and therefore was not resultant of project design. It is noted that the incident occurred in 2011, and awareness of OWF developments and the application of the measures has improved or been refined considerably in the interim, with no further collision incidents reported since despite an increase in offshore wind activity and infrastructure.

627. Project traffic movements will be managed via marine coordination for the purposes of ensuring any disruption to third party traffic is minimised. Details of the Project including in relation to vessels will be promulgated meaning areas where increased windfarm vessel traffic will be present are detailed to third party users maximising awareness.

628. Safety zones around structures where active construction/decommissioning and major maintenance works are ongoing will also be applied for to protect both third party and project vessels. Details of authorised safety zones will be promulgated in addition to details of the associated activities, meaning awareness for all third-party users will be maximised.

629. In periods of adverse visibility, third-party vessels may experience limitations regarding visual identification of any Project vessels entering or exiting the buoyed construction/decommissioning areas or array area. However, this will be mitigated by the application of the COLREGs (including Rule 6 Safe Speeds and Rule 19 Conduct of Vessels in Restricted Visibility) in adverse weather conditions and Project vessel compulsory AIS carriage.

630. The most likely consequences in the event of an encounter between a third-party and project vessel is the implementation of avoidance action in line with the COLREGs, with the vessels involved able to resume their respective passages with no long-term consequences.

631. Should an encounter develop into a collision incident, it is most likely to involve minor contact resulting in minor damage to the vessels with no harm to people (as noted in incidents occurred to date as assessed in section 9.6). As a worst case, one of the vessels could founder with PLL and pollution, with this outcome more likely where one of the vessels is a small craft with comparatively weaker structural integrity given hull materials (e.g., fishing vessel, recreational vessel, or CTV).

19.3.2 Embedded Mitigation Measures

632. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Buoyed construction/decommissioning area;
- Application for safety zones;
- Marine coordination;
- Compliance of project vessels with the international marine regulations including COLREGs and SOLAS; and
- Guard vessel(s) as required by risk assessment.

19.3.3 Significance of Risk

633. The frequency of occurrence, severity of consequence, and significance of risk due to third party to project vessel collision is presented in Table 19-3 alongside the resulting significance of risk.

Table 19-3 Risk rankings for third party to project vessel collision

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Extremely unlikely	Serious	Tolerable
	Decommissioning	Extremely unlikely	Serious	Tolerable
ORCP	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Extremely unlikely	Serious	Tolerable
	Decommissioning	Extremely unlikely	Serious	Tolerable
Offshore ECC	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Negligible	Serious	Broadly Acceptable

Project Component	Phase	Frequency	Severity	Significance of Risk
	Decommissioning	Extremely unlikely	Serious	Tolerable

634. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

19.4 Increased Vessel to Structure Allision Risk

635. The presence of surface piercing structures may result in the creation of a risk of allision for vessels.

19.4.1 In Isolation – All Users

19.4.1.1 Powered Vessel to Structure Allision Risk

636. From historical incident data (as assessed in section 9.6), there have been two instances of a third-party vessel alliding with an operational windfarm structure in the UK. These incidents both involved a fishing vessel, with a RNLI lifeboat attending on both occasions.

637. Based on the post windfarm modelling, the base case annual powered vessel to array structure allision risk was estimated at one every 187 years. This is a relatively high return period and is reflective of the high volume of traffic on routes in close proximity to the array area. However, it is noted that the shallows of the Outer Dowsing Bank form a natural separation between the Outer Dowsing Channel traffic and the array area. Its presence may also mean larger vessels may ground prior to making contact with the WTGs.

638. From the post windfarm modelling relative to traffic in proximity to the ORCP, the base case powered vessel to ORCP allision risk was estimated at one every 417 years for the northern ORCP area (noting its proximity to the routeing to the east), and one in 900 for the southern location. The final proposed location of the ORCP(s) will be discussed with the MCA post consent as required under MGN 654 (MCA, 2021), noting that the northern ORCP area is no longer under consideration.

639. Vessels are expected to comply with national and international flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan a route which minimises risk given the promulgation of information relating to the Project, including the charting of infrastructure on relevant nautical charts.

640. On approach, the operational lighting and marking on the structures will also assist in maximising awareness and project vessels will as required alert a vessel on a

closing approach with a structure, noting that Trinity House indicated during consultation that the ORCPs would likely be lit as isolated structures to minimise allision risk. During construction, the array area will be marked as a buoyed construction area, with temporary lighting used to mark individual structures. Pre commissioning safety zones of 50m will also be applied for, again to minimise allision risk prior to operational mitigations becoming active. Similar mitigations are likely to be applied during the decommissioning phase.

641. Should a powered allision incident occur, the consequences will depend on multiple factors including the energy of the contact, structural integrity of the vessel involved, and the sea state at the time of the contact. Small craft including commercial fishing vessels and recreational vessels are considered most vulnerable to the hazard given the potential for a non-steel construction.

642. With considerations for lesson learned the most likely consequences are minor damage with the vessel involved able to resume passage and undertake a full inspection at the next port of call. As a worst case, the vessel may founder leading to PLL and pollution.

19.4.1.2 Drifting Vessel to Structure Allision

643. A drifting vessel scenario may develop into an allision situation where the vessel is in proximity to a structure and the direction of the wind and/or tide is such as to direct the vessel towards the structure.

644. Based on the post windfarm modelling, the base case annual drifting vessel to array structure allision frequency was estimated at one every 958 years. This is a moderate return period compared to that estimated for other UK windfarm developments, likely due to the peak direction of drift relative to the shape and location of the array area. Again, the shallows of the Outer Dowsing Bank mean any drifting larger vessels transiting the Outer Dowsing Channel may ground prior to making contact with the WTGs.

645. From the post windfarm modelling relative to traffic in proximity to the ORCP, the combined base case drifting vessel (to both ORCP locations) return period was estimated at one every 27,006 years. As the northern area is no longer being considered, and had the highest value of allision risk, this is considered to be conservative.

646. From historical incident data, there have been no instances of a third-party vessel alliding with an operational windfarm structure in the UK whilst Not Under Command (NUC).

647. In circumstances where a vessel drifts towards a structure, there are actions which the vessel may take to prevent the drift incident developing into an allision situation. Powered vessels may be able to regain power prior to reaching the array

area (i.e., by rectifying any fault). Failing this, the vessel's emergency response procedures would be implemented which may include an emergency anchoring event following a check of the relevant nautical charts to ensure the deployment of the anchor will not lead to other risks (such as anchor snagging on a subsea cable), or the use of thrusters (depending on availability and power supply). Water depths in the local area are such that anchoring is likely to be a feasible option (dependent on the vessel).

648. Where the deployment of the anchor is not possible (e.g., for small craft), any project vessels on-site may be able to render assistance in liaison with the MCA and in line with SOLAS obligations (IMO, 1974), noting this would depend on the type and size of the vessels involved. This response will be managed via HMCG and marine coordination, and depends on the type and capability of vessels on site. This would be particularly relevant for sailing vessels relying on metocean conditions for propulsion, noting if the vessel becomes adrift in proximity to a structure there may be limited time to render assistance.

649. Should a drifting allision incident occur, the consequences will be similar to those outlined for a powered allision incident, including the determining factors. However, the speed at which the contact occurs is likely to be lower than for a powered allision, which may lead to reduced severity of consequence.

19.4.1.3 Internal Vessel to Structure Allision Risk

650. Commercial vessels are not anticipated to navigate internally within the array area and therefore the likelihood of an internal allision risk for commercial vessels is considered negligible. Vessels navigating within the array area are most likely to be small craft (e.g., fishing, recreation).

651. The base case annual fishing vessel to structure allision frequency is at a return period of approximately one every 8.9 years. This return period is reflective of the volume of fishing vessel traffic in the area, both in transit and engaged in fishing activities, and the conservative assumptions made within the modelling process – in particular, it has been assumed that the baseline fishing activity in terms of proximity to the structures will not change. In reality, it is likely that fishing vessels will increase passing distance to the WTGs. Further, most likely consequences are minor based on the incident assessment undertaken in section 9.6.

652. Due to the negligible levels of fishing vessel traffic in proximity to the ORCP locations, fishing vessel to ORCP allision frequency was also considered negligible when considering the mitigations in place e.g., lighting and marking.

653. As with any passage, a vessel navigating internally within the array is expected to passage plan in accordance with SOLAS Chapter V (IMO, 1974). The lighting and marking of the structures in the array area as required by Trinity House, MCA and CAA

including MGN 654 compliant unique identification marking of structures in an easily identifiable pattern will assist with minimising the risk of a mariner becoming disoriented whilst navigating internally. The layout itself will be agreed with MCA and Trinity House, noting that these discussions will include consideration of surface internal navigation.

654. For recreational vessels under sail navigating internally within the array area, there is also potential for effects such as wind shear, masking and turbulence to occur. From previous studies of offshore wind developments, it has been concluded that WTGs do reduce wind velocity downwind of a WTG (MCA, 2022) but that no negative effects on recreational craft have been reported on the basis of the limited spatial extent of the effect, and its similarity to that experienced when passing a large vessel or close to other large structures (such as bridges) or the coastline. In addition, no practical issues have been raised by recreational users to date when operating in proximity to existing offshore wind developments.

655. An additional allision risk associated with the WTG blades applies for recreational vessels with a mast when navigating internally within the array area. However, the minimum blade tip clearance for the Project of 40m above MSL will be greater than the minimum clearance the RYA recommend for minimising allision risk (RYA, 2019 (a)) and which is also noted in MGN 654 (22m MHWS). The offset between MSL and MHWS is ~2.1m and therefore the minimum blade tip clearance for the Project will be more than 37m above MHWS.

656. It will also be necessary for oil and gas vessels to enter into the array area to access the relevant oil and gas infrastructure, most notably the Malory platform (assuming that it remains in active production at the point of the construction of the Project). Suitable access within the layout will be discussed with the relevant operators, and has been assessed in the Vessel Access Assessment (document reference 6.3.18.2).

657. Should an internal allision incident occur, the consequences will be similar to those outlined for a powered allision incident, including the determining factors. However, as with a drifting allision incident, the speed at which the contact occurs will likely be lower than for an external powered allision, given vessels within the array area are likely to be transiting at lower speeds than when in open water.

19.4.2 Embedded Mitigation Measures

658. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654 (MCA, 2021) and its annexes;
- Appropriate marking on Admiralty charts;
- Promulgation of information;

- Buoyed construction / decommissioning area;
- Application for safety zones;
- Lighting and marking;
- Blade clearance in excess of RYA and MCA requirements; and
- Compliance of project vessels with the international marine regulations including COLREGs and SOLAS.

19.4.3 Significance of Risk

659. The frequency of occurrence, severity of consequence, and significance of risk due to vessel allision is presented in Table 19-4 alongside the resulting significance of risk.

Table 19-4 Risk Rankings For Vessel To Structure Allision Risk

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Extremely unlikely	Serious	Tolerable
	Decommissioning	Extremely unlikely	Serious	Tolerable
ORCP	Construction	Extremely unlikely	Serious	Tolerable
	O&M	Extremely unlikely	Serious	Tolerable
	Decommissioning	Extremely unlikely	Serious	Tolerable
Offshore ECC	Construction	No pathway		
	O&M			
	Decommissioning			

660. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

19.5 Reduction of Emergency Response Provision Including Sar Capability

661. The presence of structures within the array area and associated vessel activities may result in an increased likelihood of an incident occurring which requires an emergency response and may reduce access for surface and air SAR assets.

19.5.1 Emergency Response Resources

662. During construction, it is estimated that up to 174 vessels could be used with a total of up to 5,234 return trips. It is likely that vessel numbers will be similar during the decommissioning phase. During the operational phase up to 2,480 annual trips are estimated. These vessels will increase the likelihood of an incident requiring an emergency response and subsequently increase the likelihood of multiple incidents occurring simultaneously, diminishing emergency response capability.

663. Based on the incident data studied, baseline incident rates are low in proximity to the array area, reflective of the distance offshore. Additionally, based on the number of collision and allision incidents associated with UK OWFs reported to date (see section 9.6), there is an average of one incident per 1,739 operational WTG years (as of December 2023). Therefore, the Project itself is not expected to result in a marked increase in the frequency of incidents requiring an emergency response.

664. Should an incident occur in proximity to the array area, it is likely that a project vessel would be well equipped to assist under SOLAS obligations (IMO, 1974) and in liaison with the MCA, potentially as the first responder. This is reflected in past experience, with 12 known instances of a vessel (or persons on a vessel) being assisted by an industry vessel associated with a nearby UK OWF as detailed in Volume 3, Appendix 15.1: NRA (document reference 6.3.15.1).

665. The most likely consequences in the event of an incident in the region requiring an emergency response is that emergency responders are able to assist without any limitations on capability. As a worst case, there could be a delay to a response request due to a simultaneous incident associated with the Project leading to PLL, pollution, and vessel damage. However, this worst case scenario is considered highly unlikely.

19.5.2 Search and Rescue Access

666. The physical presence of surface piercing structures may restrict access for SAR responders, either due to the incident in question occurring within the array area or the array area obstructing the most effective path to an incident further offshore. This is more likely to be an issue in periods of adverse weather conditions, noting under such conditions it is likely that SAR helicopters would only enter into the array area from low altitude. Therefore, the Applicant will ensure the associated layout design principles detailed in MGN 654 are applied in consultation with the MCA. An indicative layout has been shown in section 6 which is based on a dense perimeter and an inner grid.

667. The assessment of SAR helicopter taskings data indicated that while taskings do occur in the area, the majority are rescue / recovery operations to the local oil and gas infrastructure as opposed to SAR operations (85% of the total were detailed as “Rescue/Recovery”).

668. The Applicant will agree an Emergency Response and Cooperation Plan (ERCoP) with the MCA to ensure appropriate procedures are in place in the event of an emergency incident. A SAR Checklist will also be agreed to ensure any SAR mitigations required by the MCA are implemented for the Project.

669. The final layout and structure identification system will be agreed with both the MCA and Trinity House post consent, with due consideration given to MGN 654 requirements within these discussions.

670. Given the ORCPs will be single isolated platforms, it is considered unlikely that any impact on SAR access will arise.

671. The most likely consequences in the event of a SAR operation is that SAR assets are able to fulfil their objectives without any limitations on capability. As a worst case, it may not be possible to undertake an effective search. However, given that MGN 654 SAR access principles will be applied for the final layout and the layout agreed with the MCA, this is considered highly unlikely.

19.5.3 Embedded Mitigation Measures

672. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654 (MCA, 2021) and its annexes;
- Marine coordination;
- Layout approval;
- Compliance of project vessels with the international marine regulations including COLREGs and SOLAS; and
- Guard vessel(s) as required by risk assessment.

19.5.4 Significance of Risk

673. The frequency of occurrence, severity of consequence, and significance of risk due to reduction of emergency response provision including SAR capability is presented in Table 19-5 alongside the resulting significance of risk.

Table 19-5 Risk Rankings for Reduction of Emergency Response Provision Including Sar Capability

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	Construction	Extremely unlikely	Major	Tolerable
	O&M	Extremely unlikely	Major	Tolerable

Project Component	Phase	Frequency	Severity	Significance of Risk
	Decommissioning	Extremely unlikely	Major	Tolerable
ORCP	Construction	Extremely unlikely	Major	Tolerable
	O&M	Extremely unlikely	Major	Tolerable
	Decommissioning	Extremely unlikely	Major	Tolerable
Offshore ECC	Construction	Extremely unlikely	Major	Tolerable
	O&M	Negligible	Major	Broadly Acceptable
	Decommissioning	Extremely unlikely	Major	Tolerable

674. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

19.6 Reduction of Under Keel Clearance

675. Any changes in under keel clearance as a result of the Project could lead to a risk of under keel interaction to passing vessels.

676. The use of external protection for the cables may be necessary if target burial depths cannot be met. This could lead to reductions in under keel clearance for passing vessels, and potential grounding/interaction risk. The need for and location of any external cable protection will be determined via the cable burial risk assessment which will be undertaken post consent.

677. The maximum height of external protection via rock berm is anticipated to be 1.5m within the offshore ECC, with potentially up to 21.4% of the export cable route requiring protection to be implemented. Maximum height of protection with the array area for the array and interlink cables is also anticipated to be 1.5m, with up to 22.75% and 18.75% potentially requiring protection respectively.

678. As detailed in section 10.4, study of the RYA Coastal Atlas (RYA, 2019 (a)) indicates that the nearshore offshore ECC intersects a "general boating area", which indicates that recreational vessels including those not on AIS may use the area in and around the landfall where water depths are lower and under keel clearance may be of

more concern. There are also shallow banks intersecting both the Offshore ECC and array area where water depths are such that a reduction in under keel clearance may represent a navigational hazard.

679. As required under MGN 654 and as detailed within the DCO, the Applicant will consult with the MCA and Trinity House in any instances where water depths are reduced by more than 5% as a result of cable protection to determine whether additional mitigation is necessary to ensure the safety of passing vessels. This aligns with the RYA's recommendation that the "minimum safe under keel clearance over submerged structures and associated infrastructure should be determined in accordance with the methodology set out in MGN 543 [since superseded by MGN 654]" (RYA, 2019 (a)). This will ensure any areas of shallower water depth where depths are reduced by more than 5% are suitably mitigated.

680. The most likely consequence is a reduction in navigable depths but vessels are still able to transit over the area without contact being made. As a worst case, a vessel may make contact with the cable protection potentially leading to a foundering.

19.6.1 Embedded Mitigation Measures

681. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654 (MCA, 2021) and its annexes;
- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Cable burial and protection including monitoring; and
- Guard vessel(s) as required by risk assessment.

19.6.2 Significance of Risk

682. The frequency of occurrence, severity of consequence, and significance of risk due to reduction of under keel clearance is presented in Table 19-6 alongside the resulting significance of risk.

Table 19-6 Risk Rankings for Reduction of Under Keel Clearance

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	O&M	Extremely unlikely	Moderate	Broadly Acceptable
ORCP	O&M	No pathway		
Offshore ECC	O&M	Extremely unlikely	Moderate	Broadly Acceptable

683. The impact is assessed as being Broadly Acceptable and ALARP, and therefore not significant in EIA terms.

19.7 Increased Anchor/Gear Interaction Risk With Subsea Cables

684. The presence of subsea cables may result in an interaction risk with anchors or fishing gear.

685. Scenarios that could lead to cable interaction include:

- Vessel dragging anchor over subsea cable following anchor failure;
- Vessel anchoring in an emergency over cable (e.g., to avoid drifting into a structure, of into an area of busy traffic);
- Vessel dropping anchor inadvertently (e.g., mechanical failure); or
- Negligent anchoring (e.g., use of out of date charts, neglecting to raise anchor when departing anchorage).

686. There is also a risk that deployed fishing gear may interact with subsea cables.

19.7.1 All Users – Vessel Anchors

687. The project may utilise up to 377.42km of inter array cables, 123.75km of interlink cables, and 440km of export cable. Burial will be the primary form of protection, with external protection used where identified as necessary via the cable burial risk assessment.

688. There are no charted anchorages in proximity to the offshore ECC; however, instances of anchoring activity were recorded in the nearshore area during the vessel traffic surveys for the ORCP as detailed in section 10.5. In terms of the array area, anchoring activity within the study area was observed to be limited based on the 12 months analysis.

689. Burial depths and the need for any external protection will be determined via the cable burial risk assessment process. This will consider baseline vessel activity including in terms of anchored vessel locations, general traffic volumes, and vessel size and type to determine potential anchor sizes. Protection will also be monitored to ensure it remains an effective mitigation.

690. All cables will be charted on appropriate charts meaning mariners are aware of their presence. In any anchoring scenario, an interaction risk exists only where the anchoring occurs in proximity to a subsea cable and it is anticipated that the charting of infrastructure will inform any decision to anchor, as per Regulation 34 of SOLAS (IMO, 1974).

691. The most likely consequences in the event of a vessel anchoring over a subsea cable is that no interaction occurs given the protection applied to the cable (by burial or other means). Should an interaction occur, historical incident data suggests that the consequences would be negligible, with no damage caused to the vessel or cable. As

a worst case, a snagging incident could occur to a small vessel with damaged caused to the anchor and/or the cable, compromising the stability of the vessel.

19.7.2 Fishing Vessels – Gear

692. As for vessel anchors, there is a risk that fishing gear may interact with subsea cables. It is the responsibility of the fishermen to dynamically risk assess whether it is safe to undertake fishing activities within the array area and to make a decision as to whether or not to fish. This decision will be informed by a number of factors, which will include the charted locations of subsea cables. Input received during consultation was that potting activity may continue in the array dependent on the layout (which would be limited concern from a cable interaction perspective). However, the presence of subsea cables and the windfarm structures may mean that trawling is less likely within the array area.

693. Fishermen will similarly be required to take account of the charted presence of subsea cables within the offshore ECC.

694. Active fishing activity is considered further in Volume 1, Chapter 14: Commercial Fisheries (document reference 6.1.14).

19.7.3 Embedded Mitigation Measures

695. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654 (MCA, 2021) and its annexes;
- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Buoyed construction/decommissioning area;
- Cable burial and protection including monitoring; and
- Guard vessel(s) as required by risk assessment.

19.7.4 Significance of Risk

696. The frequency of occurrence, severity of consequence, and significance of risk due to potential anchor/gear interaction risk is presented in Table 19-7 alongside the resulting significance of risk.

Table 19-7 Risk Rankings for Increased anchor/gear interaction risk with subsea cables

Project Component	Phase	Frequency	Severity	Significance of Risk
Array Area	O&M	Extremely unlikely	Moderate	Broadly Acceptable
ORCP	O&M	No pathway		
Offshore ECC	O&M	Extremely unlikely	Moderate	Broadly Acceptable

697. The impact is assessed as being Broadly Acceptable and ALARP, and therefore not significant in EIA terms.

20 Cumulative Risk Assessment

698. The overarching cumulative impact assessment has been undertaken in accordance with the methodology provided in Volume 1, Annex 5.1: Cumulative Impact Assessment Methodology (document reference 6.3.5.1). Shipping and navigation represents a unique topic due to the nature of vessel routeing spanning a wide spatial area, and as such a bespoke tiering system has been applied as detailed in section 3.3.

699. The projects and plans selected as relevant to the assessment of impacts to shipping and navigation are based upon an initial screening exercise undertaken on a long list. Each has been considered and scoped in or out on the basis of potential for interaction with main routeing, data confidence, project status and the distance from the array area. This process is summarised in Table 20-1 which shows the projects screened in. It is noted that developments that are either under construction or operational are considered as part of the baseline.

Table 20-1Projects considered within the shipping and navigation cumulative assessment

Development type	Project	Status	Data confidence assessment/phase	Tier
OWF	Dudgeon Extension	Determination	Medium	1
	Sheringham Shoal Extension	Determination	Medium	1
	Hornsea Four	Consented	High	1
	Norfolk Vanguard West	Consented	High	1
	Hornsea Three	Consented	High	1
	Dogger Bank South	Scoped	Medium	2
Carbon Capture Storage	Southern North Sea 3	Licensing Round Area	Low	2
	Southern North Sea 6	Licensing Round Area	Low	2

700. The cumulative MDS for the Project is outlined in Table 20-2. Impacts associated with anchor interaction and underkeel clearance have been screened out of cumulative basis given their localised nature.

Table 20-2 Cumulative MDS

Impact	Scenario	Justification
Cumulative Displacement of vessels leading to increased collision risk between third party vessels	Project plus other Tier 1/2 OWFs / developments.	Cumulative projects may lead to increased cumulative deviations.
Restrictions of Adverse Weather Routeing		Cumulative projects may lead to increased restriction of adverse weather routeing options.
Cumulative Increased vessel-to-vessel collision risk between a third-party vessel and project vessel		Cumulative projects will lead to increased volumes of windfarm vessel traffic.
Cumulative increased vessel to structure allision risk		Cumulative projects may lead to increased cumulative allision risk.
Cumulative reduction of emergency response provision including SAR capability.		Cumulative projects may lead to increased cumulative reduction of emergency response provision including SAR capability.

20.1 Cumulative Displacement of Vessels Leading to Increased Collision Risk between Third Party Vessels

701. Construction or decommissioning activities and the presence of surface piercing structures within the array area in combination with other cumulative developments may result in the displacement of vessels from pre-existing routes and activities. This displacement may result in an increased cumulative risk of a collision between third-party vessels.

20.1.1 All Users

20.1.1.1 Tier 1

702. Cumulative displacement was raised as a key concern by DFDS during consultation, in particular associated with cumulative effects of the Project and Hornsea Three on routeing between Immingham and Cuxhaven. Input from DFDS was

that the associated vessels would likely go north of the AfL array area and south of Hornsea Three leading to increased transit distance and time on a cumulative basis. Based on the feedback received, the northern array area order limit has been reduced, leading to increased searoom and lower deviations. DFDS have confirmed they are "broadly positive" with the changes made (email sent via the CoS on the 12th January 2024) as detailed in section 4. There is considered to be suitable sea room to safely accommodate the DFDS routeing (noting that the vessels will also need to account for local oil and gas infrastructure); however, there will be a commercial impact, albeit less so following the array area reductions.

703. For vessels anticipated to pass west of the array area (i.e., through the Outer Dowsing Channel between the Outer Dowsing bank and Triton Knoll), there may be cumulative displacement and collision risk associated with the Dudgeon and Sheringham Shoal Extensions to the south. However, based on the post windfarm routeing assessment this is not expected to represent a large increase in traffic volume when compared against baseline numbers already using these routes.

704. Certain main routes were observed to interact with both the array area and Norfolk Vanguard West. Vessels on routes interacting with Norfolk Vanguard West may deviate into the DR1 DWR, however this is likely regardless of the presence of the Project.

705. In addition, there may be limited deviations associated with the screened-in subsea cable installations (Eastern Green Link 3 and 4). However, any such deviation will be spatially limited to the area around the operation and will be temporary in nature.

20.1.1.2 Tier 2

706. No main routes identified in the study area interact with Dogger Bank South, and as such there is not considered to be an associated cumulative impact.

707. Any cumulative displacement associated with the screened in carbon capture developments will be temporary i.e., limited to periods when surface activity is occurring, and spatially limited to the area around the operation.

20.1.2 Embedded Mitigation Measures

708. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Buoyed construction/decommissioning area;
- Application for safety zones; and
- Lighting and marking.

20.1.3 Significance of Risk

709. The frequency of occurrence, severity of consequence, and significance of risk due to cumulative vessel displacement leading to collision risk is presented in Table 20-3 alongside the resulting significance of risk.

Table 20-3 Cumulative risk rankings for displacement of vessels leading to increased collision risk between third party vessels

Phase	Frequency	Severity	Significance of Risk
Construction	Remote	Serious	Tolerable
O&M	Remote	Serious	Tolerable
Decommissioning	Remote	Serious	Tolerable

710. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

20.2 Cumulative Restrictions of Adverse Weather Routeing

711. The presence of the structures within the array area in combination with other cumulative developments could restrict adverse weather routeing options in the study area.

20.2.1 All Users

20.2.1.1 Tier 1

712. DFDS indicated during consultation the key concern associated with adverse weather was in relation to Route 7 between Immingham and Cuxhaven given if the associated vessels deviate north of the AfL array area, there will be a need for increased time in port to secure cargo under certain sea conditions i.e., a commercial impact. The cumulative impact of Hornsea Three will mean there is an additional commercial impact given these vessels would also require increased transit times and distances to deviate north of the array area and south of Hornsea Three. However, there is considered to be sufficient sea space available to accommodate adverse weather transits in terms of navigational safety, and it is noted that DFDS have subsequently confirmed they are “broadly positive” about the array area changes (i.e., from the AfL array area to the array area) to address these concerns made (12th January 2024) as detailed in section 4.

713. DFDS indicated limited concerns with adverse weather transits for the Newcastle to Amsterdam routeing and adverse weather transits through the Outer Dowsing Channel.

20.2.1.2 Tier 2

714. No adverse weather routeing identified in the study area interacts with Dogger Bank South, and as such there is not considered to be an associated cumulative impact.

715. Any cumulative displacement associated with the screened in carbon capture developments will be temporary i.e., limited to periods when surface activity is occurring, and spatially limited to the area around the operation. Such operations may also be less likely during periods of adverse weather.

20.2.2 Embedded Mitigation Measures

716. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Appropriate marking on Admiralty charts;
- Promulgation of information; and
- Lighting and marking.

20.2.3 Significance of Risk

The frequency of occurrence, severity of consequence, and significance of risk due to cumulative restriction of adverse weather routeing is presented in Table 20-4 alongside the resulting significance of risk.

Table 20-4 Cumulative risk rankings for restriction of adverse weather routeing

Phase	Frequency	Severity	Significance of Risk
Construction	Remote	Serious	Tolerable
O&M	Remote	Serious	Tolerable
Decommissioning	Remote	Serious	Tolerable

717. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

20.3 Cumulative Increased Vessel-To-Vessel Collision Risk Between a Third-Party Vessel and Project Vessel

718. Cumulative increases in windfarm vessel activity associated with the Project including combination with other cumulative developments could lead to increased cumulative collision rates in the area with third party vessels.

20.3.1 All Users

20.3.1.1 Tier 1

719. Vessels routeing to the existing Hornsea projects were identified within the study area transiting from the Humber. It is anticipated that similar routeing may be used for vessels associated with Hornsea Three and Four. Depending on origin port there may also be increased windfarm vessel presence associated with other Tier 1 projects.

720. All windfarm developments are expected to be implementing appropriate vessel management procedures including via marine coordination to ensure any disruption to third party traffic is minimised. It is also expected that all developers will apply for the industry standard safety zones (i.e., similar to what the Project intends to apply for). All project vessels regardless of developer will also be required to comply with COLREGS which will manage encounter situations.

721. There may be additional collision risk regarding vessels associated with the installation of the screened-in subsea cable installations. However, the risk of collision associated with any encounters would likely be managed via implementation of COLREGs.

20.3.1.2 Tier 2

722. Any cumulative impact associated with Dogger Bank South will depend on origin port of the project vessels. However, the same mitigations as for Tier 1 developments would apply to any project vessel transits through the area.

20.3.2 Embedded Mitigation Measures

723. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Buoyed construction/decommissioning area;
- Application for safety zones;
- Marine coordination;
- Compliance of project vessels with the international marine regulations including COLREGs and SOLAS; and
- Guard vessel(s) as required by risk assessment.

20.3.3 Significance of Risk

The frequency of occurrence, severity of consequence, and significance of risk due to cumulative third party to project vessel collision is presented in Table 20-5 alongside the resulting significance of risk.

Table 20-5 Cumulative risk rankings for third party to project vessel collision

Phase	Frequency	Severity	Significance of Risk
Construction	Extremely Unlikely	Serious	Tolerable
O&M	Extremely Unlikely	Serious	Tolerable
Decommissioning	Extremely Unlikely	Serious	Tolerable

724. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

20.4 Cumulative Increased Vessel to Structure Allision Risk

725. The structures within the array area will create cumulative allision risk to third party passing vessels in combination with other cumulative developments.

20.4.1 All Users

20.4.1.1 Tier 1

726. Allision risk will be localised to individual areas around developments, and there is considered to be sufficient sea space between the array area and Tier 1 developments to mitigate cumulative allision risk. It is noted that the AfL array area reductions made post PEIR (to arrive at the 'array area') have increased searoom further, and consultation feedback has indicated that key consultees are broadly content as set out in section 4.

727. All developments will be required to implement lighting and marking in agreement with Trinity House and in line with IALA G1162 (IALA, 2021) and chart structure locations on appropriate nautical charts to ensure the structure positions are clear to passing mariners.

20.4.1.2 Tier 2

728. There is not considered to be an increase in cumulative allision risk associated with Dogger Bank South based on its distance from the array area, noting that the same mitigations discussed for Tier 1 developments would apply.

20.4.2 Embedded Mitigation Measures

729. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654 (MCA, 2021) and its annexes;
- Appropriate marking on Admiralty charts;
- Promulgation of information;
- Buoyed construction/decommissioning area;

- Application for safety zones;
- Lighting and marking;
- Blade clearance in excess of RYA and MCA requirements; and
- Compliance of project vessels with the international marine regulations including COLREGs and SOLAS.

20.4.3 Significance of Risk

730. The frequency of occurrence, severity of consequence, and significance of risk due to cumulative vessel allision risk is presented in Table 20-6 alongside the resulting significance of risk.

Table 20-6 Cumulative risk rankings for vessel to structure allision risk

Phase	Frequency	Severity	Significance of Risk
Construction	Extremely Unlikely	Serious	Tolerable
O&M	Extremely Unlikely	Serious	Tolerable
Decommissioning	Extremely Unlikely	Serious	Tolerable

731. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

20.5 Cumulative Reduction of Emergency Response Provision Including Sar Capability

732. The presence of structures within the array area and associated vessel activities may result in a cumulative increased likelihood of an incident occurring which requires an emergency response and may reduce access for surface and air SAR assets.

20.5.1 All Users

20.5.1.1 Tier 1

733. Given generally low baseline incident rates and noting historical incident data indicates limited vessel based incidents associated with windfarms, it is considered unlikely that there will be a notable increase in incidents on a cumulative basis. Furthermore, there will be additional vessel based resources that would be available at other projects which may be able to assist in the event of an incident occurring in the area (depending on the nature of the incident and vessels involved).

734. All developers will be required to comply with MGN 654 in terms of developments of an ERCoP, agreements of a SAR checklist, and approval of the layout by MCA in terms of SAR access. It is also noted that the MCA require cumulative considerations to be captured in the ERCoP.

20.5.1.2 Tier 2

735. Dogger Bank South is considered analogous to Tier 1 developments with regards to this impact.

20.5.2 Embedded Mitigation Measures

736. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654 (MCA, 2021) and its annexes;
- Marine coordination;
- Layout approval;
- Compliance of project vessels with the international marine regulations including COLREGs and SOLAS; and
- Guard vessel(s) as required by risk assessment.

20.5.3 Significance of Risk

737. The frequency of occurrence, severity of consequence, and significance of risk due to cumulative reduction of emergency response provision including SAR capability is presented in Table 20-7 alongside the resulting significance of risk.

Table 20-7 Cumulative risk rankings for reduction of emergency response provision including SAR capability

Phase	Frequency	Severity	Significance of Risk
Construction	Extremely Unlikely	Major	Tolerable
O&M	Extremely Unlikely	Major	Tolerable
Decommissioning	Extremely Unlikely	Major	Tolerable

738. The impact is assessed as being Tolerable and ALARP, and therefore not significant in EIA terms.

21 Risk Control Log

739. Table 21-1 presents a summary of the assessment of shipping and navigation hazards scoped into the risk assessment. This includes the proposed embedded mitigation measures, frequency of occurrence, severity of consequence and significance of risk, for each hazard assessed.

Table 21-1 Risk control log

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Construction	Displacement of Vessels leading increased Third Party to Third Party Vessel Collision	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Construction Area. ▪ Application for Safety Zones. ▪ Lighting and marking.	**Remote**	**Serious**	**Tolerable**
	Restriction of Adverse Weather Routeing	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Lighting and marking.	**Remote**	**Serious**	**Tolerable**
	Third-party to Project Vessel	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Construction Area. ▪ Application for Safety Zones. ▪ Marine Coordination. ▪ Compliance with international marine regulations. ▪ Guard vessels if required.	**Extremely Unlikely**	**Serious**	**Tolerable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
	Vessel to Structure Allision	▪ Promulgation of Information. ▪ Compliance with MGN 654. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Construction Area. ▪ Application for Safety Zones. ▪ Lighting and marking. ▪ Compliance with international marine regulations. ▪ Blade clearance in excess of RYA and MCA requirements.	**Extremely Unlikely**	**Serious**	**Tolerable**
	Reduction of Emergency Response Provision	▪ Compliance with MGN 654. ▪ Marine coordination. ▪ Layout approval. ▪ Compliance with international marine regulations. ▪ Guard vessel if required.	**Extremely Unlikely**	**Major**	**Tolerable**
Operations and Maintenance	Displacement of Vessels leading increased Third Party to Third Party Vessel Collision	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Lighting and marking. ▪ Marine coordination.	**Remote**	**Serious**	**Tolerable**
	Restriction of Adverse Weather Routeing	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking.	**Remote**	**Serious**	**Tolerable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
		▪ Lighting and marking.			
	Third-party to Project Vessel	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Application for Safety Zones. ▪ Marine Coordination. ▪ Compliance with international marine regulations. ▪ Guard vessels if required.	**Extremely Unlikely**	**Serious**	**Tolerable**
	Vessel to Structure Allision	▪ Promulgation of Information. ▪ Compliance with MGN 654. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Construction Area. ▪ Application for Safety Zones. ▪ Lighting and marking. ▪ Compliance with international marine regulations. ▪ Blade clearance in excess of RYA and MCA requirements.	**Extremely Unlikely**	**Serious**	**Tolerable**
	Under Keel Clearance	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Compliance with MGN 654.	**Extremely Unlikely**	**Moderate**	**Broadly Acceptable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
		▪ Cable burial and protection including monitoring. ▪ Guard vessel if required.			
	Increased anchor / gear interaction risk with subsea cables	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Compliance with MGN 654. ▪ Cable burial and protection including monitoring. ▪ Guard vessel if required.	**Extremely Unlikely**	**Moderate**	**Broadly Acceptable**
	Reduction of Emergency Response Provision	▪ Compliance with MGN 654. ▪ Marine coordination. ▪ Layout approval. ▪ Compliance with international marine regulations. ▪ Guard vessel if required.	**Extremely Unlikely**	**Major**	**Tolerable**
Decommissioning	Displacement of Vessels leading increased Third Party to Third Party Vessel Collision	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Decommissioning Area. ▪ Application for Safety Zones. ▪ Lighting and marking. ▪ Marine coordination.	**Remote**	**Serious**	**Tolerable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
	Restriction of Adverse Weather Routeing	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Lighting and marking.	**Remote**	**Serious**	**Tolerable**
	Third-party to Project Vessel	▪ Promulgation of Information. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Decommissioning Area. ▪ Application for Safety Zones. ▪ Marine Coordination. ▪ Compliance with international marine regulations. ▪ Guard vessels if required.	**Extremely Unlikely**	**Serious**	**Tolerable**
	Vessel to Structure Allision	▪ Promulgation of Information. ▪ Compliance with MGN 654. ▪ Appropriate Admiralty Chart Marking. ▪ Buoyed Construction Area. ▪ Application for Safety Zones. ▪ Lighting and marking. ▪ Compliance with international marine regulations. ▪ Blade clearance in excess of RYA and MCA requirements.	**Extremely Unlikely**	**Serious**	**Tolerable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
	Reduction of Emergency Response Provision	▪ Compliance with MGN 654. ▪ Marine coordination. ▪ Layout approval. ▪ Compliance with international marine regulations. ▪ Guard vessel if required.	**Extremely Unlikely**	**Major**	**Tolerable**
Cumulative	Cumulative Displacement of vessels leading to increased collision risk between third party vessels	▪ Appropriate marking on Admiralty charts. ▪ Promulgation of information. ▪ Buoyed construction/decommissioning area. ▪ Application for safety zones. ▪ Lighting and marking.	**Remote**	**Serious**	**Tolerable**
	Cumulative Restrictions of Adverse Weather Routeing	▪ Appropriate marking on Admiralty charts. ▪ Promulgation of information. ▪ Lighting and marking.	**Remote**	**Serious**	**Tolerable**
	Cumulative Increased vessel-to-vessel collision risk between a third-party vessel and project vessel	▪ Appropriate marking on Admiralty charts. ▪ Promulgation of information. ▪ Buoyed construction/decommissioning area. ▪ Application for safety zones. ▪ Marine Coordination.	**Extremely unlikely**	**Serious**	**Tolerable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
		▪ Compliance of project vessels with the international marine regulations including COLREGs and SOLAS. ▪ Guard vessel(s) as required by risk assessment.			
	Cumulative increased vessel to structure allision risk	▪ Compliance with MGN 654 (MCA, 2021) and its annexes. ▪ Appropriate marking on Admiralty charts. ▪ Promulgation of information. ▪ Buoyed construction/decommissioning area. ▪ Application for safety zones. ▪ Lighting and marking. ▪ Blade clearance in excess of RYA and MCA requirements. ▪ Compliance of project vessels with the international marine regulations including COLREGs and SOLAS.	**Extremely unlikely**	**Serious**	**Tolerable**
	Cumulative reduction of emergency response provision including SAR capability	▪ Compliance with MGN 654 (MCA, 2021) and its annexes. ▪ Marine Coordination. ▪ Layout approval.	**Extremely unlikely**	**Major**	**Tolerable**

Project Phase	Hazard	Mitigation Measure	Frequency of Occurrence	Severity of Consequence	Significance of Risk
		▪ Compliance of project vessels with the international marine regulations including COLREGs and SOLAS. ▪ Guard vessel(s) as required by risk assessment.			

22 Through Life Safety Management

740. Quality, Health, Safety and Environment (QHSE) documentation including a Safety Management System (SMS) will be in place and continually updated throughout the development process. Table 22-1 provides an overview of various QHSE documentation and how it will be maintained and reviewed with reference, where required, to specific marine documentation.

741. Monitoring, reviewing and auditing will be carried out on all procedures and activities and feedback actively sought. Any designated person (identified in QHSE documentation), managers and supervisors are to maintain continuous monitoring of all marine operations and determine if all required procedures and processes are being correctly implemented.

Table 22-1 Summary of QHSE Documentation

Documentation	Details
Incident reporting	An incident report will be completed following any incidents, including near misses. A review will then be undertaken to determine any possible need for operational changes. Where appropriate, the designated person (noted within the ERCoP) should inform the MCA of any exercise or incidents including any implications on emergency response, with the MCA invited to participate in debriefs.
Review of documentation	The Project will be responsible for reviewing and updating all documentation including the risk assessments, ERCoP, safety management system and, if required, will convene a review panel of stakeholders to quantify risk. A review of potential risks and response procedures will be undertaken annually.
Inspection of resources	All vessels, facilities and equipment necessary for marine operations will be subject to appropriate inspection and testing to determine fitness for purpose and availability in relation to their performance standards, including AtoNs relative to the performance standards specified by Trinity House.
Audit of performance	Audits will be undertaken periodically to evaluate the efficiency of the marine safety documentation and possible corrective actions should be undertaken in accordance with standard procedures with audit results and reviews brought to the attention of responsible personnel.
Safety management system	An integrated safety management system will be established to ensure the safety and environmental impact of activities undertaken are ALARP. This includes the use of remote monitoring and switching for AtoNs to ensure that a quick fix for a faulty light can be instigated, thus ensuring IALA availability requirements are satisfied.
Future monitoring of vessel traffic	The Development Consent Order (DCO) is expected to include the requirement for construction traffic monitoring by AIS, including continual collection of data from a suitable location. An assessment of a minimum of 28-days and comparison against the results of the vessel traffic analysis (see section 10) and anticipated future case routeing (see section 15) will be submitted to the MCA annually throughout the construction phase and is likely to continue through the first year of the O&M phase to ensure measures implemented are effective.

Documentation	Details
Cable monitoring	The subsea cables will be subject to periodic inspection post construction to monitor cable burial depths and protection. If exposed cables or ineffective cable protection measures are identified, these would be promulgated to relevant sea users including via notifications to mariners and Kingfisher Bulletins and if there was deemed to be an immediate risk additional temporary measures may be deployed until such time as the risk is permanently mitigated.
Hydrographic surveys	As required by MGN 654, detailed and accurate hydrographic surveys will be undertaken periodically at intervals agreed with the MCA.
Decommissioning plan	A decommissioning plan will be developed. For shipping and navigation, this will include consideration of the scenario where upon decommissioning and completion of removal operations, an obstruction is left on-site which is considered a danger to safe navigation and has not been possible to remove.

23 Summary

23.1 Consultation

742. The NRA process has included consultation with stakeholders of relevance to shipping and navigation. This has included consideration of the outputs of the scoping process, direct liaison with key stakeholders (both statutory and non-statutory), outreach to Regular Operators of the area, recreational outreach, and a Hazard Workshop process.

23.2 Existing Environment

743. Triton Knoll, which was fully commissioned in January 2022, is approximately 4nm to the west of the array area with Hornsea Project Two, which was fully commissioned in November 2022, approximately 9nm to the northeast. Several other OWFs are in proximity to the wider Project area.

744. Two TCE marine aggregate dredging areas are within proximity to the array area, areas Outer Dowsing 515/1 and 515/2 with the latter 0.6nm from the southwest of the array area.

745. The closest port or harbour to the array area is Wells Harbour, 32nm south of the array area on the Norfolk coast and the closest commercial port, the Port of Immingham at the entrance to the Humber, 38nm northwest (24nm from Offshore ECC). Pilotage services and anchorage areas are provided within the vicinity to the Humber.

746. Within the array area are four oil and gas platforms with the Pickerill A and B partially decommissioned (topsides removed), Galahad pending decommissioning, and the Malory operational. Surrounding the array area as many other oil and gas fields and associated platforms, with an additional 15 structures within the shipping and navigation study area. These gas fields being Clipper, Barque, Audrey, Galleon, Waveney, Lancelot, Excalibur, Amethyst, West Sole, Hoton, and Mimas.

747. There are six charted pipelines from offshore assets to shore in proximity to the array area with pipeline bundles and pipelines between assets also present. Two pipelines intersect the offshore ECC, south of the array area.

748. The closest subsea cables to the Project are the export cables for Hornsea Project One and Two which intersect the shipping and navigation study area approximately 2.4nm north of the array area. Subsea cables for Triton Knoll pass immediately north of the offshore ECC.

749. There are 93 charted wrecks or obstructions within the shipping and navigation study area with only five present within the array area.

750. There are two areas of spoil ground in close proximity to the offshore ECC. One spoil ground intersects the offshore ECC approximately 6nm offshore with the other area, although disused, 1.4nm south of the offshore ECC.

23.3 Maritime Incidents

751. From SAR helicopter taskings data between 2015 and 2023 there was an average of six incidents per year within the shipping and navigation study, the majority of these being “Rescue/Recovery” (85%). Seven taskings took place within the array area itself. There was an average of three incidents per year within the ECC study area, the majority of these also being “Rescue/Recovery” (63%). Three taskings took place within the offshore ECC. There was an average of four incidents per year within the ORCP area study area, with the majority being “Rescue/Recovery” (46%). One tasking took place within the ORCP area itself. The closest SAR helicopter base is located at Humberside Airport.

752. From RNLI incident data recorded between 2013 and 2022 there was an average of one to two incidents per year within the shipping and navigation study area with one incident recorded within the array area. The most common incident types recorded were “Machinery Failure” (40%) and “Unspecified” (27%). The most common casualty types recorded were fishing vessels (27%) and powered recreational vessels (27%). An average of six to seven incidents per year were recorded within the ECC study area with the majority occurring off the coast and six within the offshore ECC. The most common incident types recorded were "Person in Danger" (31%) and ”Unspecified” (22%). The most common casualty types recorded were “Unspecified” (63%), “Person in danger” (17%) and “Powered Recreational” (14%). An average of 32 incidents per year were recorded within the ORCP area study area with none recorded within the ORCP area itself. The most common incident types were “Unspecified” (55%), “Person in Danger” (25%), and “Machinery Failure” (7%). The most common casualty types were “Unspecified” (45%), “Person in Danger” (28%) and “Powered Recreational” (11%). The most common RNLI base stations recorded for lifeboat launches for incidents in the ECC study area were Skegness (56%) and Mablethorpe (37%).

753. From MAIB incident data recorded between 2012 and 2022 there was on average two incidents per year within the shipping and navigation study area, with an average of one incident recorded every two years in the ECC study area and two incidents per year within the ORCP area study area. Throughout the 10-year period, no incidents occurred within the array area, Offshore ECC or ORCP area. The most common incident types for the shipping and navigation study area were “Accident to Person” (35%) and “Machinery Failure” (35%), with the most frequent vessel types being service vessels (40%) and fishing vessels (35%). The most common incident types for the offshore ECC study area were “Accident to Person” (40%) and “Flooding/Foundering” (40%), with the most frequent vessel types being service

vessels (40%) and other commercial vessels (40%). The most common incident types for the ORCP area study area were "Accident to Person" (24%), "Collision" (19%), and "Machinery Failure" (19%), with the most frequent vessel types being other commercial vessels (29%), service vessels (29%), and fishing vessels (25%).

23.4 Vessel Traffic Movements

754. From 14-days of vessel traffic survey data recorded in August 2022 (summer) within the shipping and navigation study area, there was an average of between 64 and 65 unique vessels per day with an average of eight unique vessels per day recorded intersecting the array area. From 14-days of vessel traffic survey data recorded in November 2022 (winter) within the shipping and navigation study area, there was an average of 58 unique vessels per day with an average of seven unique vessels per day recorded intersecting the array area. The main vessel types recorded within the shipping and navigation study area were cargo vessels (46%), tankers (21%) and oil and gas vessels (15%).

755. During the summer survey period an average of 58 unique vessels per day were recorded within the ECC study area with an average of 55 unique vessels per day recorded intersecting the offshore ECC. The main vessel types recorded within the ECC study area were cargo vessels (50%), tankers (16%) and windfarm vessels (14%). During the winter survey period an average of 60 unique vessels per day were recorded within the ECC study area with an average of 57 unique vessels per day recorded intersecting the offshore ECC. The main vessel types recorded within the ECC study area were cargo vessels (58%), tankers (18%) and oil and gas vessels (9%).

756. During the winter survey period an average of 44 unique vessels per day were recorded within the ORCP area study area with an average of one unique vessel every two days recorded intersecting the ORCP area. The main vessel types recorded within the ECC study area were cargo vessels (73%), tankers (13%) and windfarm vessels (10%). During the summer survey period an average of 47 unique vessels per day were recorded within the ORCP area study area with an average of one unique vessels every five days recorded intersecting the ORCP area. The main vessel types recorded within the ORCP area study area were cargo vessels (50%), windfarm vessels (20%), and tankers (11%).

757. A total of 13 main commercial routes in proximity to the array area were identified from the vessel traffic survey data. The highest use main commercial route was between Ports within the Humber and to Rotterdam, The Netherlands with an average of 16 unique vessels per day. This route was also used by commercial ferries. Several other routes were identified in and out of the Humber including routes to and from ports in The Netherlands and Germany. A total of nine main commercial routes in proximity to the ORCP area were identified from the vessel traffic survey data. The highest use main commercial route was again between Ports within the Humber and

to Rotterdam, The Netherlands with an average of 10 unique vessels per day. This route was also used by commercial ferries.

23.5 Future Case Vessel Traffic

758. An indicative 10% and 20% increase in vessel traffic associated with commercial vessels has been considered for the future case scenario in the NRA.

759. Deviations could be required for five out of the 13 main commercial routes identified in proximity to the array area, with the level of deviation varying between a 0.23nm increase for a route between Tees and Amsterdam, and a 2.61nm increase for a route between Humber Ports and Bremerhaven/Hamburg, Germany. No deviations are considered to be required for the routes in proximity to the ORCP area.

23.6 Collision Risk Modelling

760. The NRA process included quantitative modelling of the change in allision and collision frequency as a result of the array area and ORCP area, with consideration given to future cases in terms of potential future traffic increases.

761. It was estimated that the return period of a vessel being involved in a collision in proximity to the array area post windfarm was 28 years assuming base case traffic levels. This represents a 12% increase in collision frequency compared to the pre windfarm base case result, noting that the equivalent increase due to the array area pre PEIR was estimated as 19%.

762. The powered allision return period in proximity to the array area post windfarm was estimated at 187 years assuming base case traffic levels. The corresponding drifting allision return period post windfarm was estimated at 958 years. The fishing vessel allision return period was estimated at 8.9 years, noting extremely conservative assumptions have been applied.

763. It was estimated that the return period of a vessel being involved in a collision in proximity to the ORCP area pre windfarm was 92 years assuming base case traffic levels, noting that as no route deviations are expected due to the presence of the ORCP, this value is not expected to change post windfarm.

764. The powered allision return period in proximity to the ORCP area post windfarm was estimated at 285 years assuming base case traffic levels. The corresponding drifting allision return period post windfarm was estimated at 27,006 years.

23.7 Risk Statement

765. Using the baseline data, quantitative modelling, expert opinion, outputs of the Hazard Workshops, and lessons learnt from existing offshore developments, shipping and navigation hazards have been identified and assessed in line with the FSA

methodology. The full risk control log including details of hazards, embedded mitigation measures, and significant of risk is presented in section 21.

766. The significance of risk has been determined as either Broadly Acceptable or Tolerable with Mitigation for all shipping and navigation hazards assessed. No additional mitigation measures have been identified, and thus the residual risk is also Broadly Acceptable or Tolerable with Mitigation for all shipping and navigation hazards.

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Annex A Marine Guidance Note 654 Checklist

767. The MGN 654 Checklist can be divided into two distinct checklists, one considering the main MGN 654 guidance document and one considering the Methodology for Assessing Marine Navigational Safety and Emergency Response Risks of OREIs (MCA, 2021) which serves as Annex 1 to MGN 654.

768. The checklist for the main MGN 654 guidance document is presented in Table A.1. Following this, the checklist for the MCA's methodology annex is presented in Table A.2. For both checklists, references to where the relevant information and/or assessment is provided in the NRA is given.

Table A.1 MGN 654 Checklist for main document

Issue	Compliance	Comments
Site and Installation Coordinates. Developers are responsible for ensuring that formally agreed coordinates and subsequent variations of site perimeters and individual OREI structures are made available, on request, to interested parties at relevant project stages, including application for consent, development, array variation, operation, and decommissioning. This should be supplied as authoritative Geographical Information System (GIS) data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners data should also be provided with latitude and longitude coordinates in WGS84 (European Terrestrial Reference System 1989 (ETRS89)) datum.		
Traffic Survey. Includes:		
All vessel types.	✓	**Section 10: Vessel Traffic Movements** All vessel types are considered with specific breakdowns by vessel type given within the study area.
At least 28 days duration, within either 12 or 24 months prior to submission of the ES.	✓	**Section 5: Data Sources** The NRA is primarily based on 28 days of vessel traffic survey data collected during 2022. A further 28 days of data has also been collected for the ORCP.
Multiple data sources.	✓	**Section 5: Data Sources** The vessel traffic survey data includes AIS, Radar and visual observations to maximise coverage of vessels not broadcasting on AIS. Long-term vessel traffic data recorded on AIS have also been considered.
Seasonal variations.	✓	**Section 5: Data Sources** The NRA is based primarily on 28 days of vessel traffic survey data collected during summer / winter 2022. **Annex E: Long-Term Vessel Traffic Movements** To assist with the assessment of seasonal variation a long-term AIS dataset covering 12 months in April 2021-March 2022 has also been assessed.

Issue	Compliance	Comments
MCA consultation.	✓	**Section 4: Consultation** The MCA has been consulted as part of the NRA process including through the Hazard Workshops.
General Lighthouse Authorities (GLA) consultation.	✓	**Section 4: Consultation** Trinity House has been consulted as part of the NRA process including through the Hazard Workshops.
UK CoS.	✓	**Section 4: Consultation** The UK CoS has been consulted as part of the NRA process including through the Hazard Workshops.
Recreational and fishing vessel organisations consultation.	✓	**Section 4: Consultation** The RYA, CA and NFFO were all invited to input into the NRA process including through the Hazard Workshops.
Port and navigation authorities consultation, as appropriate.	✓	**Section 4: Consultation** ABP Humber have been consulted as part of the NRA process including through the Hazard Workshops.
Assessment of the cumulative and individual effects of (as appropriate):		
i. Proposed OREI site relative to areas used by any type of marine craft.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the Project has been analysed. **Section 19: Risk Assessment – In isolation** The hazards due to the Project have been assessed. **Section 20: Cumulative Risk Assessment** The hazards due to the Project have been assessed on a cumulative basis.
ii. Numbers, types and sizes of vessels presently using such areas.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the Project has been analysed and includes breakdowns of daily vessel count, vessel type and vessel size.
iii. Non-transit uses of the areas, e.g., fishing, day cruising of leisure craft, racing, aggregate dredging, personal watercraft, etc.	✓	**Section 7: Navigational Features** Non-transit uses of the areas in proximity to the Project have been identified, including marine aggregate dredging, and anchoring. **Section 10: Vessel Traffic Movements** Non-transit users were identified in the vessel traffic survey data and included fishing vessels engaged in fishing activities, marine aggregate dredgers engaged in dredging activities, oil and gas activity and anchoring activities.
iv. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✓	**Section 11: Base Case Vessel Routeing** Main commercial routes have been identified using the principles set out in MGN 654 in proximity to the Project, with these routes taking into account coastal, deep-draught and internationally scheduled vessels.

Issue	Compliance	Comments
v. Alignment and proximity of the site relative to adjacent shipping lanes.	✓	**Section 7: Navigational Features** There are no IMO routeing measures in proximity to the array area as per section 7.10.
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas.	✓	**Section 7: Navigational Features** There are no IMO routeing measures in proximity to the array area as per section 7.10.
vii. Proximity of the site to areas used for anchorage (charted or uncharted), safe haven, port approaches and pilot boarding or landing areas.	✓	**Section 7: Navigational Features** Section 7.2 identifies port approaches in proximity to the Project and section 7.4 identifies anchorage areas in proximity to the Project.
viii. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 7: Navigational Features** Section 7.2 identifies the locations of ports in proximity to the Project.
ix. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	**Section 10: Vessel Traffic Movements** Fishing vessel movements are considered within the study area. Detailed analysis of dedicated fishing vessel activities is undertaken in Volume 1, Chapter 14: Commercial Fisheries (document reference 6.1.14).
x. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 7: Navigational Features** There are no military practice areas in proximity to the Project as per section 7.11.
xi. Proximity of the site to existing or proposed submarine cables or pipelines, offshore oil/gas platforms, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Areas or other exploration/exploitation sites.	✓	**Section 7: Navigational Features** Section 7.3 identifies the marine aggregate dredging areas in proximity to the Project and section 7.8 identifies the charted wrecks in proximity to the Project. **Section 16: Cumulative and Transboundary Overview** Considers other developments in proximity to the Project cumulatively.
xii. Proximity of the site to existing or proposed OREI developments, in cooperation with other relevant developers, within each round of lease awards.	✓	**Section 7: Navigational Features** Section 7.1 Identifies other baseline OWF developments in proximity to the Project. **Section 16: Cumulative and Transboundary Overview** Considers other OREI sites in proximity to the Project cumulatively.
xiii. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping ground.	✓	**Section 7: Navigational Features** Section 7.9 Identifies spoil and dumping grounds in proximity to the Project.

Issue	Compliance	Comments
xiv. Proximity of the site to AtoNs and/or VTS in or adjacent to the area and any impact thereon.	✓	**Section 7: Navigational Features** Section 7.2 identifies VTS areas in proximity to the Project and section 7.5 identifies AtoNs in proximity to the Project.
xv. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density and nearby or consented OREI sites not yet constructed.	✓	**Section 17: Collision and Allision Risk Modelling** Provides quantification of collision risk resulting from the Project including pinch (or choke) points in proximity to the array area.
xvi. With reference To xv. above, the number and type of incidents to vessels which have taken place in or near to the proposed site of the OREI to assess the likelihood of such events in the future and the potential impact of such a situation.	✓	**Section 8: Emergency Response and Incident Overview** Historical vessel incident data published by DfT (section 9.1), RNLI (section 9.2) and MAIB (section 9.5) in proximity to the Project has been considered alongside historical OWF incident data throughout the UK (section 9.6).
xvii. Proximity of the site to areas used for recreation which depend on specific features of the area.	✓	**Section 10: Vessel Traffic Movements** Non-transit users were identified in the vessel traffic survey data and included recreational activities.
Predicted effect of OREI on traffic and interactive boundaries. Where appropriate, the following should be determined:		
a. The safe distance between a shipping route and OREI boundaries.	✓	**Section 15: Future Case Vessel Traffic** A methodology for post windfarm routeing is outlined and includes a minimum distance of 1nm from offshore installations and existing OWF boundaries.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	**Section 16: Future Case Vessel Traffic** Section 16.2 assesses cumulative routeing. Noted that the distance between the array area and the Hornsea projects is considered large enough that no "corridor" is created (in excess of 9nm), and the gap between the array area and Triton Knoll OWF is already established via presence of the Outer Dowsing Shoal.
OREI Structures. The following should be determined:		

Issue	Compliance	Comments
a. Whether any feature of the OREI, including auxiliary platforms outside the main generator site, mooring and anchoring systems, inter-device and export cabling could pose any type of difficulty or danger to vessels underway, performing normal operations, including fishing, anchoring and emergency response.	✓	**Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of users such as commercial vessels, commercial fishing vessels in transit, recreational vessels, anchored vessels and emergency responders.
b. Clearances of fixed or floating WTG blades above the sea surface are not less than 22m (above Mean High Water Springs (MHWS) for fixed). Floating WTG allow for degrees of motion.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** Section 6 outlines the shipping and navigation MDS for WTGs including the minimum air gap above MHWS.
c. Underwater devices: i. Changes to charted depth; ii. Maximum height above seabed; and iii. Under keel clearance.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** Section 6.4 outlines the shipping and navigation MDS for subsea cables including the cable burial specifications.
d. Whether structures block or hinder the view of other vessels or other navigational features.	✓	**Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of the potential for vessels navigating in proximity to structures to be visually obscured.
The effect of tides, tidal streams and weather. It should be determined whether:		
a. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide, i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** Section 6.1 outlines the shipping and navigation project description for the NRA and includes the range of existing water depths. **Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the Project has been analysed including vessel draught. **Section 17: Collision and Allision Risk Modelling** Provides quantification of collision and allision risk.
b. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✓	**Section 17: Collision and Allision Risk Modelling** Provides quantification of collision risk, and allision modelling which includes account of tidal conditions.

Issue	Compliance	Comments
c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓	
d. The set is across the major axis of the layout at any time, and, if so, at what rate.	✓	
e. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream, including unpowered vessels and small, low speed craft.	✓	**Section 17: Collision and Allision Risk Modelling** Provides quantification of collision risk, and allision risk which will includes account of tidal conditions and assessment of whether machinery failure could cause vessels to be set into danger.
f. The structures themselves could cause changes in the set and rate of the tidal stream.	✓	**Section 17: Collision and Allision Risk Modelling** Provides quantification of collision risk and allision risk modelling which includes account of tidal conditions.
g. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the windfarm area or adjacent to the area.	✓	**Section 19 : Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of the potential for reduction in under keel clearance.
h. The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the Project has been analysed including recreational vessels. **Section 12: Adverse Weather Routeing** Section 12.2 identifies alternative vessel routeing in proximity to the Project in adverse weather. **Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of adverse weather routeing.
i. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of internal allision risk for vessels under sail.
j. In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred to above.	✓	**Section 17: Collision and Allision Risk Modelling** Provides quantification of collision risk and allision risk modelling which includes account of tidal conditions. **Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of drifting allision risk.

Issue	Compliance	Comments
Assessment of access to and navigation within, or close to, an OREI. To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:		
a. Navigation within or close to the site would be safe:		
i. For all vessels.	✓	**Section 4: Consultation** Section 4.2.4 outlines Regular Operator consultation undertaken following the vessel traffic surveys. **Section 12: Adverse Weather Routeing** Section 12.2 identifies alternative vessel routeing in proximity to the Project in adverse weather. **Section 17: Collision and Allision Risk Modelling** Provides quantification of collision risk and allision risk modelling which includes account of tidal conditions. **Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of internal allision risk.
ii. For specified vessel types, operations and/or sizes.		
iii. In all directions or areas.		
iv. In specified directions or areas.		
v. In specified tidal, weather or other conditions.		
b. Navigation in and/or near the site should be prohibited or restricted:		
i. For specified vessel types, operations and/or sizes.	✓	**Section 14: Navigation, Communication and Position Fixing Equipment** Assesses potential hazards on navigation of the different communications and position fixing devices used in and around OWFs. **Section 15: Future Case Vessel Traffic** A methodology for post windfarm routeing is outlined and includes a minimum distance of 1nm from offshore installations and existing OWF boundaries, i.e., it is assumed that commercial vessels will avoid the array area. **Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of vessel displacement.
ii. In respect of specific activities.	✓	
iii. In all areas or directions.	✓	
iv. In specified areas or directions.	✓	
v. In specified tidal or weather conditions.	✓	

Issue	Compliance	Comments
c. Where it is not feasible for vessels to access or navigate through the site it could cause navigational, safety or routeing problems for vessels operating in the area, e.g., by preventing vessels from responding to calls for assistance from persons in distress.	✓	**Section 19: Risk Assessment – In Isolation** The hazards due to the Project have been assessed for each phase and include consideration of vessel displacement and emergency response capability.
d. Guidance on the calculation of safe distance of OREI boundaries from shipping routes has been considered.	✓	**Section 15: Future Case Vessel Traffic** A methodology for post windfarm routeing is outlined and includes consideration of the Shipping Route Template.
SAR, maritime assistance service, counter pollution and salvage incident response.		
The MCA, through HM Coastguard, is required to provide SAR and emergency response within the sea area occupied by all OREIs in UK waters. To ensure that such operations can be safely and effectively conducted, certain requirements must be met by developers and operators.		
a. An ERCoP will be developed for the construction, operation and decommissioning phases of the OREI.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including compliance with MGN 654 which includes the provision of an ERCoP.
b. The MCA's guidance document *Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response* (MCA, 2021) for the design, equipment and operation requirements will be followed.	✓	**Section 2: Guidance and Legislation** Outlines the guidance and legislation used within the NRA including Annex 5 of MGN 654. **Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including compliance with MGN 654 and its annexes.
c. A SAR checklist will be completed to record discussions regarding the requirements, recommendations and considerations outlined in Annex 5 (to be agreed with MCA).	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including compliance with MGN 654 which includes the completion of the SAR checklist.
6. Hydrography. In order to establish a baseline, confirm the safe navigable depth, monitor seabed mobility and to identify underwater hazards, detailed and accurate hydrographic surveys are included or acknowledged for the following stages and to MCA specifications:		
i. Pre-construction: The proposed generating assets area and proposed cable route.	✓	**Section 22: Through life safety management** Confirms that hydrographic surveys will be undertaken in agreement with the MCA.

Issue	Compliance	Comments
ii. On a pre-established periodicity during the life of the development.	✓	
iii. Post construction: Cable route(s).	✓	
iv. Post decommissioning of all or part of the development: the installed generating assets area and cable route.	✓	
Communications, Radar and positioning systems. To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:		
a. The structures could produce radio interference such as shadowing, reflections or phase changes, and emissions with respect to any frequencies used for marine positioning, navigation and timing (PNT) or communications, including GMDSS and AIS, whether ship borne, ashore or fitted to any of the proposed structures, to:		
i. Vessels operating at a safe navigational distance.	✓	**Section 14: Navigation, Communication and Position Fixing Equipment** Assesses the potential risks associated with the use of navigation, communication and position fixing equipment due to the Project including in relation to radio interference.
ii. Vessels by the nature of their work necessarily operating at less than the safe navigational distance to the OREI, e.g., support vessels, survey vessels, SAR assets.	✓	
iii. Vessels by the nature of their work necessarily operating within the OREI.	✓	
b. The structures could produce Radar reflections, blind spots, shadow areas or other adverse effects:		
i. Vessel to vessel.	✓	**Section 14: Navigation, Communication and Position Fixing Equipment** Assesses the potential risks associated with the use of navigation, communication and position fixing equipment due to the Project including in relation to marine Radar.
ii. Vessel to shore.	✓	
iii. VTS Radar to vessel.	✓	
iv. Racon to/from vessel.	✓	
c. The structures and generators might produce SONAR interference affecting fishing, industrial or military systems used in the area.	✓	**Section 14: Navigation, Communication and Position Fixing Equipment** Assesses the potential risks associated with the use of navigation, communication and position fixing equipment due to the Project including in relation to SONAR.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 14: Navigation, Communication and Position Fixing Equipment** Assesses the potential risks associated with the use of navigation, communication and position fixing equipment due to the Project including in relation to noise.

Issue	Compliance	Comments
e. Generators and the seabed cabling within the site and onshore might produce EMFs affecting compasses and other navigation systems.	✓	**Section 14: Navigation, Communication and Position Fixing Equipment** Assesses the potential risks associated with the use of navigation, communication and position fixing equipment due to the Project including in relation to electromagnetic interference.
Risk mitigation measures recommended for OREI during construction, operation and decommissioning.		
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the EIA. The specific measures to be employed will be selected in consultation with the MCA and will be listed in the developer's ES. These will be consistent with international standards contained in, for example, SOLAS Chapter V (IMO, 1974), and could include any or all of the following:		
i. Promulgation of information and warnings through notices to mariners and other appropriate MSI dissemination methods.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including promulgation of information.
ii. Continuous watch by multi-channel VHF, including DSC.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including marine coordination.
iii. Safety zones of appropriate configuration, extent and application to specified vessels[8].	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including the application for Safety Zones.
iv. Designation of the site as an Area to be Avoided (ATBA).	✓	There are no plans to designate the Project as an ATBA.
v. Provision of AtoNs as determined by the GLA.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including lighting and marking in accordance with Trinity House and MCA requirements.
vi. Implementation of routeing measures within or near to the development.	✓	There are no plans to implement any new routeing measures in proximity to the Project.

[8] As per SI 2007 No 1948 "The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

Issue	Compliance	Comments
vii. Monitoring by Radar, AIS, Closed Circuit Television (CCTV) or other agreed means.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards. Includes MGN 654 compliance and therefore agreement of a SAR checklist with the MCA. **Section 22: Through life safety management** Confirms that monitoring of the site will be undertaken in line with standard DCO/dML traffic monitoring condition approach.
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of Safety Zones.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including the application for Safety Zones and use of guard vessels, which will be considered in further detail in the Safety Zone Application, submitted post consent.
ix. Creation of an ERCoP with the MCA's SAR Branch for the construction phase onwards.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including compliance with MGN 654 which include the provision of an ERCoP.
x. Use of guard vessels, where appropriate.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards including the use of guard vessels.
xi. Update NRAs every two years, e.g. at testing sites.	✓	Not applicable to the Project.
xii. Device-specific or array-specific NRAs.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** Describes all offshore elements of the Project including all infrastructure (surface and sub-sea) within the array area and offshore export cable corridor.
xiii. Design of OREI structures to minimise risk to contacting vessels or craft.	✓	There is no additional risk posed to craft compared to previous OWFs and so no additional measures are identified.
xiv. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 17.2.2.4: Embedded Mitigation Measures** Outlines the embedded mitigation measures to be implemented to reduce the significance of risk of shipping and navigation hazards. **Section 22: Through life safety management** Outlines how QHSE documentation will be maintained and reviewed.

Table A.2 MGN 654 Annex 1 checklist

Item	Compliance	Comments
A risk claim is included that is supported by a reasoned argument and evidence.	✓	**Section 19: Risk Assessment – In Isolation** The risk assessment provides a risk claim for a range of hazards based on a number of inputs including (but not limited to) baseline data, expert opinion, outputs of the Hazard Workshops, stakeholder concerns and lessons learnt from existing offshore developments.
Description of the marine environment.	✓	**Section 7: Navigational Features** Relevant navigational features in proximity to the Project have been described including (but not limited to) other OWF developments, marine aggregate dredging areas, ports, harbours and related facilities, charted anchorage areas, AtoNs, sub-sea cables, oil and gas infrastructure, and charted wrecks. **Section 16: Cumulative and Transboundary Overview** Potential future developments have been screened in to the cumulative risk assessment where a cumulative or in combination activity has been identified based upon the location and distance from the Project, including consideration of other OWFs, oil and gas infrastructure and marine aggregate dredging areas.
SAR overview and assessment.	✓	**Section 8: Emergency Response and Incident Overview** Existing SAR resources in proximity to the Project are summarised including the UK SAR operations contract, RNLI stations and assets and HMCG stations. **19: Risk Assessment – In Isolation** The risk assessment includes an assessment of how activities associated with the Project may restrict emergency response capability of existing resources.
Description of the OREI development and how it changes the marine environment.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** The maximum extent of the Project for which any shipping and navigation hazards are assessed is provided including a description of the boundary, array area and export cable corridor infrastructure, construction phase programme and indicative vessel and helicopter numbers during the construction and O&M phases. **Section 15: Future Case Vessel Traffic** Worst case alternative routeing for commercial traffic has been considered.
Analysis of the marine traffic, including base case and future traffic densities and types.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the Project has been analysed and includes vessel density and breakdowns of vessel type.

Item	Compliance	Comments
		Section 15: Future Case Vessel Traffic Worst case alternative routeing for commercial traffic has been considered, and potential future case increases of 10 and 20% have been modelled.
Status of the hazard log: ▪ Hazard identification; ▪ Risk assessment; ▪ Influences on level of risk; ▪ Tolerability of risk; and ▪ Risk matrix.	✓	**Section 3: Navigational Risk Assessment Methodology** A tolerability matrix has been defined to determine the tolerability (significance) of risks. **Annex B: Hazard Log** The complete hazard log is presented and includes a description of the hazards considered, possible causes, consequences (most likely and worst case) and relevant embedded mitigation measures. Using this information, each hazard is then ranked in terms of frequency of occurrence and severity of consequence to give a tolerability (significance) level.
NRA: ▪ Appropriate risk assessment; ▪ MCA acceptance for assessment techniques and tools; ▪ Demonstration of results; and ▪ Limitations.	✓	**Section 2: Guidance and Legislation** MGN 654 and the IMO's FSA guidelines are the primary guidance documents used for the assessment. **Section 17: Collision and Allision Risk Modelling** Provides quantification of collision and allision risk with the results outlined numerically and graphically, where appropriate.
Risk control log	✓	**Section 21: Risk Control Log** Provides the risk control log which summarises the assessment of shipping and navigation hazards scoped into the risk assessment. This includes the proposed embedded mitigation measures, frequency of occurrence, severity of consequence and significance of risk, per hazard.

Annex B Hazard Log

769. As per section 4.2.5, Hazard Workshops were held for the Project on 10 November 2022 and 23 November 2023. Following the workshops, a Hazard Log was drafted and distributed to attendees for agreement.

770. The Hazard Log was based on the discussions held and captured the following:

- Relevant impacts;
- Embedded mitigations;
- Possible causes;
- Frequency and consequence;
- Risk; and
- Any relevant additional mitigations discussed at the workshop.

771. The Hazard Log is shown below.

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
Displacement from Routeing including adverse weather routeing																							
Commercial vessels (exc. oil and gas)	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects on schedule but no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable	Liaison with Boskalis during construction to minimise impact on marine aggregate dredging operations.	PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		5	1	1	1	2	1.3	Tolerable		2	3	3	4	4	3.5	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Promulgation of information	• Installation vessel which is RAM	Minor and temporary displacement with manageable effects on schedule but no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		3	1	1	1	2	1.3	Broadly Acceptable		1	2	3	4	4	3.3	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of under construction ORCP • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects on schedule but no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure	• Presence of surface structure • Maintenance vessels which are RAM		4	1	1	1	2	1.3	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
				• Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information																			
	Cumulative	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Simultaneous buoyed construction/ decommissioning areas • Adverse weather • Construction vessels which are RAM	Displacement with manageable effects on schedule but no safety risks	5	1	1	1	3	1.5	Tolerable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	4	5	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		5	1	1	1	3	1.5	Tolerable		2	3	3	4	5	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Promulgation of information	• Installation vessel which is RAM	Minor and temporary displacement with manageable effects on schedule but no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	4	3	3.3	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		3	1	1	1	2	1.3	Broadly Acceptable		1	3	3	4	3	3.3	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of under construction ORCP • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects on schedule but no safety risks	4	1	1	1	3	1.5	Broadly Acceptable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	3	3	3.0	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structure • Maintenance vessels which are RAM		4	1	1	1	2	1.3	Broadly Acceptable		2	3	3	3	3	3.0	Broadly Acceptable		
Oil and gas vessels	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Construction/ decommissioning vessels which are RAM	Displacement from historic access routes to platforms but no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on schedule and vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		Consultation with oil and gas operators is ongoing
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		5	1	1	1	2	1.3	Tolerable		2	3	3	4	4	3.5	Broadly Acceptable		
Commercial fishing vessels in transit	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects and no safety risks	5	1	1	1	1	1.0	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately.
			O	• Application for safety zones (major maintenance only)	• Presence of surface structures • Adverse weather		5	1	1	1	1	1.0	Tolerable		2	4	2	3	3	3.0	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
				• Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Maintenance vessels which are RAM																		Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Promulgation of information	• Installation vessel which is RAM	Minor and temporary displacement with manageable effects and no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		3	1	1	1	2	1.3	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of under construction ORCP • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects and no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structure • Adverse weather • Maintenance vessels which are RAM		4	1	1	1	2	1.3	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable		
	Cumulative	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Simultaneous buoyed construction/ decommissioning areas • Adverse weather • Construction vessels which are RAM	Displacement with manageable effects and no safety risks	3	1	1	1	2	1.3	Broadly Acceptable	Displacement with effects on vessel stability in adverse weather	2	4	2	3	3	3.0	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		3	1	1	1	2	1.3	Broadly Acceptable		2	4	2	3	3	3.0	Broadly Acceptable		second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Promulgation of information	• Installation vessel which is RAM	Minor and temporary displacement with manageable effects and no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	3	3.3	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		3	1	1	1	2	1.3	Broadly Acceptable		1	3	3	4	3	3.3	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of under construction ORCP • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects and no safety risks	4	1	1	1	3	1.5	Broadly Acceptable	Displacement with effects on vessel stability in adverse weather	2	3	3	3	3	3.0	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structure • Maintenance vessels which are RAM		4	1	1	1	2	1.3	Broadly Acceptable		2	3	3	3	3	3.0	Broadly Acceptable		
Recreational vessels (2.5 to 24m length)	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects and no safety risks	2	1	1	1	1	1.0	Broadly Acceptable	Displacement with effects on vessel stability in adverse weather	1	4	1	2	3	2.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				• Promulgation of information • Traffic Monitoring																			concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM		2	1	1	1	1	1.0	Broadly Acceptable		1	4	1	2	3	2.5	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Promulgation of information	• Installation vessel which is RAM	Minor and temporary displacement with manageable effects and no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		3	1	1	1	2	1.3	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of under consrtuction ORCP • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement with manageable effects and no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	4	3.5	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structure • Adverse weather • Maintenance vessels which are RAM		4	1	1	1	2	1.3	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable		
	Cumulative	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure	• Simultaneous buoyed construction/ decommissioning areas • Adverse weather	Displacement with manageable effects and no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Displacement with effects on vessel stability in adverse weather	2	4	1	2	3	2.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
				• Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Construction vessels which are RAM																		subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately.
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		3	1	1	1	1	1.0	Broadly Acceptable		2	4	1	2	3	2.5	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Promulgation of information	• Installation vessel which is RAM	Minor and temporary displacement with manageable effects and no safety risks	5	1	1	1	2	1.3	Tolerable	Displacement with effects on vessel stability in adverse weather	2	3	3	4	3	3.3	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		3	1	1	1	2	1.3	Broadly Acceptable		1	3	3	4	3	3.3	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Adverse weather • Construction vessels which are RAM	Displacement with manageable effects and no safety risks	4	1	1	1	3	1.5	Broadly Acceptable	Displacement with effects on vessel stability in adverse weather	2	3	3	3	3	3.0	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structure • Maintenance vessels which are RAM		4	1	1	1	2	1.3	Broadly Acceptable		2	3	3	3	3	3.0	Broadly Acceptable		
Increased Vessel to Vessel Collision Risk Between Third-Party Vessels																							

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
Commercial vessels	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM • Reduction of navigable sea room	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM • Reduction of navigable sea room		3	2	2	3	3	2.5	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Installation vessel which is RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	2	2.3	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	3	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		1	2	2	3	2	2.3	Broadly Acceptable		1	4	3	4	3	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM		2	2	2	3	3	2.5	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				654 • Guard vessels • Pollution planning • Promulgation of information																			
	Cumulative	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Adverse weather • Construction vessels which are RAM • Reduction of navigable sea room	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM • Reduction of navigable sea room		3	2	2	3	3	2.5	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Installation vessel which is RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	2	2.3	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	3	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		2	2	2	3	2	2.3	Broadly Acceptable		2	4	3	4	3	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Adverse weather • Construction vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		2	2	2	3	3	2.5	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
Commercial fishing vessels in transit	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM		3	2	2	3	3	2.5	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Installation vessel which is RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	2	2.3	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	3	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		1	2	2	3	2	2.3	Broadly Acceptable		1	4	3	4	3	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		
				• Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring																			
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM		2	2	2	3	3	2.5	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
	Cumulative	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Simultaneous buoyed construction/ decommissioning areas • Adverse weather • Construction vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		3	2	2	3	3	2.5	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Installation vessel which is RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	2	2.3	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	3	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		2	2	2	3	2	2.3	Broadly Acceptable		2	4	3	4	3	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones	• Simultaneous buoyed construction/	Displacement results in	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased	1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				• Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	decommissioning areas • Adverse weather • Construction vessels which are RAM	increased encounters and potential for low impact collision to occur								encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution									
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		2	2	2	3	3	2.5	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
Recreational vessels (2.5 to 24m length)	Isolation	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
			O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM		3	2	2	3	3	2.5	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Guard vessels	• Installation vessel which is RAM	Displacement results in increased encounters and potential for low	2	2	2	3	2	2.3	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs	1	4	3	4	3	3.5	Broadly Acceptable		
			O		• Maintenance vessel which is RAM		1	2	2	3	2	2.3	Broadly Acceptable		1	4	3	4	3	3.5	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				• Pollution planning • Promulgation of information		impact collision to occur								involving vessel damage, PLL, and/or pollution									
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Presence of buoyed construction/ decommissioning area • Adverse weather • Construction/ decommissioning vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		
		ORCP	O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Adverse weather • Maintenance vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		
	Cumulative	Array area	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Simultaneous buoyed construction/ decommissioning areas • Adverse weather • Construction vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
	Cumulative	Array area	O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
		Cable corridor	C/D	• Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Installation vessel which is RAM	Displacement results in increased encounters and potential for low impact collision to occur	3	2	2	3	2	2.3	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	2	4	3	4	3	3.5	Broadly Acceptable		
		Cable corridor	O		• Maintenance vessel which is RAM		2	2	2	3	2	2.3	Broadly Acceptable		2	4	3	4	3	3.5	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Buoyed construction/ decommissioning area • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information • Traffic Monitoring	• Simultaneous buoyed construction/ decommissioning areas • Adverse weather • Construction vessels which are RAM	Displacement results in increased encounters and potential for low impact collision to occur	2	2	2	3	3	2.5	Broadly Acceptable	Displacement results in increased encounters and high impact collision occurs involving vessel damage, PLL, and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		
		ORCP	O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Guard vessels • Pollution planning • Promulgation of information	• Presence of surface structures • Maintenance vessels which are RAM		2	2	2	3	3	2.5	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
Collision Risk (Third-Party with Project Vessel in Transit)																							
Commercial vessels	Isolation	Array Area	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure	• Project vessels in transit	Increased encounters	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving	2	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
			O	• Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Lack of third-party awareness	resulting in increased alertness but no safety risks	2	1	1	1	1	1.0	Broadly Acceptable	vessel damage, injury to person and/or pollution	1	4	3	4	4	3.8	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
	Cumulative	Array Area	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	4	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	3	4	3	4	4	3.8	Tolerable		
			O		• Project vessels in transit • Lack of third-party awareness		3	1	1	1	1	1.0	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O		• Project vessels in transit • Lack of third-party awareness		2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		
		ORCP	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
Commercial fishing vessels in transit	Isolation	Array Area	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
				regulations (COLREGs) • Promulgation of information																			
	Cumulative	Array Area	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	4	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	3	4	3	4	4	3.8	Tolerable		
			O				3	1	1	1	1	1.0	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O		• Project vessels in transit • Lack of third-party awareness		2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
		ORCP	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
Recreational vessels (2.5 to 24m length)	Isolation	Array area	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs)	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
				• Promulgation of information																			
		Cable corridor	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
		ORCP	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
	Cumulative	Array area	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	4	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	3	4	3	4	4	3.8	Tolerable		
			O		• Project vessels in transit • Lack of third-party awareness		3	1	1	1	1	1.0	Broadly Acceptable		2	4	3	4	4	3.8	Broadly Acceptable		
		Cable corridor	C/D	• Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O		• Project vessels in transit • Lack of third-party awareness		2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				regulations (COLREGs) • Promulgation of information																			
		ORCP	C/D	• Application for safety zones • Charting of infrastructure • Guard vessels • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (COLREGs) • Promulgation of information	• Project vessels in transit • Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	3	4	4	3.8	Broadly Acceptable		
			O				2	1	1	1	1	1.0	Broadly Acceptable		1	4	3	4	4	3.8	Broadly Acceptable		
Allision Risk (Powered, Drifting or Internal)																							
Commercial vessels	Isolation	Array area	O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
		ORCP		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable	ORCP marked as an isolated structure	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		
				• Promulgation of information																			
	Cumulative	Array area		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
		ORCP		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable		2	3	3	4	4	3.5	Broadly Acceptable	ORCP marked as an isolated structure	
Commercial fishing vessels in transit	Isolation	Array area	O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				• Promulgation of information																			separately.
		ORCP		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable	ORCP marked as an isolated structure	Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
	Cumulative	Array area		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately.
		ORCP		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable	ORCP marked as an isolated structure	Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required	Additional Comments
				• Promulgation of information																			
Recreational vessels (2.5 to 24m length)	Isolation	Array area	O	• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Minimum blade tip clearance • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
		ORCP		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Minimum blade tip clearance • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable	ORCP marked as an isolated structure	
	Cumulative	Array area		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Minimum blade tip	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable		PEIR stage hazard log indicated site boundary refinements required to reduce hazards to ALARP. Broad workshop consensus was that the subsequent site boundary changes made address the shipping and navigation concerns previously

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		
				clearance • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information																			raised. Noted that DFDS were not present at second workshop and will be followed up with separately. Note DFDS followed up via CoS: "Feedback from DFDS has been broadly positive regarding navigational safety and the RLB change".
		ORCP		• Application for safety zones (major maintenance only) • Charting of infrastructure • Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Minimum blade tip clearance • Pollution planning • Project vessel compliance with international marine regulations (SOLAS) • Promulgation of information	• Presence of surface structures • Human/navigation error • Mechanical/technical failure • Adverse weather • Aid to navigation failure		4	1	1	1	1	1.0	Broadly Acceptable	Allision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	Broadly Acceptable	ORCP marked as an isolated structure	
Interference with Marine Navigation, Communication and Position Fixing Equipment																							
All vessels	Isolation	Array area	O	• Cable Burial Risk Assessment	• Human error relating to adjustment of Radar controls • Presence of surface structures	Structures have no effect upon the Radar, communications and navigation equipment on a vessel	4	1	1	1	1	1.0	Broadly Acceptable	Minor level of Radar interference due to the structures	3	1	1	1	1	1.0	Broadly Acceptable		
All vessels	Isolation	Cable corridor	O	• Cable Burial Risk Assessment	• EMF from cables	Cables have no material effect upon the Radar, communications and navigation equipment on a vessel	3	1	1	1	1	1.0	Broadly Acceptable	Minor level of EMF interference due to the wind farm infrastructure	2	1	1	1	1	1.0	Broadly Acceptable		MCA confirmed no concerns with EMF given cables will be HVAC.
All vessels	Isolation	ORCP	O	• Cable Burial Risk Assessment	• Human error relating to adjustment of Radar controls • Presence of ORCP	ORCP has no material effect upon the Radar, communications and navigation equipment on a vessel	4	1	1	1	1	1.0	Broadly Acceptable	Minor level of interference due to the ORCP	3	1	1	1	1	1.0	Broadly Acceptable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
Reduction in Emergency Response Capability																							
Emergency responders	Isolation	Array area	C/D	• Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Under construction array does not facilitate responder access • Limited resource capability • Adverse weather	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury to person or loss of life	1	4	5	5	5	4.8	Tolerable		
			O		• Array does not facilitate responder access • Limited resource capability • Adverse weather		2	1	1	1	2	1.3	Broadly Acceptable		1	4	5	5	5	4.8	Tolerable		
		Cable corridor	C/D	• Cable Burial Risk Assessment • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Limited resource capability	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury or loss of life	1	4	4	4	4	4.0	Tolerable		
			O				2	1	1	1	2	1.3	Broadly Acceptable		1	4	4	4	4	4.0	Tolerable		
		ORCP	C/D	• Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Under construction array does not facilitate responder access • Limited resource capability • Adverse weather	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury to person or loss of life	1	4	5	5	5	4.8	Tolerable		
			O		• Array does not facilitate responder access • Limited resource capability • Adverse weather		2	1	1	1	2	1.3	Broadly Acceptable		1	4	5	5	5	4.8	Tolerable		
	Cumulative	Array area	C/D	• Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Simultaneous buoyed construction/ decommissioning areas • Under construction array does not facilitate responder access • Limited resource capability • Adverse weather	Delay to emergency response request	3	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury or loss of life	2	4	5	5	5	4.8	Tolerable		
			O		• Simultaneous operation		3	1	1	1	2	1.3	Broadly Acceptable		2	4	5	5	5	4.8	Tolerable		

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Separate Sheet)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required	Additional Comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average Consequence	Risk		Frequency	People	Environment	Property	Business	Average Consequence	Risk		
					• Array does not facilitate responder access • Limited resource capability • Adverse weather																		
		Cable corridor	C/D	• Cable Burial Risk Assessment • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Limited resource capability	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury or loss of life	1	4	4	4	4	4.0	Tolerable		
			O				2	1	1	1	2	1.3	Broadly Acceptable		1	4	4	4	4	4.0	Tolerable		
		ORCP	C/D	• Compliance with MGN 654 • Lighting and marking • Marine coordination for Project vessels • Pollution planning • Project vessel compliance with international marine regulations (SOLAS)	• Simultaneous buoyed construction/ decommissioning areas • Under construction array does not facilitate responder access • Limited resource capability • Adverse weather	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury or loss of life	1	4	5	5	5	4.8	Tolerable		
			O		• Simultaneous operation • Array does not facilitate responder access • Limited resource capability • Adverse weather		2	1	1	1	2	1.3	Broadly Acceptable		1	4	5	5	5	4.8	Tolerable		

Annex C Consequences Assessment

772. This appendix presents an assessment of the consequences of collision and allision incidents, in terms of people and the environment, due to the presence of the windfarm structures.

773. The significance of risk of the hazards due to the presence of the array area are also assessed based upon risk evaluation criteria and comparison with historical accident data in UK waters[9].

C.1 Risk Evaluation Criteria

C.1.1 Risk to People

774. With regard to the assessment of risk to people two measures are considered, namely:

- Individual risk; and
- Societal risk.

C.1.2 Annual Individual Risk

775. Individual risk considers whether the risk from an incident to a particular individual changes significantly due to the presence of the Project. Individual risk considers not only the frequency of the accident and the consequences (e.g., likelihood of death), but also the individual's fractional exposure to that risk, i.e., the probability of the individual being in the given location at the time of the incident.

776. The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of the Project are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of the Project relative to the background individual risk levels.

777. Annual risk levels to crew (the annual risk to an average crew member) for different vessel types are presented in Figure C.1, which also includes the upper and lower bounds for risk acceptance criteria as suggested in IMO MSC 72/16 (IMO, 2001). The annual individual risk to crew falls within the ALARP region for each of the vessel types presented.

[9] For the purposes of this assessment, UK waters is defined as the UK EEZ and UK territorial waters refers to the 12 nm limit from the British Isles, excluding the Republic of Ireland.

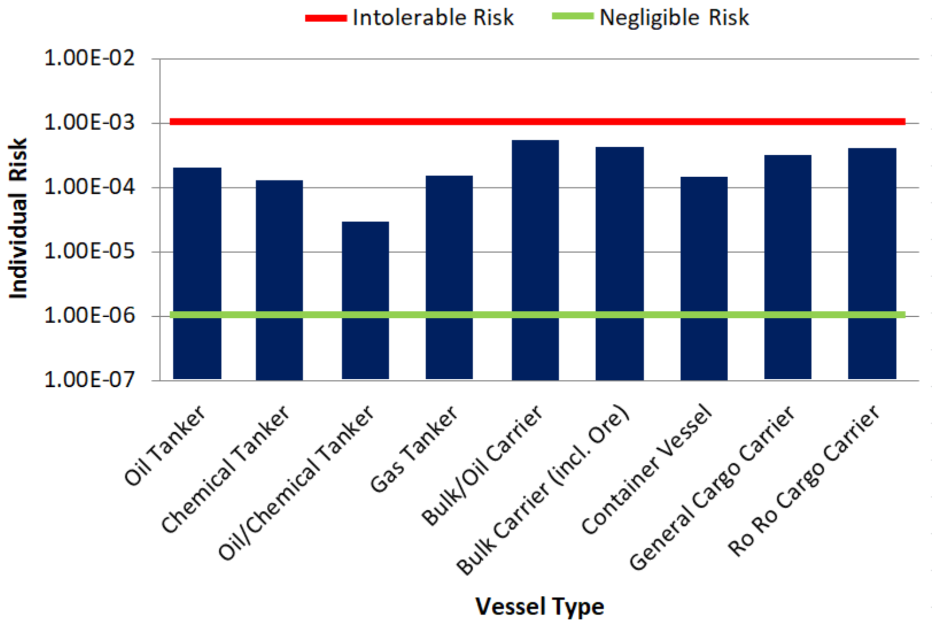


Figure C.1 Individual Risk Levels and Acceptance Criteria per Vessel Type

778. Typical bounds defining the ALARP regions for decision making within shipping are presented in Table C.1. It can be seen that for a new vessel the target upper bound for ALARP is set lower since new vessels are expected to be safer.

Table C.1 Individual Risk ALARP Criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
To crew member	10^{-6}	10^{-3}
To passenger	10^{-6}	10^{-4}
Third party	10^{-6}	10^{-4}
New vessel target	10^{-6}	Above values reduced by one order of magnitude

779. On a UK basis, the MCA website presents individual risks for various UK industries based upon Health, Safety, and Environment (HSE) data from 1987 to 1991. The risks for different industries are presented in Figure C.2.

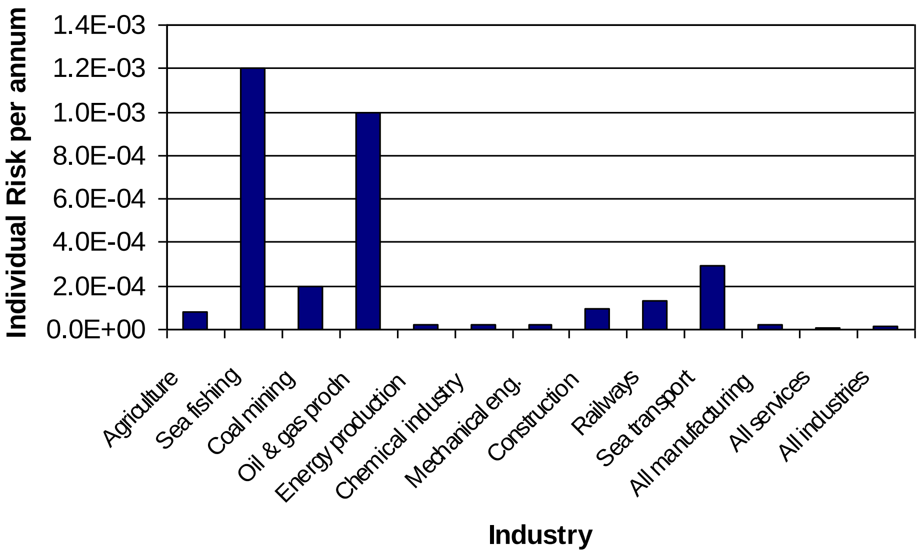


Figure C.2 Individual Risk per Year for Various UK Industries

780. The individual risk for sea transport of 2.9×10^{-4} per year is consistent with the worldwide data presented in Figure C.2, whilst the individual risk for sea fishing of 1.2×10^{-3} per year is the highest across all of the industries included.

C.1.3 Societal Risk

781. Societal risk is used to estimate risks of accidents affecting many persons (catastrophes) and acknowledging risk adverse or neutral attitudes. Societal risk includes the risk to every person, even if a person is only exposed to risk on one brief occasion. For assessing the risk to a large number of affected people societal risk is desirable because individual risk is insufficient in evaluating risks imposed on large numbers of people.

782. Within this assessment, societal (navigation-based) risk can be assessed within the array area, giving account to the change in risk associated with each accident scenario caused by the introduction of the windfarm structures. Societal risk may be expressed as:

- Annual fatality rate where frequency and fatality are combined into a convenient one-dimensional measure of societal risk (also known as PLL); and
- F-N diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

783. When assessing societal risk this study focuses on PLL, which takes into account the number of people likely to be involved in an incident (which is higher for certain vessel types) and assesses the significance of the change in risk compared to the background risk levels.

C.1.4 Risk to Environment

784. For risk to the environment the key criteria considered in terms of the risk due to the Project is the potential quantity of oil spilled from a vessel involved in an incident.

785. It is recognised that there will be other potential pollution, e.g., hazardous containerised cargoes; however, oil is considered the most likely pollutant and the extent of predicted oil spills will provide an indication of the significance of pollution risk due to the Project to background pollution risk levels for the UK.

C.2 Marine Accident Investigation Branch Incident Analysis

C.2.1 All UK Waters Incidents

786. All British flagged commercial vessels are required to report accidents to the MAIB. Non-UK flagged vessels do not have to report unless they are at a UK port or within 12 nm territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to the MAIB; however, a significant proportion of these incidents are reported to and investigated by the MAIB.

787. Only incidents occurring in UK waters have been considered within this assessment for which the MAIB data is most comprehensive. It is also noted that incidents occurring in ports/harbours and rivers/canals have been excluded since the causes and consequences may differ considerably from an accident occurring offshore, which is the location of most relevance to the Project.

788. Taking into account these criteria, a total of 12,093 accidents, injuries and hazardous incidents were reported to the MAIB between 2000 and 2019 involving 13,965 vessels (however it is worth noting that some incidents, such as collisions, involved more than one vessel).

789. The locations of all incidents reported in proximity to the UK are presented in Figure C.3, colour-coded by incident type. The distribution of unique incidents by year in UK waters is presented in Figure C.4.

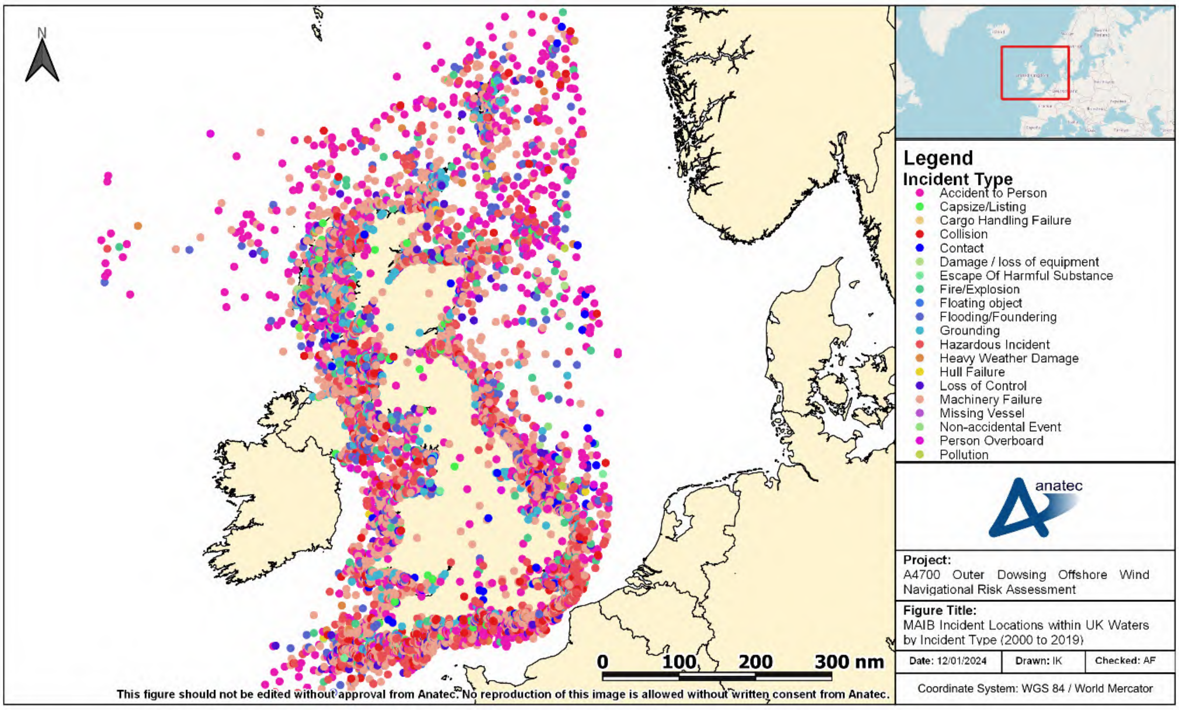


Figure C.3 MAIB Incident Locations within UK Waters by Incident Type (2000 to 2019)

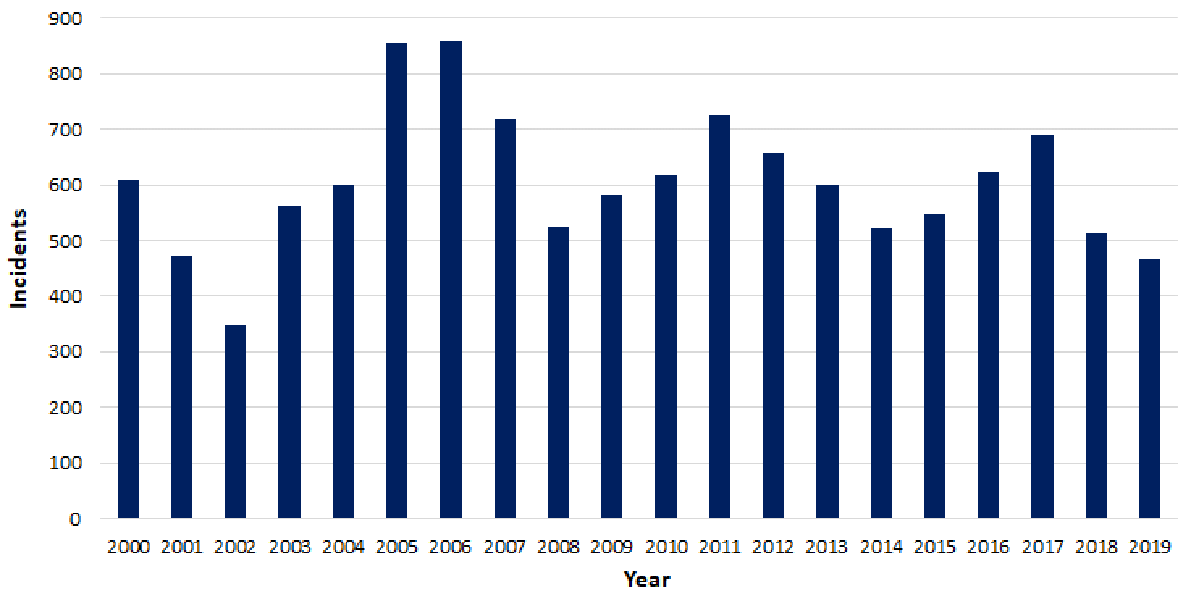


Figure C.4 MAIB Unique Incidents per Year within UK Waters (2000 to 2019)

790. The average number of unique incidents per year was 605. There has generally been a fluctuating trend in incidents over the 20-year period.

791. The distribution of incidents in UK waters by incident type is presented in Figure C.5.

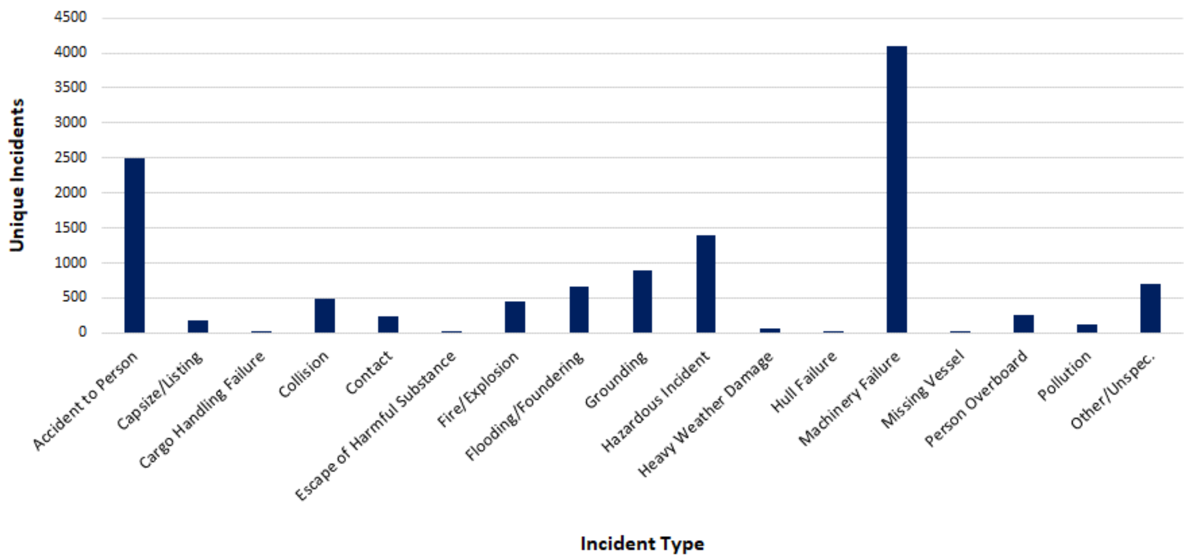


Figure C.5 MAIB Incident Types Breakdown within UK Waters (2000 to 2019)

792. The most frequent incident types were *"machinery failure"* (34%), *"accident to person"* (21%) and *"hazardous incident"* (12%). *"Collision"* and *"contact"* incidents represented 4% and 2% of total incidents, respectively.

793. The distribution of incidents in UK waters by vessel type is presented in Figure C.6.

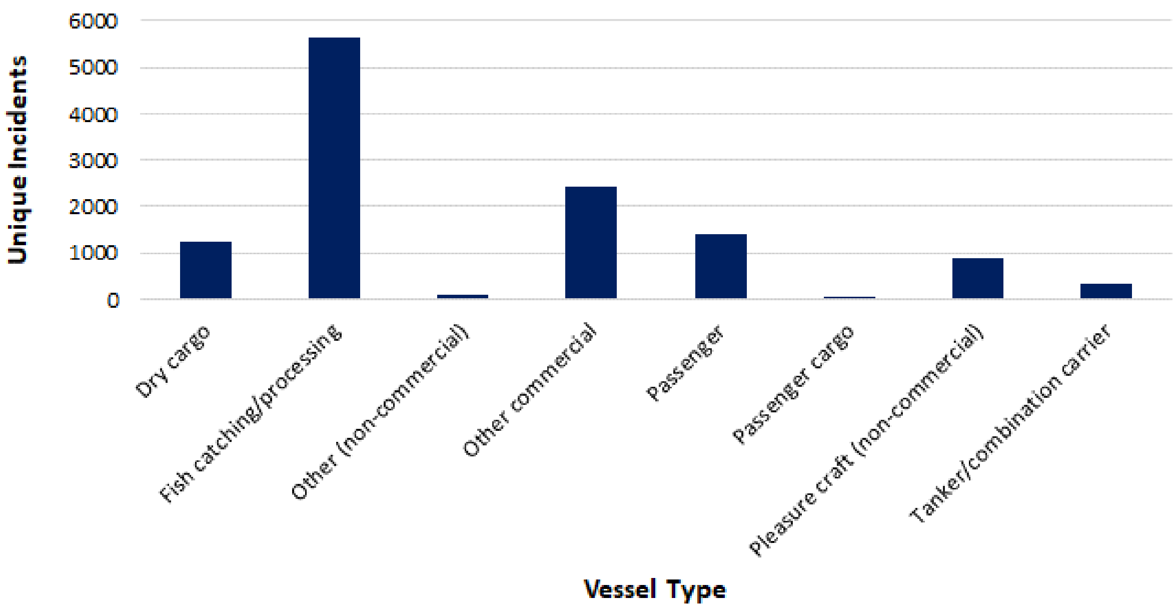


Figure C.6 MAIB Incident Types Breakdown within UK Waters (2000 to 2019)

794. The vessel types most frequently involved in incidents were fishing vessels (46%), other commercial vessels (20%) (including offshore industry vessels, tugs, workboats and pilot vessels) and dry cargo vessels (10%).

795. The total of 373 fatalities were reported in the MAIB incidents within UK waters from 2000 to 2019, averaging 19 fatalities per year.

796. The distribution of fatalities in UK waters by vessel type and person category (namely crew, passenger and other) is presented in Figure C.7.

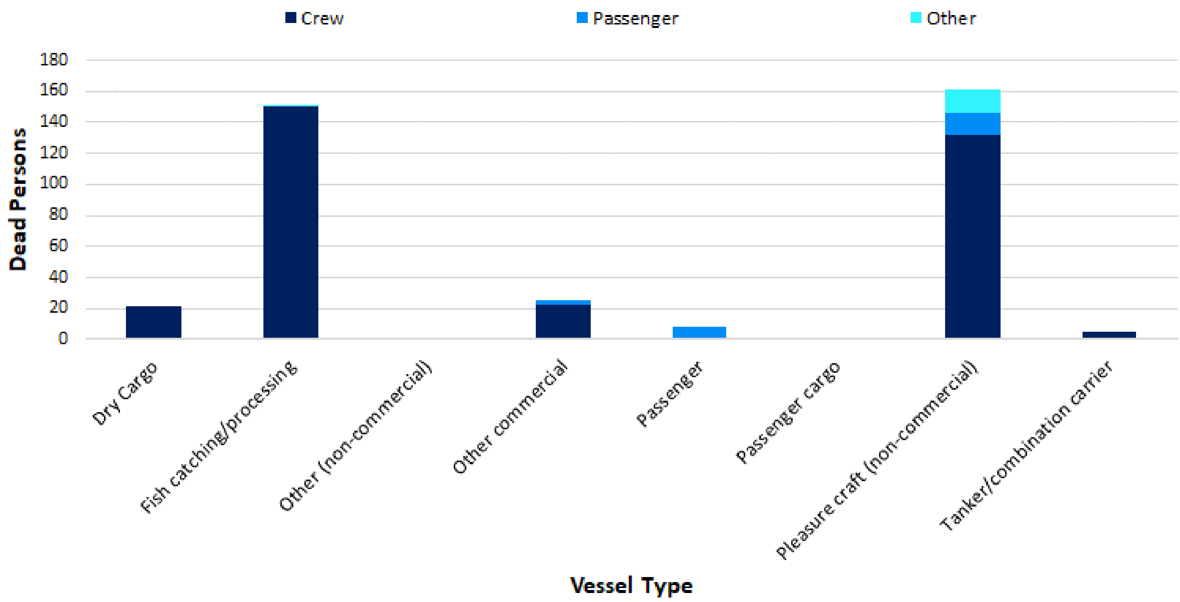


Figure C.7 MAIB Fatalities by Vessel Type within UK Waters (2000 to 2019)

797. The majority of fatalities occurred to pleasure craft (43%) and fishing vessels (40%), with crew members the main people involved (89%).

C.2.2 Collision Incidents

798. The MAIB define a collision incident as “ships striking or being struck by another ship, regardless of whether the ships are underway, anchored or moored” (MAIB, 2013).

799. A total of 481 collision incidents were reported to the MAIB in UK waters between 2000 and 2019 involving 1,090 vessels (it is worth noting that in a small number of cases the other vessel involved was not logged).

800. The locations of collision incidents reported in proximity to the UK are presented in Figure C.8. The distribution of collision incidents per year is presented in Figure C.9.

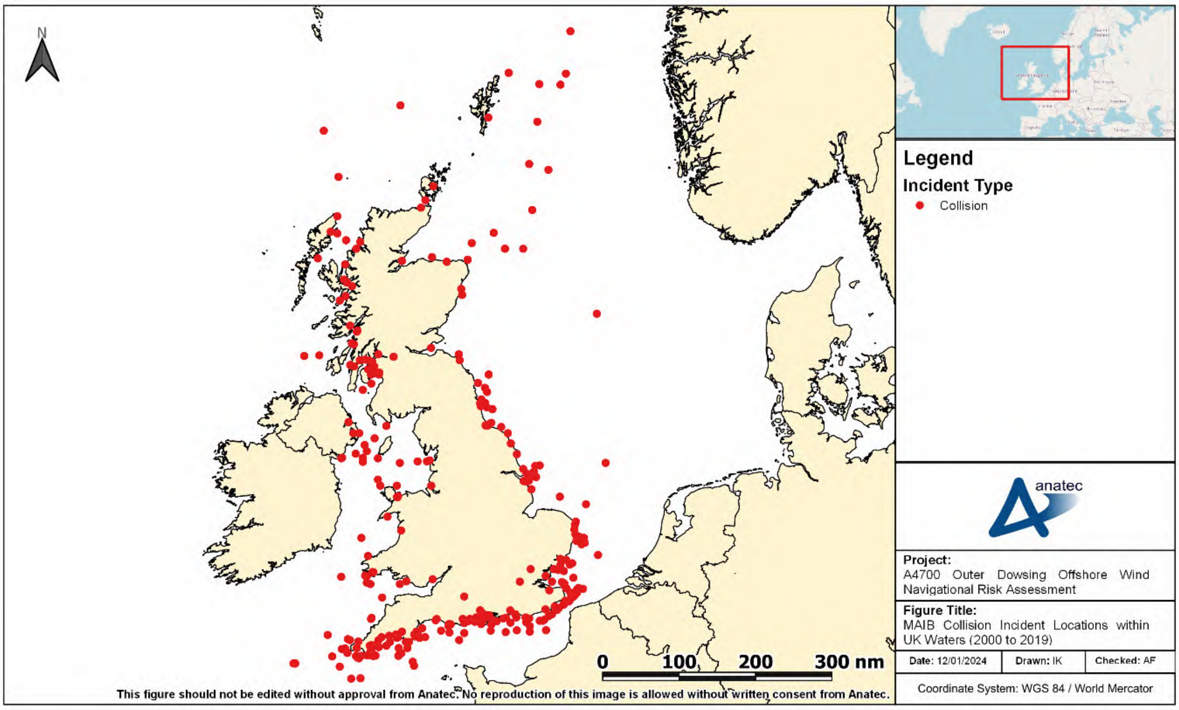


Figure C.8 MAIB Collision Incident Locations within UK Waters (2000 to 2019)

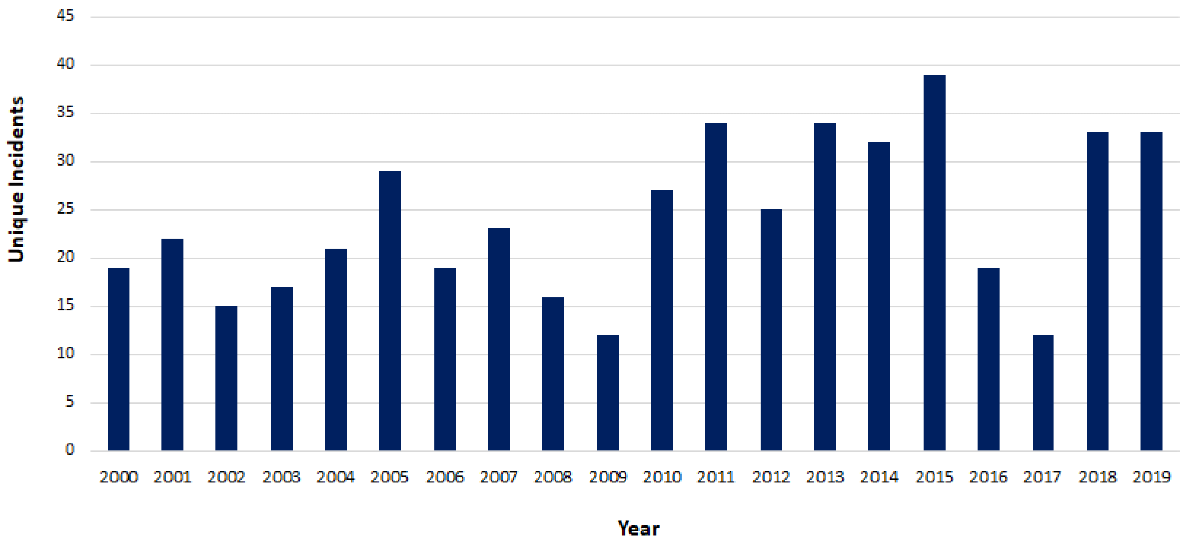


Figure C.9 MAIB Annual Collision Incidents within UK Water (2000 to 2019)

801. The average number of unique collision incidents per year was 14. There has been an overall slight increasing trend in collision incidents over the 20-year period, which may be due to better reporting of less serious incidents in recent years.

802. The most common vessel types involved in collision incidents were other commercial vessels (29%), fishing vessels (24%), non-commercial pleasure craft (23%), and dry cargo vessels (12%).

803. The total of six fatalities were reported in MAIB collision incidents within UK waters between 2000 and 2019. Details of each of these fatal incidents reported by the MAIB are presented in Table C.2.

Table C.2 Description of Fatal MAIB Collision Incidents (2000 to 2019)

Date	Description	Fatalities
October 2001	Collision between dry cargo vessel and chemical tanker following lateness by watchkeepers in taking effective action. Dry cargo vessel sank with five of the six crew members rescued.	1
July 2005	Collision between two powerboats at night. Both vessels were unlit and both helmsmen had consumed alcohol. One of the helmsmen died.	1
October 2007	Collision between fishing vessel and coastal general cargo vessel following failure to keep an effective lookout. Fishing vessel sank with three of the four crew members abandoning ship into a life raft but the fourth crew member was not recovered.	1
August 2010	Collision between passenger ferry and fishing vessel. Fishing vessel sank with one of the two crew members recovered from the sea but the other member was not recovered despite an extensive search.	1
June 2015	Collision between Rigid-hulled Inflatable Boat (RIB) and yacht. Believed that around a dozen persons were onboard the motorboat with the majority taken ashore by lifeboat. One person seriously injured and airlifted to hospital before being pronounced dead later.	1
June 2018	Collision between power boats during a race. One of the vessels overturned with the pilot pronounced dead at the scene.	1

C.2.3 Contact Incidents

804. The MAIB define a contact incident as “ships striking or being struck by an external object. The objects can be: floating object (cargo, ice, other or unknown); fixed object, but not the sea bottom; or flying object” (MAIB, 2013).

805. A total of 235 contact incidents were reported to the MAIB within UK waters between 2000 and 2019 involving 270 vessels (in a small number of cases the contact involved a moving vessel and a stationary vessel).

806. The locations of contact incidents reported in proximity to the UK are presented in Figure C.10. The distribution of contact incidents is presented in Figure C.11.

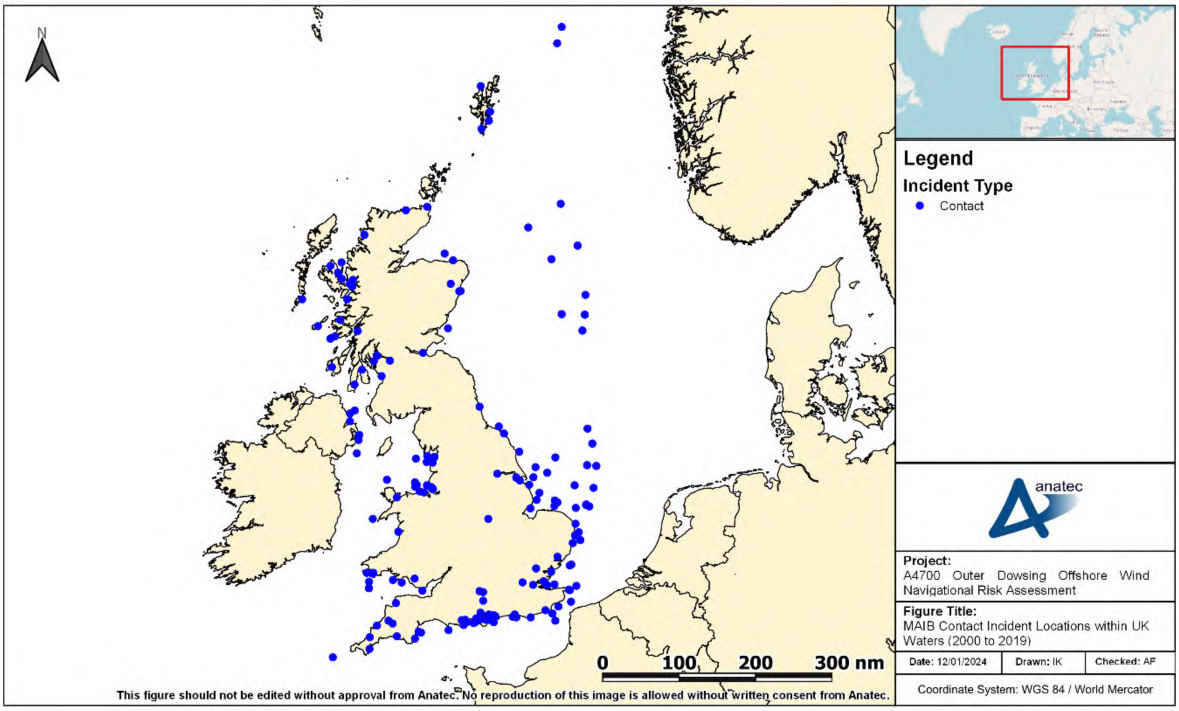


Figure C.10 MAIB Contact Incident Locations within UK Waters (2000 to 2019)

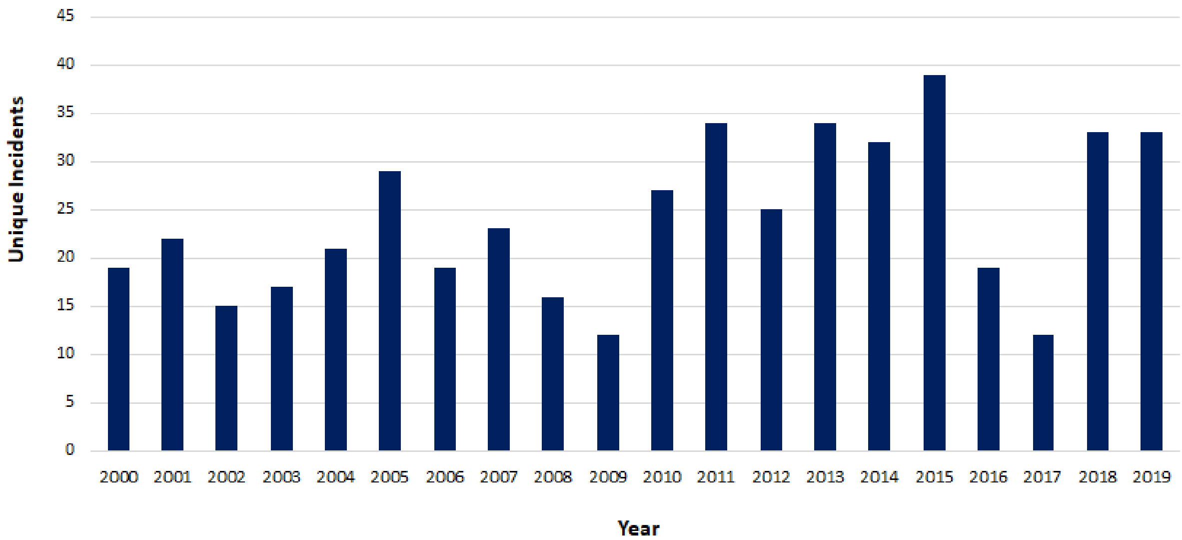


Figure C.11 MAIB Contact Incidents per Year within UK Waters (2000 to 2019)

807. The average number of contact incidents per year was 12. As with collision incidents, there has been an overall slight increasing trend over the 20-year period, which may be due to better reporting of less serious incidents in recent years.

808. The distribution of vessel types involved in contact incidents is presented in Figure C.12.

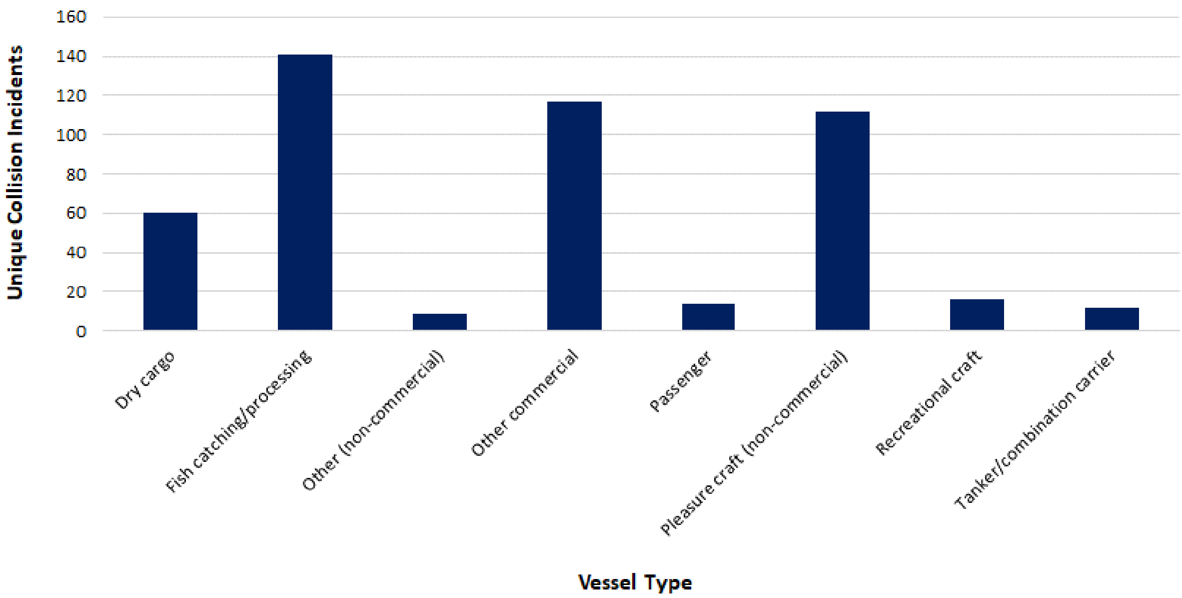


Figure C.12 MAIB Contact Incidents by Vessel Type within UK Waters (2000 to 2019)

809. The most commonly involved vessel types in contact incidents were other commercial vessels (43%), fishing vessels (15%), and non-commercial pleasure craft (13%).

810. One fatality was reported in MAIB contact incidents within UK waters between 2000 and 2019. Details of this fatal incident reported by the MAIB are presented in Table C.3.

Table C.3 Description of Fatal MAIB Contact Incidents (2000 to 2019)

Date	Description	Fatalities
June 2012	Contact between RIB and jetty. RIB badly damaged around the bow and fenders on the jetty also damaged. The RIB owner had consumed alcohol and suffered fatal injuries following the impact.	1

C.3 Fatality Risk

C.3.1 Incident Data

811. This section uses the MAIB incident data along with information on average manning levels per vessel type to estimate the probability of a fatality in a marine incident associated with the Project.

812. The windfarm structures are assessed to have the potential to affect the following incidents:

- Vessel to vessel collision;
- Powered vessel to structure allision;
- Drifting vessel to structure allision; and
- Fishing vessel to structure allision.

813. Of these incident types, only vessel to vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in section C.2.2 is considered to be directly applicable to these types of incidents.

814. The other scenarios of powered vessel to structure allision, drifting vessel to structure allision and fishing vessel to structure allision are technically contacts since they would involve a vessel striking an immobile object in the form of a WTG or substation. From section C.2.3, it can be seen that only one of the 235 contact incidents reported by the MAIB between 2000 and 2019 resulted in a fatality, with the contact occurring with a jetty in the approaches to a harbour.

815. As the mechanics involved in a vessel contacting a WTG may differ in severity from hitting, for example, a buoy, quayside, or moored vessel, the MAIB collision fatality risk rate has also been conservatively applied for the allision incident types.

C.3.2 Fatality Probability

816. Six of the 481 collision incidents reported by the MAIB within UK waters between 2000 and 2019 resulted in one or more fatalities. This gives a 1.2% probability that a collision incident will lead to a fatal accident.

817. To assess the fatality risk for personnel on-board a vessel (crew, passenger or other) the number of persons involved in the incidents needs to be estimated. From analysis of the long-term AIS data, the average commercial passenger vessel had approximately 2,263 people on board (POB) (total of crew and passengers). For commercial cargo/freight vessels there was an average of 13 POB. For fishing vessels and recreational vessels, the average POB was 3.1 and 2.8, respectively, based on analysis of the MAIB incident data.

Table C.4 Estimated Average POB by Vessel Category

Vessel Category	Sub Categories	Source of Estimated Average POB	Estimated Average POB
Cargo/freight	Dry cargo, other commercial, service ship, etc.	MAIB incident data	15
Tanker	Tanker/combination carrier	MAIB incident data	22

Vessel Category	Sub Categories	Source of Estimated Average POB	Estimated Average POB
Passenger	RoPax, cruise liner, etc.	Vessel traffic survey data / online information	203
Fishing	Trawler, potter, dredger, etc.	MAIB incident data	3.3
Recreational	Yacht, small commercial motor yacht, etc.	MAIB incident data	3.3

818. It is recognised that these numbers can be substantially higher or lower on an individual vessel basis depending upon the size, subtype, etc. but applying reasonable averages is considered sufficient for this analysis.

819. Using the average number of POB, along with the vessel type information involved in collision incidents reported by the MAIB, there were an estimated 10,533 POB on vessels involved in the collision incidents.

820. Based upon six fatalities, the overall fatality probability in a collision for any individual on board is approximately 5.7×10^{-4} (0.057%) per collision.

821. It is considered inappropriate to apply this rate uniformly as the statistics indicate that the fatality probability associated with smaller craft, such as fishing vessels and recreational vessels, is higher. Therefore, the fatality probability has been subdivided into five categories of vessel as presented in Table C.5.

Table C.5 Collision Incident Fatality Probability by Vessel Category (2000 to 2019)

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	1	16,256	6.2×10^{-5}
Fishing	Trawler, potter, dredger, etc.	2	880	2.3×10^{-3}
Recreational	Yacht, small commercial motor yacht, etc.	3	713	4.2×10^{-3}

822. The risk is higher by up to two orders of magnitude for POB small craft compared to larger commercial vessels.

C.3.3 Fatality Risk due to the Project

823. The base case and future case annual collision and allision frequency levels pre and post windfarm for the array area are summarised in Table C.6, where change refers to the increase in collision and allision frequency due to the presence of the

Project (estimated at overall 1.23×10^{-1}, equating to an additional collision or allision every 8.1 years) for the base case.

Table C.6 Summary of Annual Collision and Allision Risk Results

Risk	Traffic Level Scenario	Annual Frequency (Return Period)		
		Pre Windfarm	Post Windfarm	Change
Vessel to vessel collision	Base case	3.21×10^{-2} (1 in 31 years)	3.59×10^{-2} (1 in 28 years)	3.76×10^{-3} (1 in 266 years)
	Future case (10%)	3.88×10^{-2} (1 in 26 years)	4.32×10^{-2} (1 in 23 years)	4.40×10^{-3} (1 in 227 years)
	Future case (20%)	4.60×10^{-2} (1 in 22 years)	5.13×10^{-2} (1 in 19 years)	5.30×10^{-3} (1 in 189 years)
Powered vessel to structure allision	Base case	-	5.35×10^{-3} (1 in 187 years)	5.35×10^{-3} (1 in 187 years)
	Future case (10%)	-	5.89×10^{-3} (1 in 170 years)	5.89×10^{-3} (1 in 170 years)
	Future case (20%)	-	6.42×10^{-3} (1 in 156 years)	6.42×10^{-3} (1 in 156 years)
Drifting vessel to structure allision	Base case	-	1.04×10^{-3} (1 in 958 years)	1.04×10^{-3} (1 in 958 years)
	Future case (10%)	-	1.15×10^{-3} (1 in 871 years)	1.15×10^{-3} (1 in 871 years)
	Future case (20%)	-	1.25×10^{-3} (1 in 798 years)	1.25×10^{-3} (1 in 798 years)
Fishing vessel to structure allision	Base case	-	1.13×10^{-1} (1 in 8.9 years)	1.13×10^{-1} (1 in 8.9 years)
	Future case (10%)	-	1.24×10^{-1} (1 in 8.0 years)	1.24×10^{-1} (1 in 8.0 years)
	Future case (20%)	-	1.36×10^{-1} (1 in 7.4 years)	1.36×10^{-1} (1 in 7.4 years)
Total	**Base case**	**3.21×10^{-2} (1 in 31 years)**	**1.55×10^{-1} (1 in 6.4 years)**	**1.23×10^{-1} (1 in 8.1 years)**
	Future case (10%)	**3.88×10^{-2} (1 in 26 years)**	**1.73×10^{-1} (1 in 5.8 years)**	**1.34×10^{-1} (1 in 7.4 years)**
	Future case (20%)	**4.60×10^{-2} (1 in 22 years)**	**1.95×10^{-1} (1 in 5.1 years)**	**1.49×10^{-1} (1 in 6.7 years)**

824. From the detailed results of the collision and allision risk modelling, the distribution of the predicted change in annual collision and allision frequency by vessel type due to the Project for the base case and future cases are presented in Figure C.13.

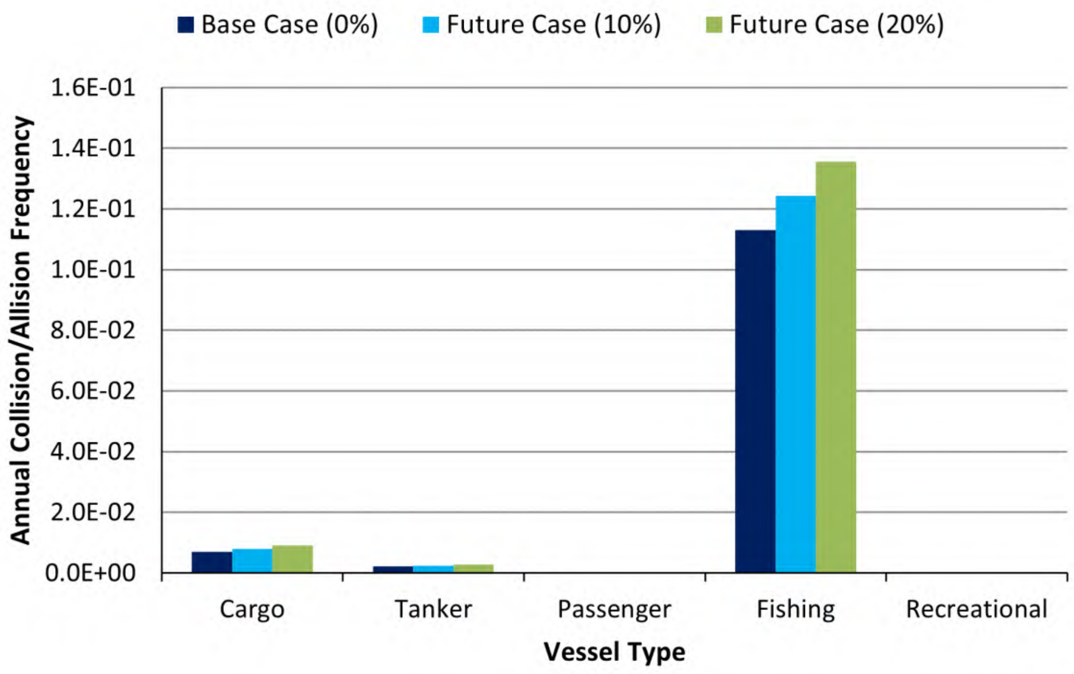


Figure C.13 Estimated Change in Annual Collision and Allision Frequency by Vessel Type

825. It can be seen that the majority of change in collision and allision frequency is associated with fishing vessels, owing to the greater duration of time spent in proximity to array area by fishing vessels engaged in fishing activities and the possibility of fishing occurring internally within the array area itself.

826. Combining the annual collision and allision frequency, estimated number of POB for each vessel type, and estimated fatality probability for each vessel category, the total annual increase in PLL due to the presence of the Project for the base case is estimated to be 7.65×10^{-4}, equating to one additional fatality every 1,308 years.

827. The estimated incremental increases in PLL due to the Project, distributed by vessel type for the base and future cases, are presented in Figure C.14.

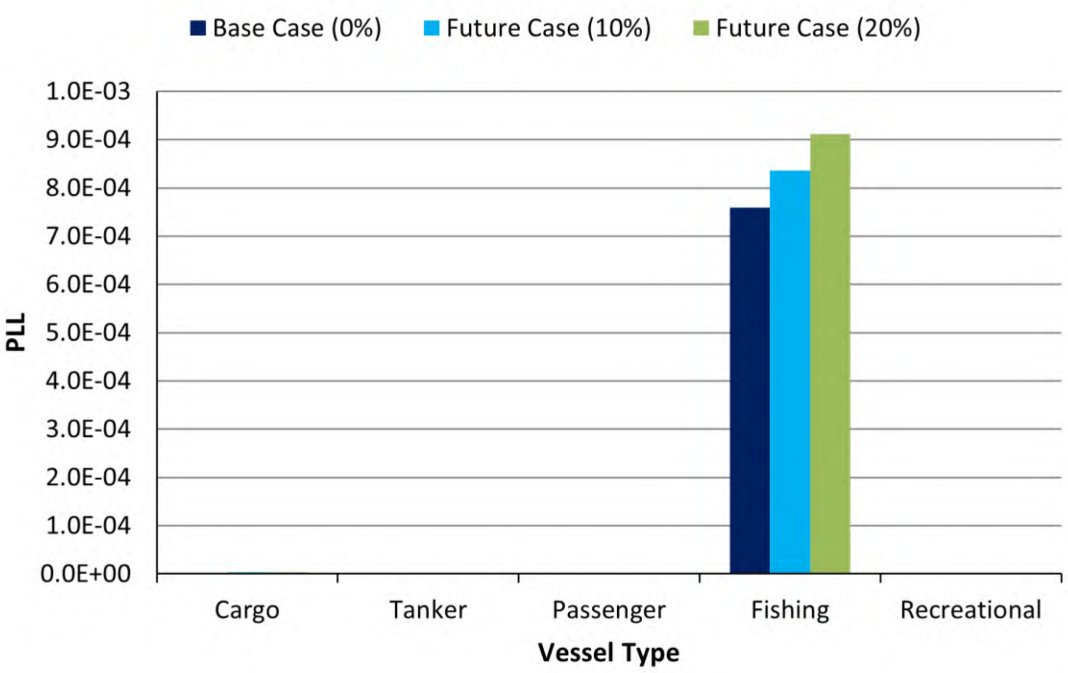


Figure C.14 Estimated Change in Annual PLL by Vessel Type

828. As with the change in annual collision and allision frequency, it can be seen that the majority of the change in annual PLL is associated with fishing vessels, which historically have a higher fatality probability than commercial vessels. However, the conservative assumptions made within the fishing modelling should be considered (see section 17.2.2.5).

829. A conversion of the PLL to individual risk based upon the average number of people exposed by vessel type is presented in Figure C.15.

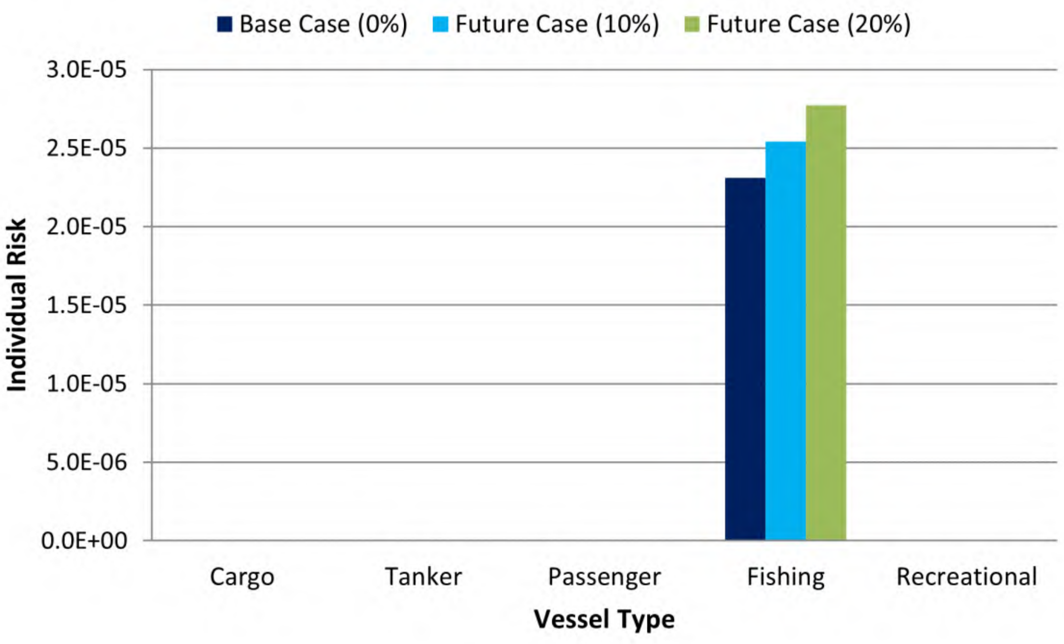


Figure C.15 Estimated Change in Individual Risk by Vessel Type

830. It can be seen that the individual risk is highest for people on fishing vessels, which reflects the higher probability of a fatality occurring in the event of an incident involving a fishing vessel. However, the conservative assumptions made within the fishing modelling should be considered (see section 17.2.2.5).

C.3.4 Significance of Increase in Fatality Risk

831. In comparison to MAIB statistics, which indicate an average of 20 fatalities per year in UK territorial waters, the overall increase for the base case in PLL of one additional fatality per 1,308 years represents a small change.

832. In terms of individual risk to people, the change for commercial vessels attributed to the Project (approximately 2.26×10^{-8} for the base case) is very low compared to the background risk level for the UK sea transport industry of 2.9×10^{-4} per year.

833. For fishing vessels, the change in individual risk attributed to the Project (approximately 2.31×10^{-5} for the base case) is low compared to the background risk level for the UK sea fishing industry of 1.2×10^{-3} per year.

C.4 Pollution Risk

C.4.1 Historical Analysis

834. The pollution consequences of a collision in terms of oil spill depend upon the following criteria:

- Spill probability (i.e., the likelihood of outflow following an incident); and
- Spill size (quantity of oil).

835. Two types of oil spill are considered within this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

836. Research undertaken as part of the UK's DfT Marine Environmental High Risk Area (MEHRA) project (DfT, 2001) has been used as it was comprehensive and based upon worldwide marine oil spill data analysis. From this research, the overall probability of a spill incident per accident was calculated based upon historical accident data for each accident type as presented in Figure C.16.

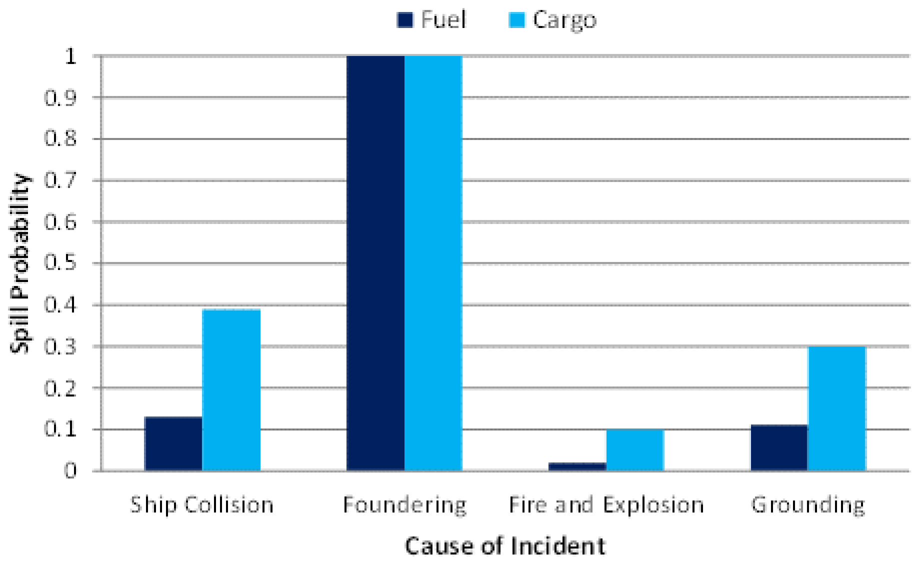


Figure C.16 Probability of an Oil Spill Resulting from an Accident

837. Therefore, it was estimated that 13% of vessel collisions result in a fuel oil spill and 39% of collisions involving a laden tanker result in a cargo oil spill.

838. In the event of a bunker spill, the potential outflow of oil depends upon the bunker capacity of the vessel. Historical bunker spills from vessels have generally been limited to a size below 50% of bunker capacity, and in most incidents much lower.

839. For the types and sizes of vessels exposed to the Project, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

840. For oil spills from laden tankers, the spill size can vary significantly. The International Tanker Owners Pollution Federation (ITOPF) reported the following spill size distribution for tanker collisions between 1974 and 2004:

- 31% of spills below seven tonnes;
- 52% of spills between seven and 700 tonnes; and
- 17% of spills greater than 700 tonnes.

841. Based upon this data and the tankers transiting in proximity to the array area, an average spill size of 400 tonnes is considered conservative.

842. For fishing vessel collisions comprehensive statistical data is not available. Consequently, it is conservatively assumed that 50% of all collisions involving fishing vessels will lead to oil spill with the quantity spilled being on average five tonnes. Similarly, for recreational vessels, owing to a lack of data 50% of collisions are assumed to lead to a spill with an average size of one tonne.

C.4.2 Pollution Risk due to the Project

843. Applying the above probabilities to the annual collision and allision frequency by vessel type and the average spill size per vessel, the estimated amount of oil spilled per year due to the presence of the Project would equate to 0.71 tonnes of oil per year for the base case. For the future case scenarios, this estimate increases to 0.80 tonnes and 0.90 tonnes for traffic increases of 10% and 20%, respectively.

844. The estimated increase in tonnes of oil spilled, distributed by vessel type, for the base and future cases are presented in Figure C.17.

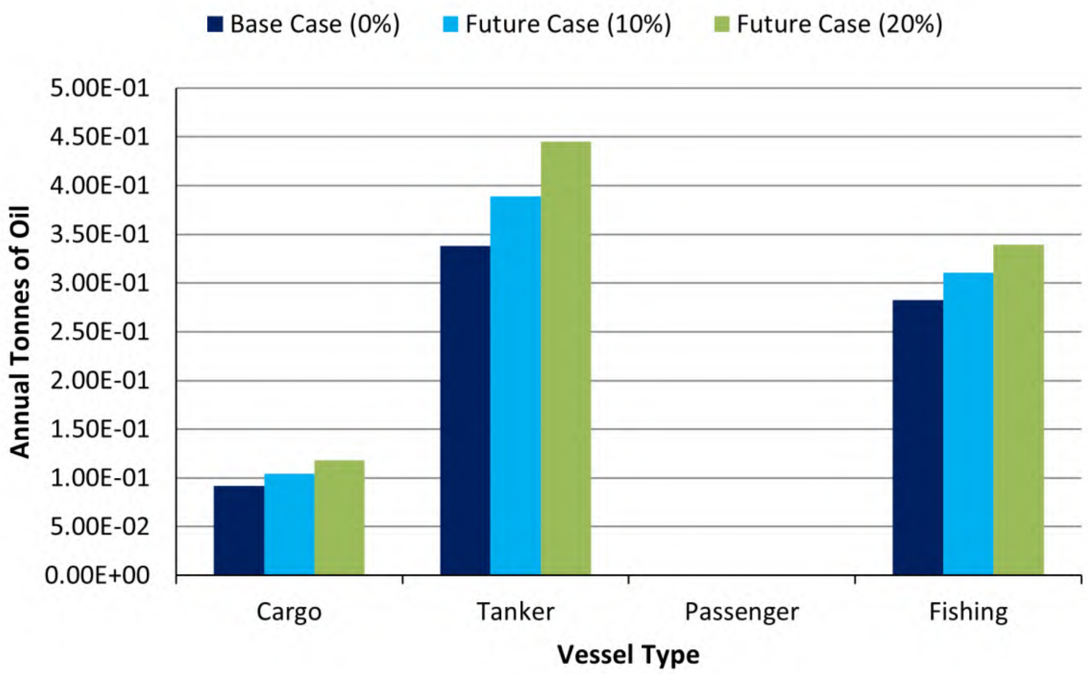


Figure C.17 Estimated Change in Pollution by Vessel Type

845. The majority of annual oil spill results are associated with tankers due to the greater spillage size anticipated in associated incidents. Fishing vessels also contribute due to the high annual allision frequency associated with fishing vessels.

C.4.3 Significance of Increase in Pollution Risk

846. To assess the significance of the increased pollution risk from vessels caused by the Project, historical oil spill data for the UK has been used as a benchmark.

847. From the MEHRAs research, the annual average tonnes of oil spilled in UK waters due to maritime incidents in the 10-year period from 1989 to 1998 was 16,111 tonnes. This is based upon a total of 146 reported oil pollution incidents of greater than one tonne (smaller spills are excluded as are incidents which occurred within port or harbour areas or as a result of operational errors or equipment failure). Commercial vessel spills accounted for approximately 99% of the total while fishing vessel incidents accounted for less than 1%.

848. The overall increase in pollution estimated due to the Project of 0.71 tonnes for the base case represents a 0.0044% increase compared to the historical average pollution quantities from marine incidents in UK waters.

C.5 Conclusion

849. This appendix has quantitatively assessed the fatality and pollution risk associated with the Project in the case of a collision or allision incident occurring. It is concluded, based upon the results, that the collision and allision risk of the Project on people and the environments is very low compared to the existing background risk levels.

Annex D Regular Operator Consultation

850. As part of the consultation process for the Project, regular operators identified as potentially being of relevance based on the vessel traffic survey data were contacted to request comment on the Project. An example of the correspondence sent to the regular operators is presented below.

Anatec Ltd.
Cain House
10 Exchange Street
Aberdeen AB11 6PH
Tel: 01224 253700
Email: aberdeen@anatec.com
Web: www.anatec.com

Date: 8th September 2022

Opportunity to Participate in Consultation Relating to Shipping and Navigation for the Proposed Outer Dowsing Offshore Wind Farm

Dear Stakeholder,

As you may be aware, the Outer Dowsing offshore wind farm is proposed to be a 1.5 gigawatt project located approximately 54 kilometres off the Lincolnshire coast. It is being developed as a joint venture between TotalEnergies and Corio Generation. Further information about the Project can be found here.

Following a Scoping Report submitted to the Planning Inspectorate in August 2022 (see here), the Project has commenced drafting of the Preliminary Environmental Information Report (PEIR) including the Navigational Risk Assessment (NRA). The outputs of this process will feed into the subsequent Environmental Statement (ES) which will include any relevant NRA updates following the PEIR outputs.

The site covers an area of approximately 145 nm², and is located approximately 4nm to the east of the operational Triton Knoll offshore wind farm. An overview of the current site boundary is provided in Figure 1. The figure includes the Offshore Export Cable Corridor (ECC) Area of Search for reference.

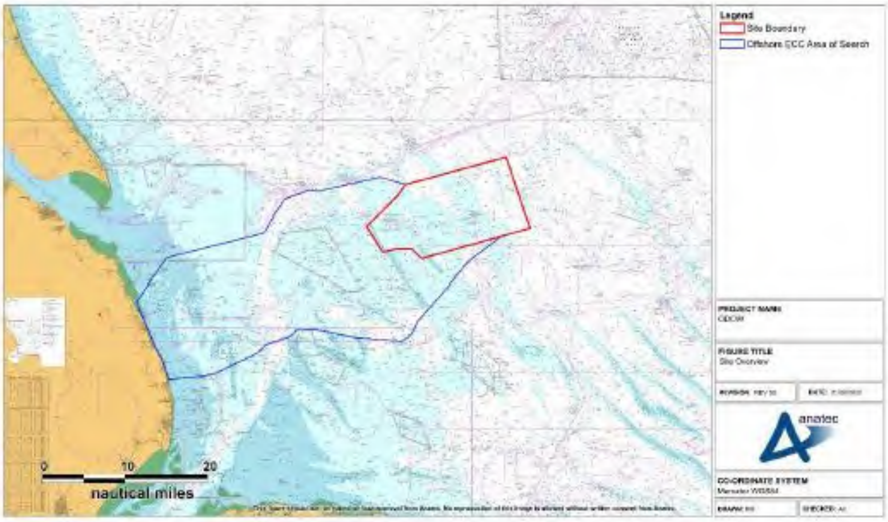


Figure 1 Overview of the Site Boundary

Anatec has been contracted to provide technical support on shipping and navigation during the consenting process, and to coordinate consultation with relevant stakeholders. As part of the NRA process, Anatec has undertaken an assessment of 12 months of AIS data covering the period from April 2021 to March 2022 to identify regular commercial operators. This exercise has identified your organisation as a regular operator within or in proximity to the site boundary.

We therefore invite your feedback on the Project, including any impact it may have upon the navigation of vessels. Whilst we welcome all feedback we are particularly interested in any comments or feedback on the following:

1. Whether the Project is likely to impact the routeing of any specific vessels and/or routes.
2. Whether the Project poses any safety concern to the routeing of your vessels, including any adverse weather routeing.
3. Whether the cumulative scenario (i.e., other potential wind farm projects) affects your responses to the previous questions.
4. Whether you would choose to make passage internally through the site boundary and associated structures.

Additionally, we would like to invite you to attend a Hazard Workshop for the Project. Further details can be provided if this is of interest.

We would appreciate if any responses are provided via email to [redacted] by the 23rd September 2022, as well as an indication of whether you are interested in attending the Hazard Workshop noted above. In the meantime I would be grateful if you could confirm receipt of this letter for our records.

Please do not hesitate to get in touch should you have any queries or require any further information.

Yours sincerely,

[redacted]
Risk Analyst
Anatec Ltd.

Annex E Long-Term Vessel Traffic Movements

E.1 Introduction

851. This appendix assesses the additional long-term vessel traffic data for the project. The NRA and Volume 1, Chapter 15: Shipping and Navigation (document reference 6.1.15) consider 28-days of AIS, Radar and visual observation data as the primary vessel traffic data source. However, it should be considered that studying a 28-day period in isolation may exclude certain activities or periods of pertinence to shipping and navigation.

852. Therefore, in line with good practice assessment procedures, this NRA has also considered a longer term dataset covering 12-months from 1 April 2021 to the 31 March 2022 to ensure a comprehensive characterisation of vessel traffic movements can be established including the capture of any seasonal variation.

853. This approach (i.e., the use of both short- and long-term data) has been agreed with the MCA and Trinity House.

E.2 Methodology

E.2.1 Study Area

854. This appendix has assessed the long-term vessel traffic data within the same shipping and navigation study area introduced in section 3.4.

E.2.2 Date Period and Temporary Vessel Traffic

855. The long-term vessel traffic data was collected from coastal AIS receivers for the 12-month between 1 April 2021 and 31 March 2022. The percentage uptime[10] per month for the AIS receivers that the AIS data has used within this report was analysed. The uptime for the receivers was estimated at 99%.

856. As per the vessel traffic surveys, a number of vessel tracks recorded during the data period were classified as temporary (non-routine) and have been excluded from the characterisation of the vessel traffic baseline, including vessels associated with Hornsea Project Two which was still under construction at the time of data collection.

E.2.3 AIS Carriage

857. General limitations associated with the use of AIS data (for example carriage requirements) are discussed in full within section 5.4.1.

[10] The time period when AIS data was being received by the receiver

E.3 Long-Term Vessel Traffic Movements

858. A plot of the vessel tracks recorded within the shipping and navigation study area during the data period, colour-coded by vessel type and excluding temporary traffic, is presented in Figure E.1.

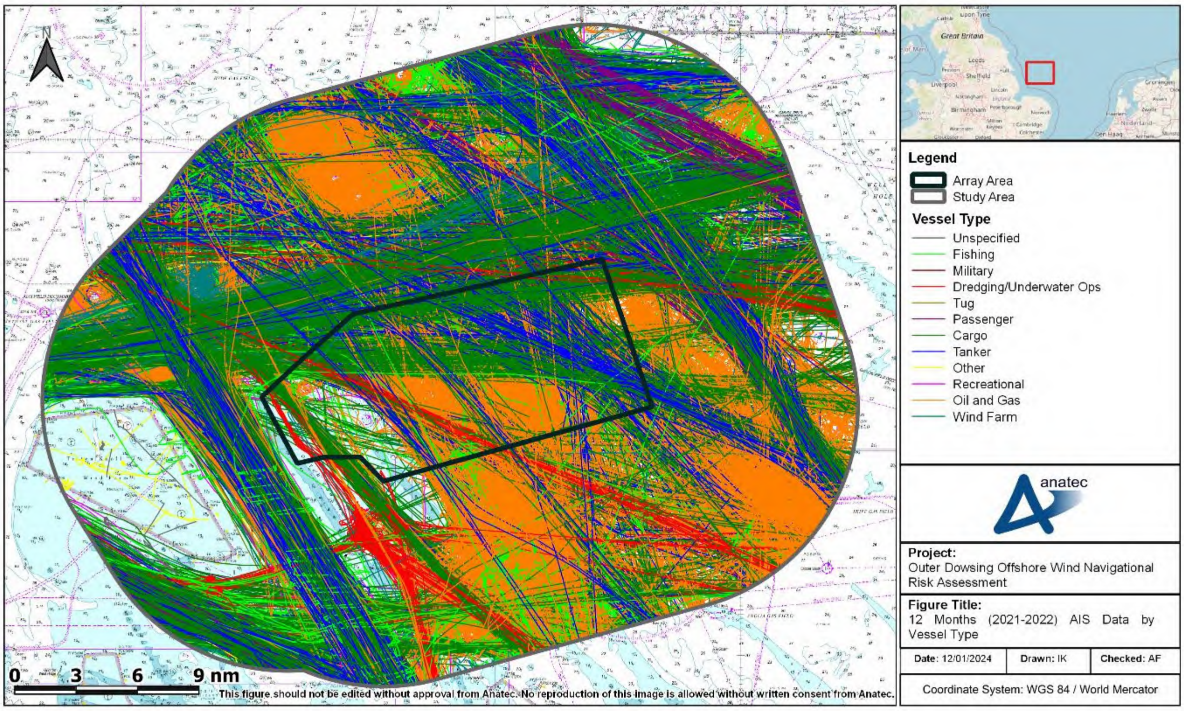


Figure E.1 Long-term Vessel Traffic Data by Vessel Type (12-Months, 2021-2022)

E.3.2 Vessel Count

859. The average daily number of vessels within the shipping and navigation study area for each month of the 12-month data periods are presented in Table E.1.

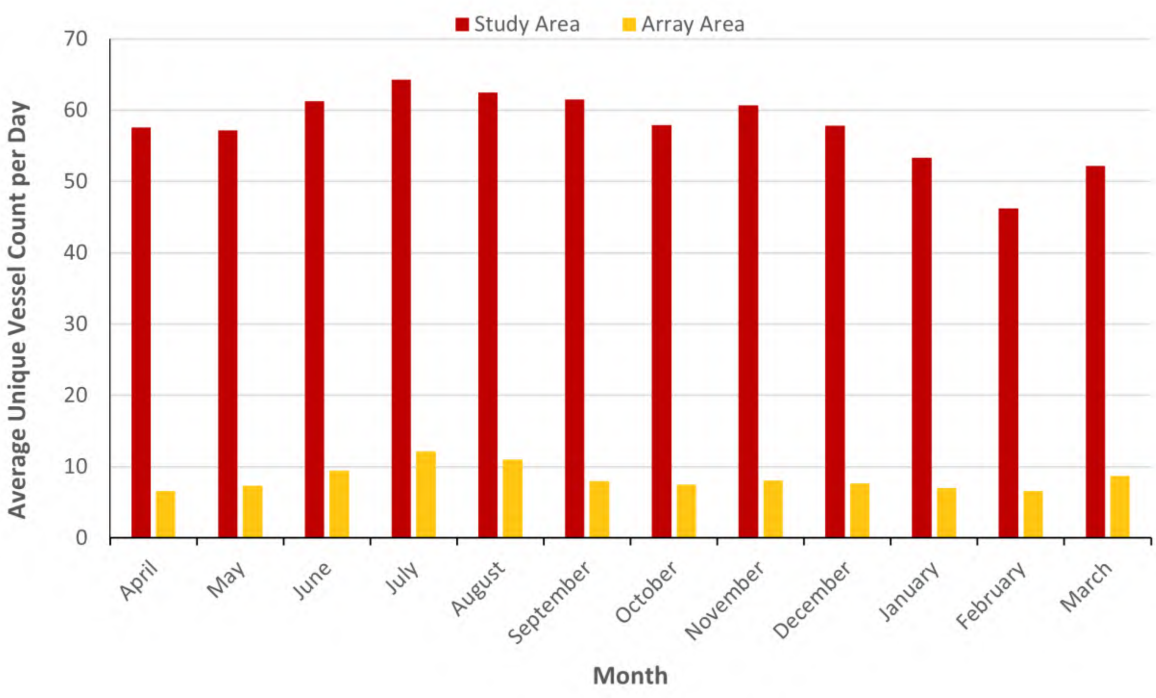


Table E.1 Long-Term Daily Counts by Month within the Shipping and Navigation Study Area and Array Area (12-Months, 2021-2022)

860. The busiest month recorded within the shipping and navigation study area was July with approximately 64 unique vessels per day, noting the average for the entire data period was 58 unique vessels per day. The quietest month was February with approximately 46 unique vessels per day recorded. Overall, there was not considered to be notable fluctuation in traffic volumes over the data period within the shipping and navigation study area.

861. In total, approximately 14% of all vessels recoded within the shipping and navigation study area during the data periods intersected the array area.

E.3.3 Vessel Type

862. The distribution of the main vessel types recorded during the data period are presented in Figure E.2. Vessel types accounting for less than 1% of the overall activity during the data period (including military vessels, High Speed Crafts, and recreational vessels) have been incorporated into the 'other' vessel category.

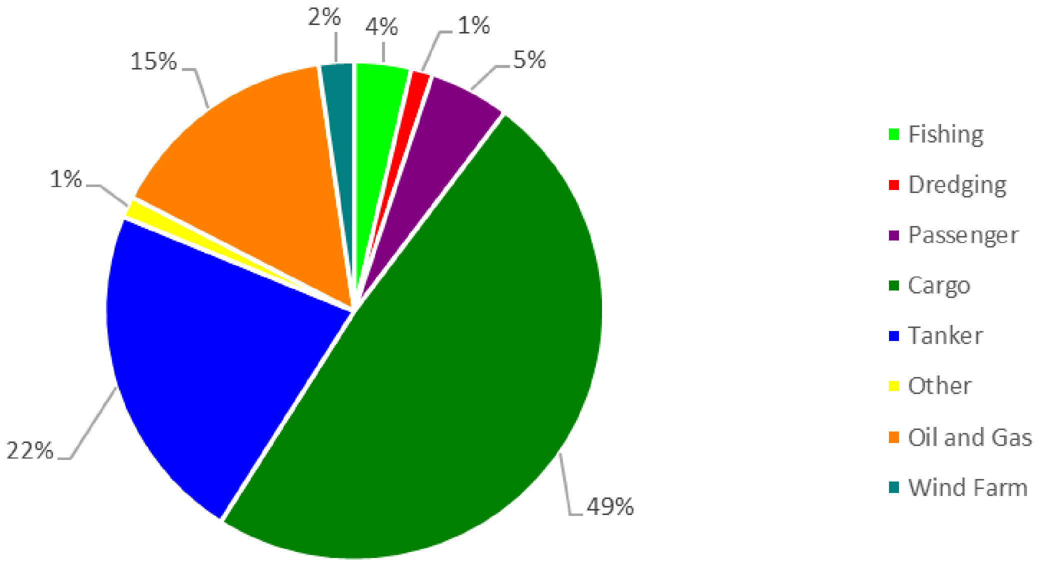


Figure E.2 Main Vessel Types Distribution (12-Months, 2021-2022)

863. The most common vessel type recorded was cargo vessels, accounting for approximately 49% of all traffic recorded within the shipping and navigation study area during the data period. Other common vessel types included tankers (22%), oil and gas vessels (15%), passenger vessels (5%), and fishing vessels (4%).

E.4 Site Specific Analysis

E.4.1 Commercial Vessels

864. The commercial vessels (in this instance relating to cargo vessels, tankers, and passenger vessels) recorded within the shipping and navigation study area during the data period are presented in Figure E.3.

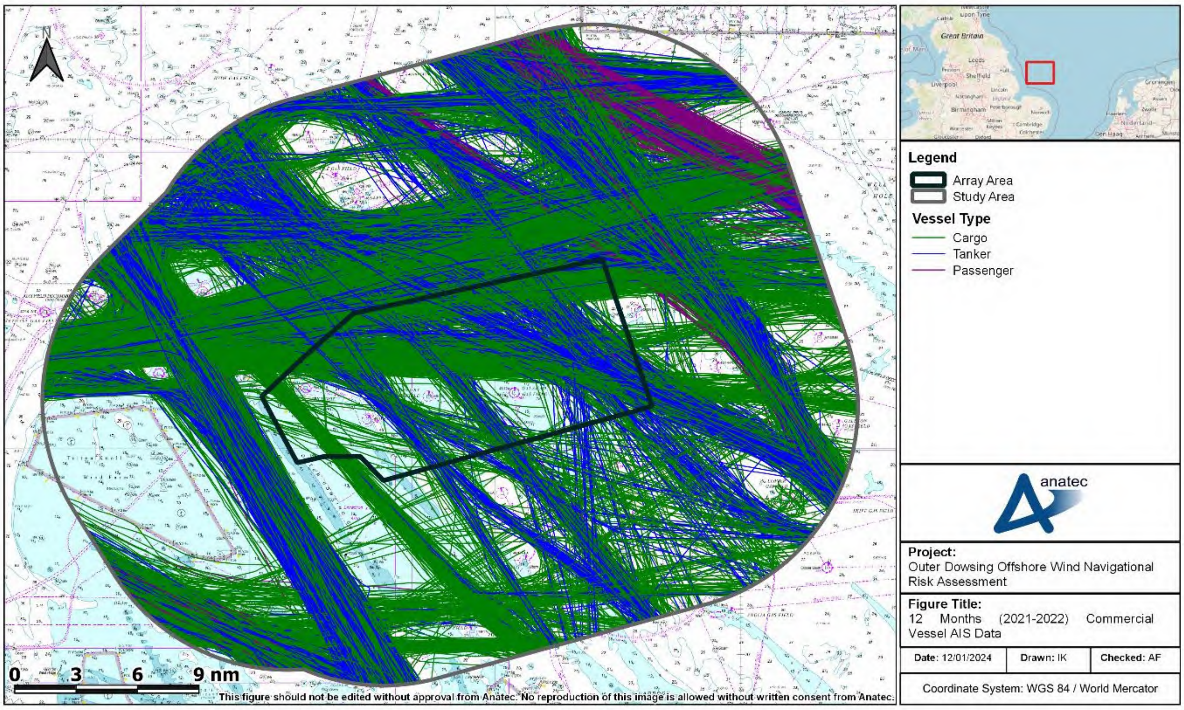


Figure E.3 Commercial Vessels within the Shipping and Navigation Study Area by Vessel Type (12-months, 2021-2022)

865. An average of 44 unique commercial vessels per day were recorded within the shipping and navigation study area during the data period.

866. The cargo vessels and tankers recorded were noted on well-defined routes through the site boundary both in a northwest-southeast and east-west orientation with these primarily comprising the main commercial routes that have been identified from the vessel traffic survey data (see section 11.2). Cargo vessels and tankers were on routes primarily between ports on the Humber and Tees (UK), and mainland Europe ports such as Rotterdam (the Netherlands), Zeebrugge (Belgium), and Cuxhaven (Germany).

867. Additionally, passenger routes were observed primarily between Tyne (UK) and Ijmuiden (the Netherlands) operated by Stena Line and P&O Ferries; and between Hull (UK) and Rotterdam operated by DFDS Seaways. Other routes included alternate adverse weather passage for the route between Ijmuiden and Tyne.

868. The number of unique cargo, tanker, and passenger vessels recorded per day for each month within the shipping and navigation study area and array area itself are presented in Figure E.4, and Figure E.5 respectively.

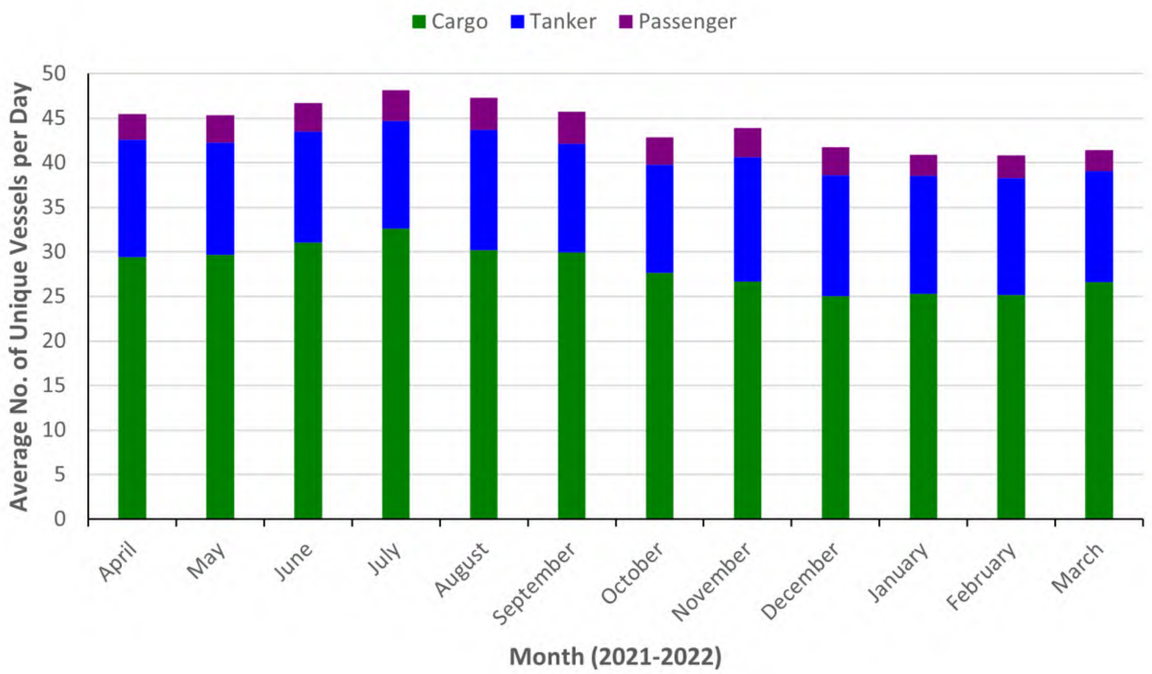


Figure E.4 Long-Term Average Daily Counts by Month Per Type within the Shipping and Navigation Study Area (12-Months, 2021-2022)

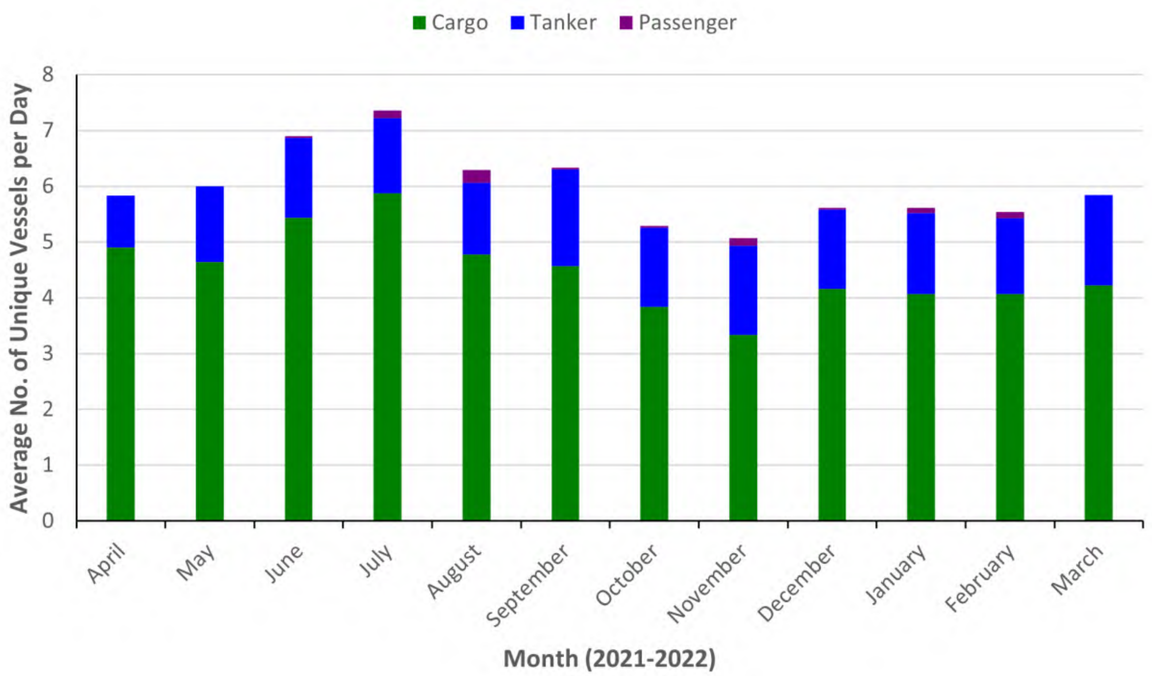


Figure E.5 Long-Term Average Daily Counts by Month Per Type within the Array Area (12-Months, 2021-2022)

869. On average throughout the data period there was 28 unique cargo vessels, 13 unique tankers, and three unique passenger vessels per day. Approximately 11% of commercial vessels were recorded intersecting the array area, the majority being cargo vessels.

870. Cargo vessels showed some seasonal variation, albeit minimal, with slightly higher vessel numbers being recorded in summer months. The busiest month within the shipping and navigation study area was July with an average of 32 unique cargo vessels per day. The quietest month for cargo vessels was December with 25 unique cargo vessels per day.

871. Tankers similarly showed minimal seasonal variation with the busiest month within the shipping and navigation study area being November with an average of 14 unique tankers per day. The quietest month for tankers was July with approximately 12 unique tankers per day.

872. Passenger vessels similarly showed some seasonal variation, albeit minimal, with slightly higher vessel numbers being recorded in summer months also. The busiest month within the shipping and navigation study area was August with an average of between three and four unique passenger vessels per day. The quietest month was March with an average of two unique passenger vessels per day.

873. In total, of all commercial vessels recorded within the shipping and navigation study area, 14% of cargo vessels, 11% of tanker, and 1% of passenger vessels intersected the array area during the data period.

874. Table E.2 presents a summary of the average number of vessels within the shipping and navigation study area and array area during the busiest month, quietest month, and the average throughout the full data period.

Table E.2 Quietest Month, Busiest Month, and Overall Average Daily Count for Commercial Vessels (2021-2022)

Vessel Type	Study Area			Array Area		
	Quietest	Busiest	Average	Quietest	Busiest	Average
Passenger	2	4	3	0	<1	<1
Cargo	25	32	28	3	5	4
Tanker	12	14	13	1	1	1

875. In summary, the most common type of commercial vessel recorded within the shipping and navigation study area was cargo vessels. Cargo vessels and passenger vessels showed little seasonal variation with slightly higher numbers recorded in summer months whilst tanker activity was consistent throughout the data period.

E.4.2 Oil and Gas Vessels

876. Vessel tracks of oil and gas vessels recorded within the shipping and navigation study area during the data period were analysed for activity, with vessels likely to be on station or engaged in O&M activities, as opposed to in transit, separated. The oil and gas vessel tracks are colour-coded by likely vessel activity and presented in Figure E.6.

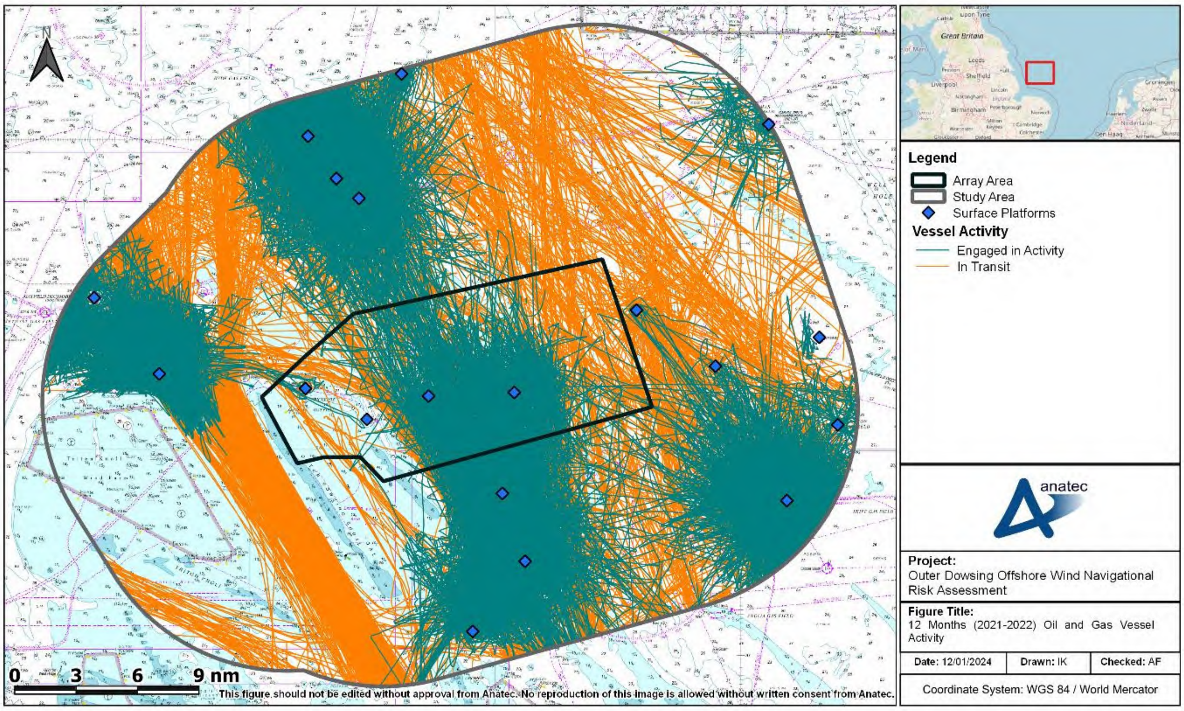


Figure E.6 Oil and Gas Vessels within the Shipping and Navigation Study Area by Vessel Activity (12-Months, 2021-2022)

877. An average of nine unique oil and gas vessels per day were recorded within the shipping and navigation study area during the data period with a total of 27% of all oil and gas vessels recorded intersecting the array area.

878. The oil and gas vessels recorded were noted routeing through the site boundary with a well-defined route, passing in a northwest-southeast orientation to the west of the array, on one of the main commercial routes that have been identified from the vessel traffic survey data (see section 11.2). Transits to/from ports and harbours that were noted on this route included Great Yarmouth, Lowestoft, and oil and gas fields including York, Villages, Breagh, Tolmount, and Ravensprun as well as jack-up rigs Maersk Resolve, Noble Sam Hartley, and Erda. Oil and gas vessels in transit accounted for approximately 41% of all oil and gas vessels with those vessels likely to be engaged in activity at a platform or in O&M activity equated to 58%.

879. Vessels engaged in activity within the shipping and navigation study area during the data period were noted at platforms within the gas fields surrounding the array area. These fields being Clipper, Barque, Galleon, Amethyst, West Sole, Malory, and Excalibur.

E.4.3 Fishing Vessels

880. The fishing vessels recorded within the shipping and navigation study area during the data period are presented in Figure E.7. It should be considered that as this assessment was via AIS only, it is likely to under-represent actual fishing vessels within the area (see section 5.4.1).

881. Analysis of vessel speed and movement was undertaken to determine the likely status of fishing vessel behaviour within the shipping and navigation study area (i.e., actively fishing or in transit). The results of this assessment are colour-coded by fishing vessel behaviour and illustrated in Figure E.7. It is noted that the same vessel may be represented multiple times if it changed behaviour whilst in the shipping and navigation study area. Following this, the average number of fishing vessels engaged in fishing and exclusively transiting per day for each month within the shipping and navigation study area are summarised in Figure E.8.

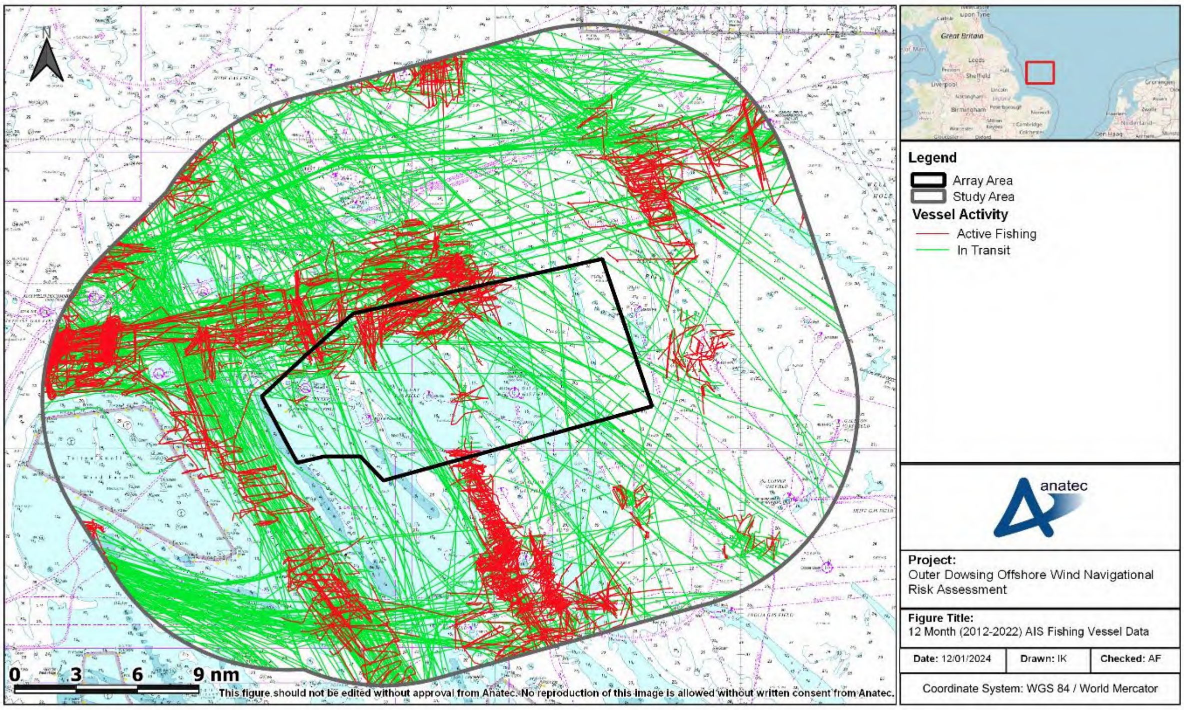


Figure E.7 Fishing Vessels within the Shipping and Navigation Study Area by Vessel Activity (12-Months, 2021-2022)

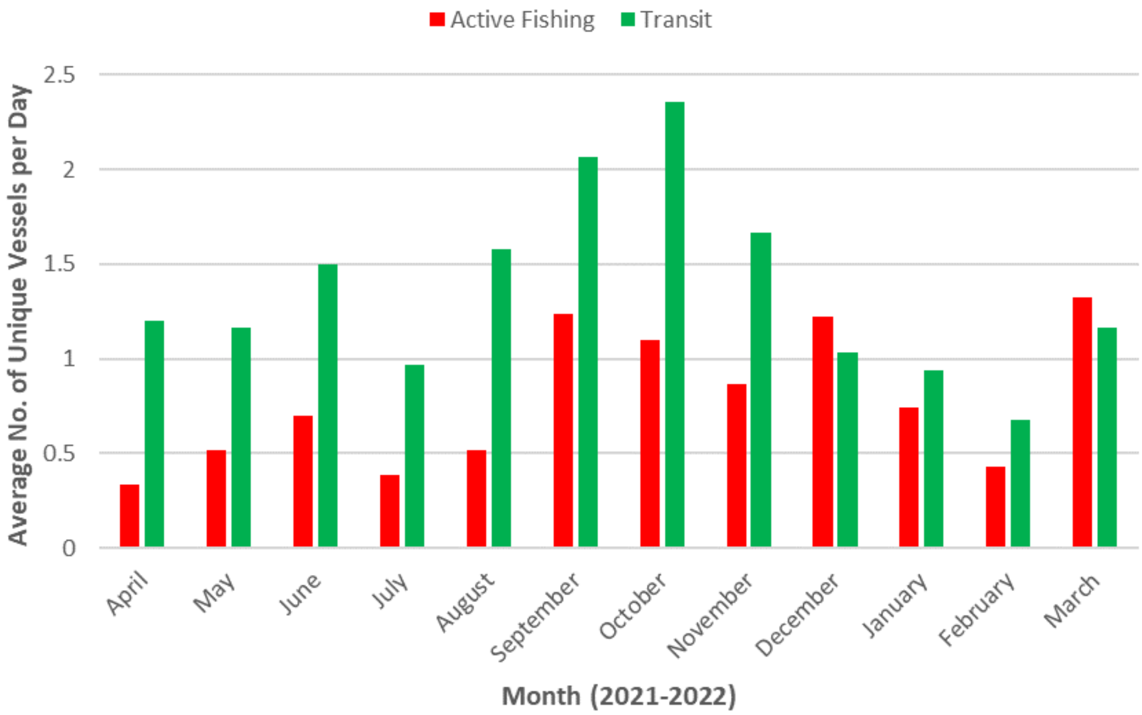


Figure E.8 Unique Fishing Vessels by Vessel Activity

882. An average of two unique fishing vessels per day were recorded within the shipping and navigation study area during the data period with 64% of vessels likely to be in transit with the other 36% engaged in likely fishing activity.

883. Fishing activity was recorded throughout the shipping and navigation study area with a high density noted to and within the north of the array area as well as within the south of the shipping and navigation study area. Overall, fishing levels peaked in October, but this was not the same trend for vessels engaged in active fishing with the highest levels of active fishing activity recorded in March.

884. Of all fishing vessels recorded within the shipping and navigation study area during the data period, irrespective of activity, 16% were recorded intersecting the array area.

E.4.4 Windfarm Vessels

885. The windfarm vessels recorded within the shipping and navigation study area during the data period, along with the surrounding developments, are presented in Figure E.9.

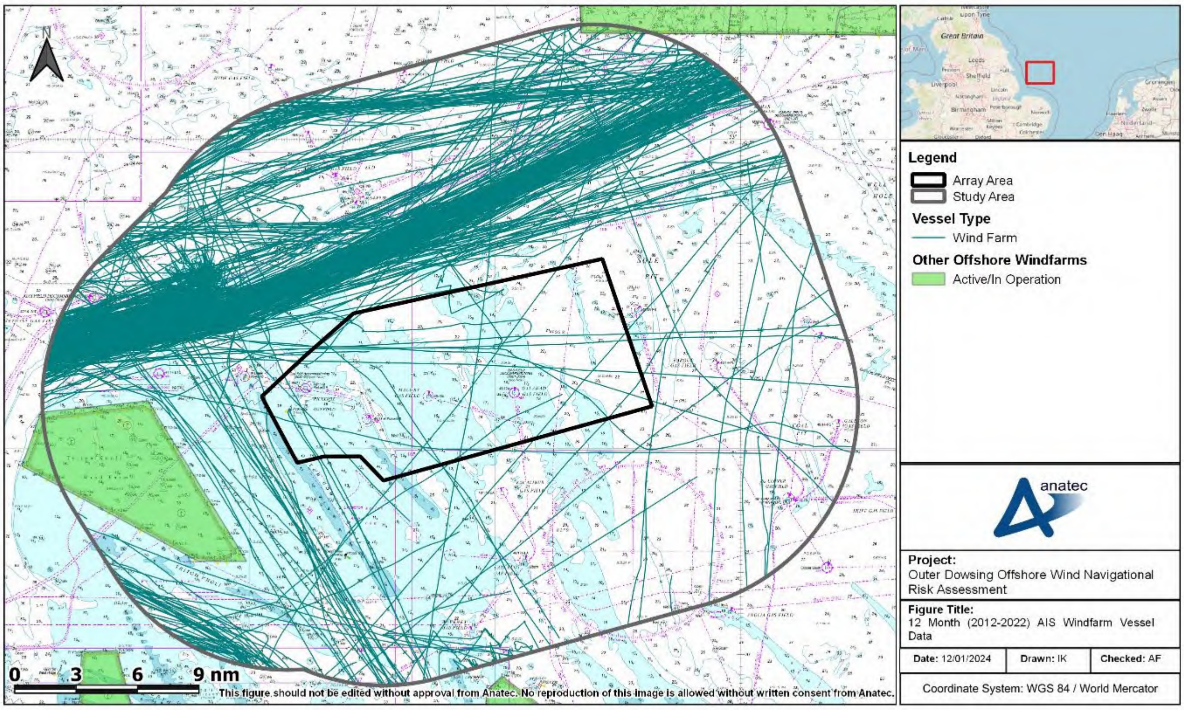


Figure E.9 Windfarm Vessels within the Shipping and Navigation Study Area (12-Months, 2021-2022)

886. An average of one unique windfarm vessel per day was recorded within the shipping and navigation study area during the data period. The majority of windfarm vessels recorded were associated with the O&M of Hornsea Project One, with others associated with the Dudgeon, Race Bank, and Sheringham OWFs.

887. A total of 4% of all windfarm vessels recorded within the shipping and navigation study area during the data period were recorded intersecting the array area.

E.4.5 Marine Aggregate Dredging/ Subsea Operations

888. The marine aggregate dredging/subsea operations vessels recorded within the shipping and navigation study area during the data period are presented in Figure E.10.

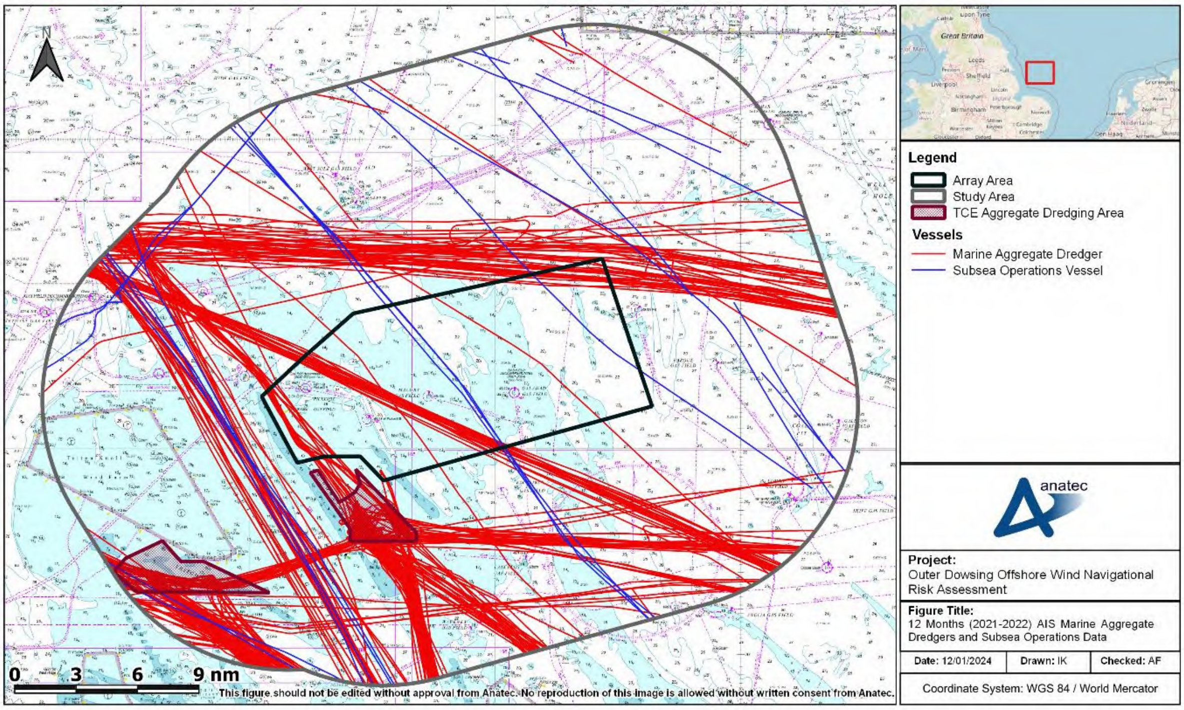


Figure E.10 Marine Aggregate Dredgers/ Subsea Operation Vessels within the Shipping and Navigation Study Area (12-Months, 2021-2022)

889. An average of one unique dredging/subsea operations vessel per day was recorded within the shipping and navigation study area during the data period. Marine aggregate dredgers were predominately recorded transiting to the two Outer Dowsing aggregate dredging area to the southwest of the array area. Other vessels were transiting to dredging areas in proximity to the Humber as well as on routes to various locations in Belgium and the Netherlands, such as Oostende, Zeebrugge, Ijmuiden, and Harlingen.

890. Subsea operation vessels included cable laying and pipe burial vessels with common destinations including Middlesbrough and Grimsby, UK, and Rotterdam, the Netherlands.

891. A total of 20% of all dredging/subsea operation vessels recorded within the shipping and navigation study area during the data period were recorded intersecting the array area.

E.4.6 Recreational Vessels

892. The recreational vessels recorded within the shipping and navigation study area during the data period are presented in Figure E.11.

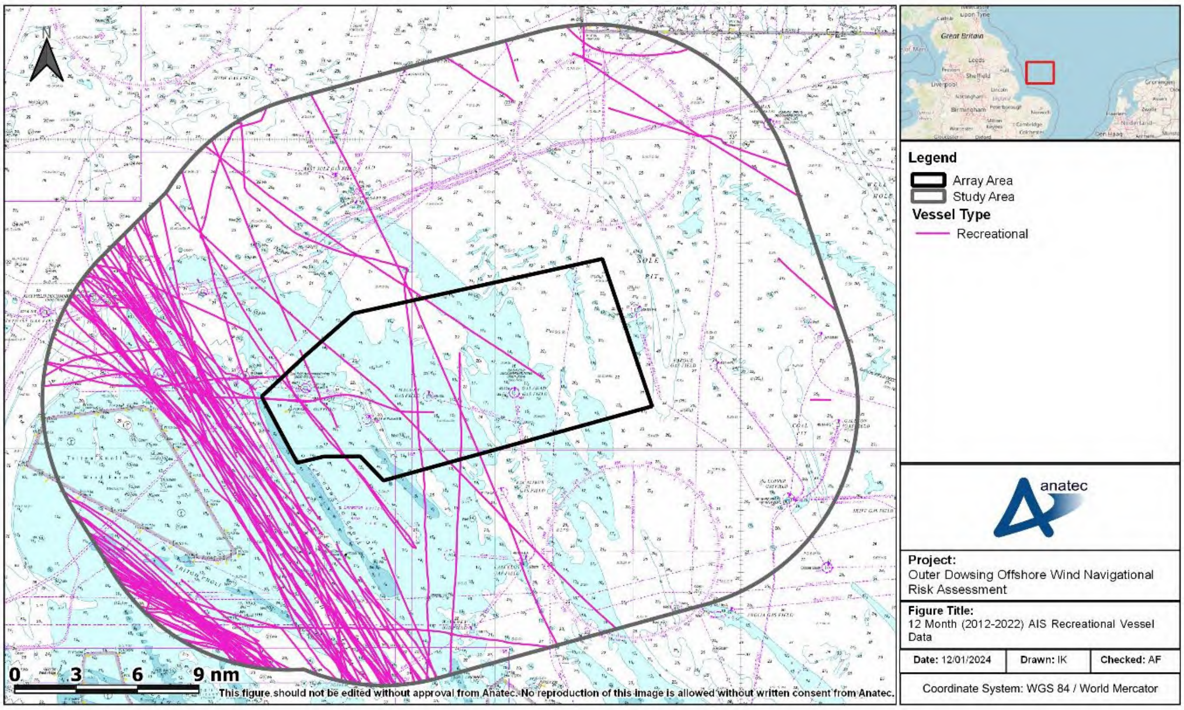


Figure E.11 Recreational Vessels within the Shipping and Navigation Study Area (12-Months, 2021-2022)

893. An average of less than one unique recreational vessel per day was recorded within the shipping and navigation study area during the data period. Recreational vessels were recorded mostly on the west of the array area, in the shallower waters closer to the shore. Vessels also made use of the navigational corridors on routes on a northwest-southeast bearing split east and west of Triton Knoll OWF. Recreational vessels charted a high degree of seasonality with approximately 79% of vessels being recorded in the four-month period between 1 May 2021 and 31 August 2021.

894. A total of 11% of all recreational vessels recorded within the shipping and navigation study area during the data period were recorded intersecting the array area.

E.4.7 Anchored Vessels

895. Speed analysis was performed on the 12-months of data to identify vessels at anchor within the shipping and navigation study area. This analysis has identified likely anchored vessels as those transiting at less than 1kt for a period of 30 minutes or longer. Based on this, vessel behaviour patterns, and navigational status broadcast through AIS, the vessels identified as likely being at anchor within the shipping and navigation study area during the survey period are colour-coded by vessel type and presented in Figure E.12.

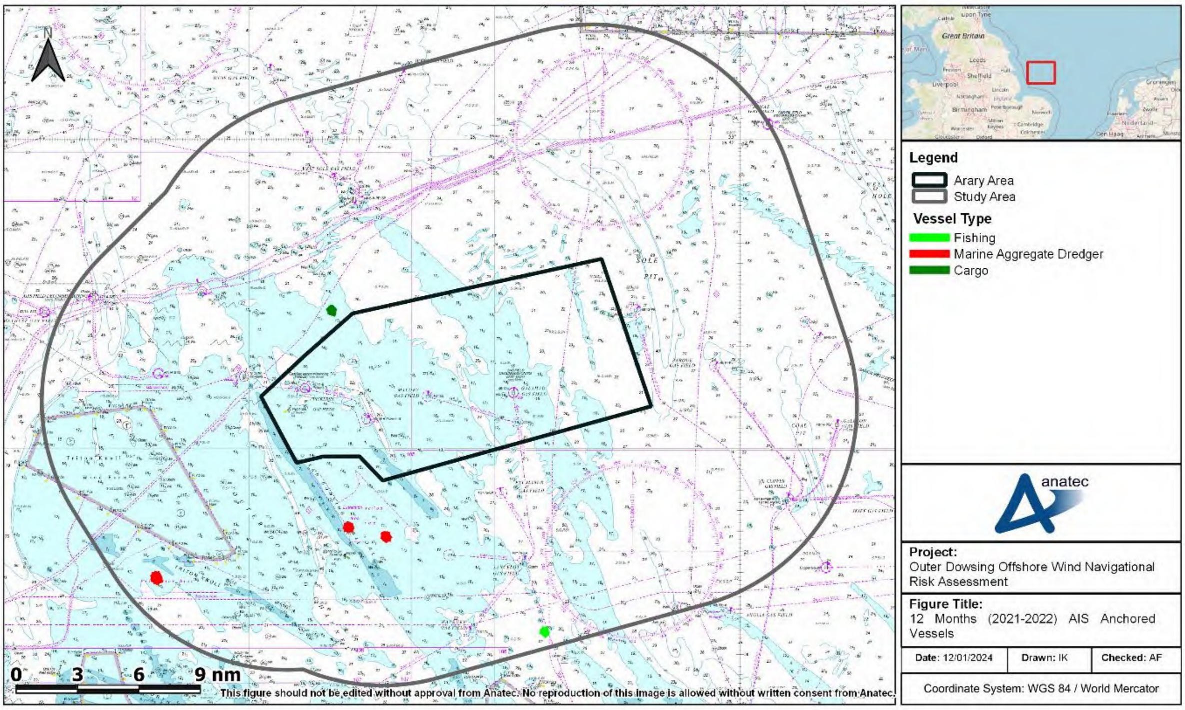


Figure E.12 Anchored Vessels within the Shipping and Navigation Study Area (12-Months, 2021-2022)

896. In total, there was five separate instances of vessels anchoring within the shipping and navigation study area during the data period. This low value is expected for anchoring vessels due to water depths and distance offshore. The vessels at anchor within the shipping and navigation study area were in depths between approximately 11m and 20m below CD. The marine aggregate dredgers that are at anchor are all present within the Outer Dowsing aggregate dredging areas and all three unique vessel anchor occurrences extended over the course of two separate days with the longest time at anchor for any vessel recorded was 40 hours. The cargo vessel and fishing vessel were at anchor for 7.25 hours and 3.7 hours, respectively.

E.5 Survey Data Comparison

897. A comparison of the average number of each main vessel type analysed in the previous sections recorded throughout the 2021-2022 data period against the average number of each vessel type recorded throughout the two vessel traffic surveys are presented in Table E.3.

Table E.3 Comparison of the Number of each Main Vessel Type Detected During 2021-2022 and the Vessel Traffic Survey Data

Vessel type	Long-term AIS data			Summer survey	Winter survey
	Busiest month	Quietest month	Average vessels per day	Average vessels per day	Average vessels per day
Cargo vessels	July	Dec	28	27	27
Tankers	Nov	July	13	11	12
Passenger vessels	Aug	Mar	3	5	4
Marine aggregate dredgers	Feb	Aug	1	1	1
Oil and Gas vessels	Dec	Mar	9	9	9
Windfarm vessels	Nov	Feb	1	6	3
Recreational vessels	July	Feb/Dec	1	1	0
Fishing vessels	Oct	Feb	2	2	2

898. The only notable difference between the long term AIS and the summer vessel traffic survey was the number of windfarm vessels, which were notable higher during the summer survey than the long term AIS. This is likely due to a number of factors notably including changes in status of local windfarms and seasonal variation in windfarm traffic (vessel numbers were lower during winter conditions).

Annex F Review of ORBA Impact on Displacement and Collision Risk

F.1 Introduction

899. This annex presents a consideration of the environmental implications of the introduction of an ORBA over a part of the array area for the Project in terms of impacts on vessel displacement and collision risk.

900. During the NRA process for the Project, it was identified that existing vessel routes pass in close proximity to the northern boundary of the array area, or intersect its northern extent. Red Line Boundary changes at the PEIR stage reduced the northern boundary which was observed to reduce displacement and vessel to vessel collision risk based on the outputs of an NRA remodelling process undertaken prior to submission of the ES.

901. This annex provides quantification of the introduction of the ORBA, and supports the qualitative assessment for shipping and navigation provided in the Environmental Report for the ORBA and Revision to the Offshore Export Cable Corridor (document reference 15.9). The annex assesses the impact of the ORBA on the Red Line Boundary post-PEIR in isolation, and therefore does not consider the updates previously made to the array area.

902. The aims of this annex are as follows:

- Based on the introduction of the ORBA, update and assess the level of displacement of vessels estimated to deviate north of the array area; and
- Analyse how these changes will impact collision risk of vessels in proximity to the array area.

903. Three scenarios have been considered with this annex. These are:

- **'Pre-wind farm'**: the baseline environment prior to the Project commencing;
- **'Post-windfarm'**: the shipping and navigation environment post wind farm without the ORBA (i.e., the scenario assessed in the NRA); and
- **'Post-windfarm with ORBA':** the shipping and navigation environment post wind farm with the ORBA implemented.

F.2 Site Refinement

F.2.1 Consultation

904. Relevant consultation pertaining to routeing at the northern extent of the array area is listed below.

MCA Scoping response:

- The cumulative impacts of other windfarms in close proximity, in particular the Hornsea Three and Dudgeon Extension developments will change routing, particularly those that transect the western and northern sections of the site.

MCA Section 42 response:

- Of note [to cumulate routeing] are Hornsea Three due its potential impact with the Immingham to Cuxhaven route.

Chamber of Shipping Section 42 response:

- The northernly extent has the most interaction to high density traffic routes and the most impact upon navigational squeeze and accordingly safety.

DFDS stakeholder meeting (2nd June 2021):

- Limited concern with the Newcastle to Ijmuiden route [Route 5]. However, the Immingham-Cuxhaven routeing will be affected [Route 3]. Adverse weather routeing between Immingham and Esbjerg may also be impacted.

DFDS consultation meeting (8th September 2022):

- Key DFDS concern is the Immingham to Cuxhaven route [Route 3].

DFDS and Chamber of Shipping consultation meeting (7th September 2023):

- DFDS estimated a 2nm increase in journey distance as a combined result of the array area and Hornsea Three.
- DFDS stated that vessels forced to deviate on acute angles will show increased risk of allision/collision.
- The Chamber of Shipping noted that the northern boundary should be angled in a manner to least impact the routeing DFDS vessels [on Route 3].

MCA consultation meeting (13th September 2023):

- General satisfaction was noted regarding the reduced northern boundary presented at ES, although it was emphasised that feedback from DFDS was critical.

Trinity House consultation meeting (15th September 2023):

- General satisfaction was noted regarding the reduced northern boundary presented at ES, although feedback from DFDS was critical.
- In addition to vessels routeing on Route 3, the impact of the northern boundary on vessel traffic running east-west should also be considered.

Second Hazard Workshop (23rd November 2023):

- The Chamber of Shipping and MCA both noted general satisfaction with the array area presented at ES, after reductions were made to the northern boundary.

MCA consultation meeting (15th August 2024):

- The MCA noted that the implementation of the ORBA is a very welcome development, noting satisfaction with the additional searoom provided.

Chamber of Shipping consultation meeting (15th August 2024):

- The Chamber of Shipping remarked that the introduction of the ORBA is very positive, with the increased searoom and decreased collision risk welcome.
- Confirmed in subsequent email correspondence (dated 4th September 2024) that DFDS had “no issues and find the changes positive”.

Trinity House consultation meeting (20th August 2024):

- General satisfaction was noted regarding the ORBA from Trinity House.

F.2.2 Array Area Changes and ORBA

905. Following the PEIR stage of the Project and based on stakeholder feedback (see section F.2.1), refinements were made to the ‘AfL array area’, with the site reduced at the northern and western extents, and resulting in the array area assessed at ES.

906. Following submission of the ES, the Applicant will also implement an ORBA within the array area. The Red Line Boundary for the Project is not changing in relation to the array area, but no surface-piercing structures will be located within the ORBA. This will therefore alter the previously-identified impacts of the Project on shipping and navigation. In total, the ORBA comprises an area of 20.8nm^2 – comprising approximately 16.4% of the total array area.

907. The ORBA is located in the northern extent of the array area, as presented alongside the array area and AfL array area in Figure F.1

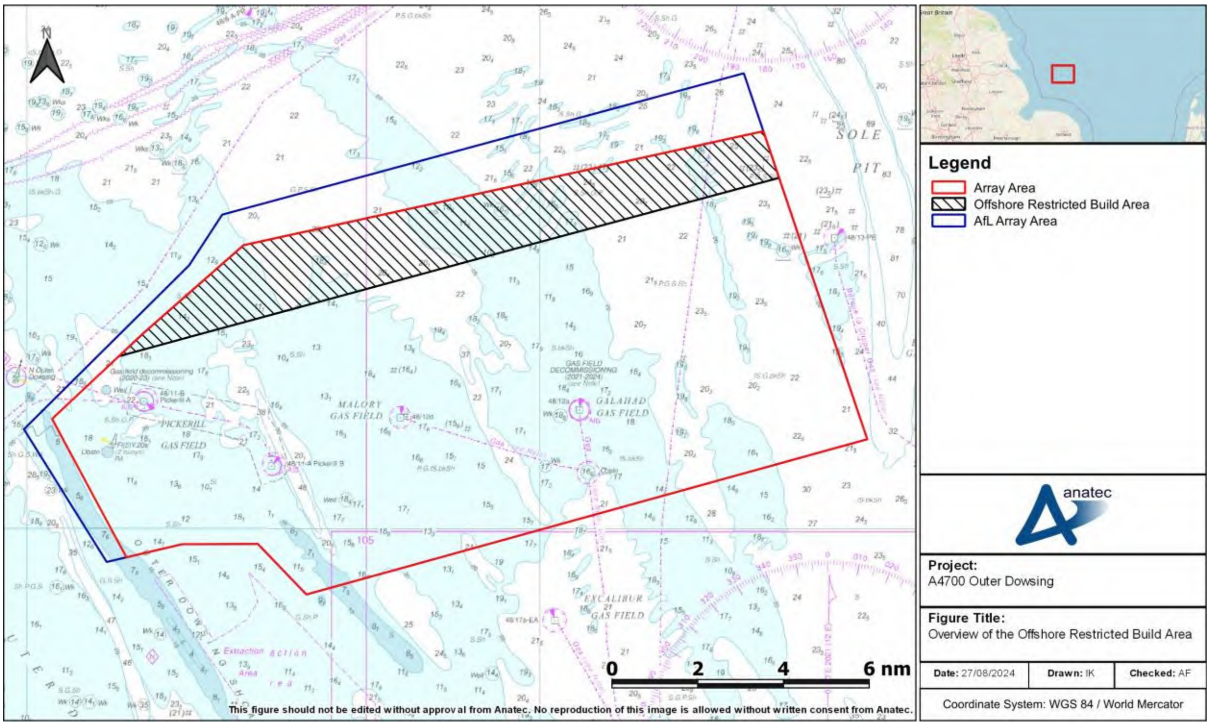


Figure F.1 Overview of the ORBA

F.3 Vessel Displacement

F.3.1 Overview of Main Route Deviations

908. During the NRA process, each of the 13 main routes identified from the vessel traffic data studied was assessed for the potential to deviate. The 13 main pre-windfarm routes are presented relative to the array area and the ORBA in Figure F.2.

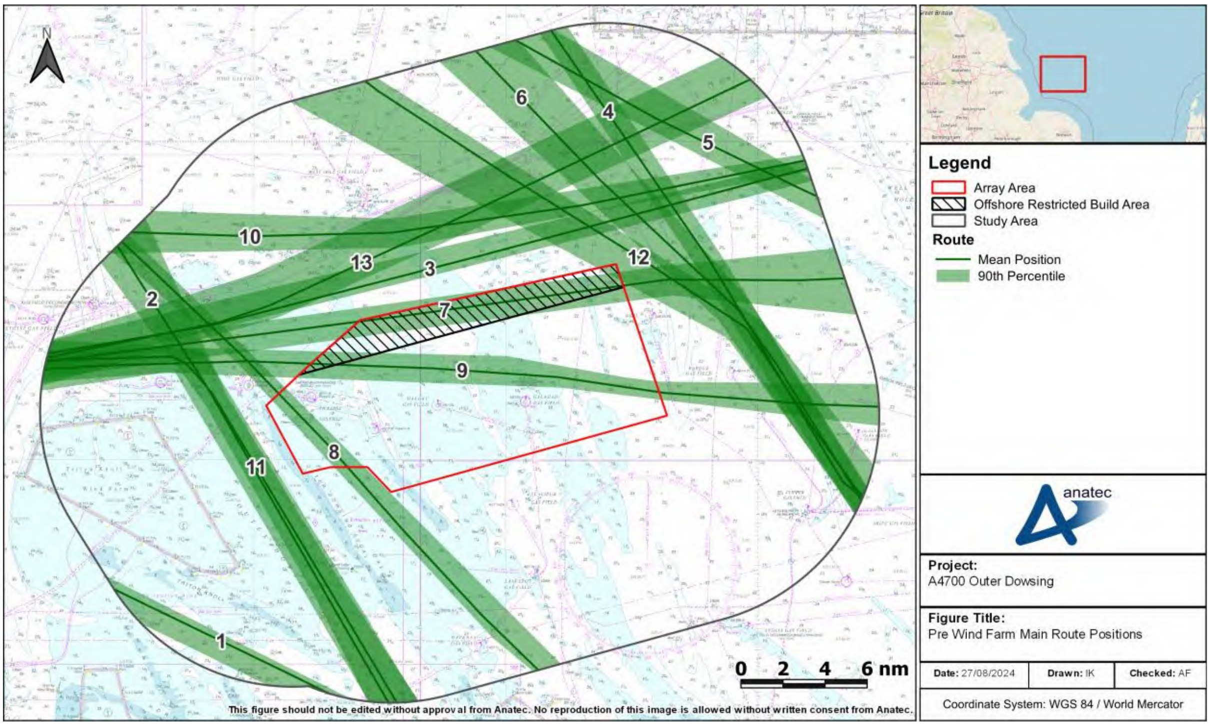


Figure F.2 Pre-Windfarm Main Route Positions

909. Based on the full array area assessment within the NRA, a total of four of the 13 main pre-windfarm routes identified were anticipated to require a deviation (Routes 7, 8, 9, and 12) in the post-windfarm scenario. Utilising the same methodology to assess deviations as per the NRA, the deviation of routes was re-assessed considering the implementation of the ORBA to elicit direct comparison. It was determined as an output of this process that only three of the 13 main pre-windfarm routes identified for the post-windfarm with ORBA are now anticipated to require a potential deviation.

910. The route which may no longer require a deviation is Route 12, which is used by DFDS as an adverse weather route. Route 12 is shown relative to the array area and the ORBA in Figure F.3. Given this is an adverse weather route, the mean route position and percentile shown may still change in the post wind farm with ORBA scenario, however any change is anticipated to be limited noting that DFDS confirmed as part of the NRA process limited concern with impacts on this route in the post wind farm scenario.

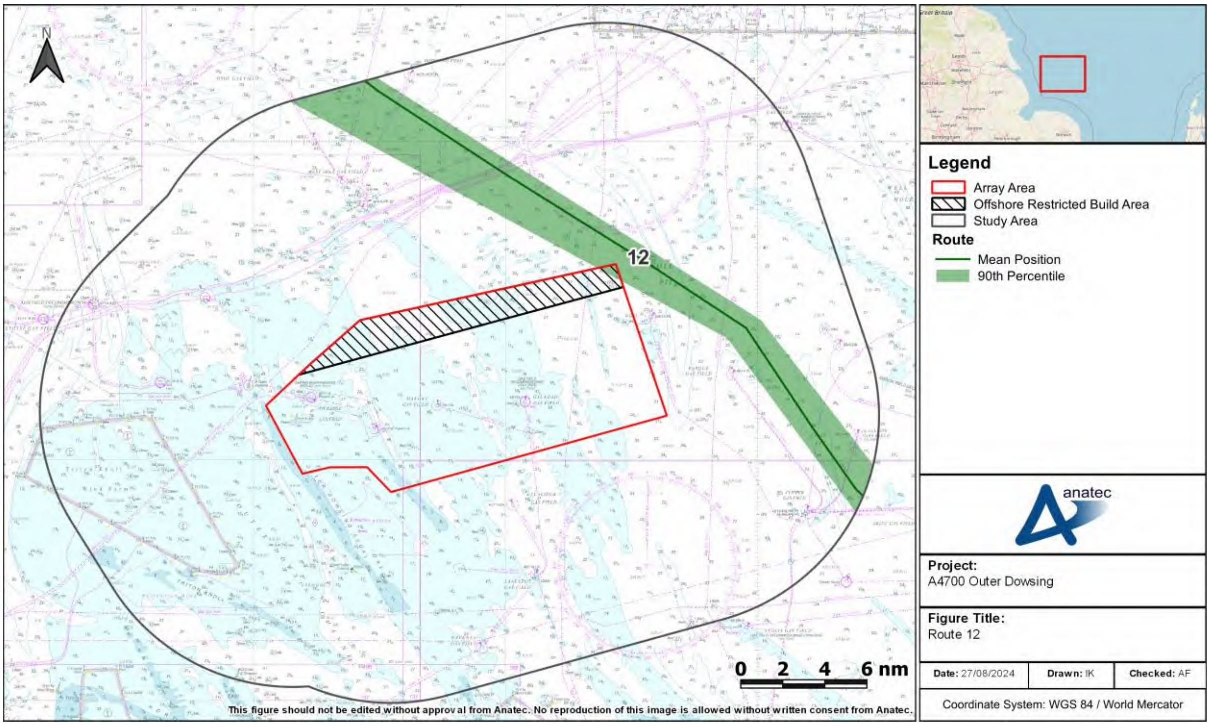


Figure F.3 Overview of Route 12

911. It is noted that one deviated route is unaffected by the changes to the northern boundary of the array area – Route 8, which is likely to pass through the Outer Dowsing Channel west of the array area. The two other routes still requiring a deviation in the post-windfarm with ORBA case are presented relative to the array area and the ORBA in Figure F.4, alongside the routes identified in the pre-windfarm and post-windfarm cases. Following this, a summary of the deviations is provided for these three routes in Table 3.1. As shown, deviations to these routes decrease as a result of the ORBA.

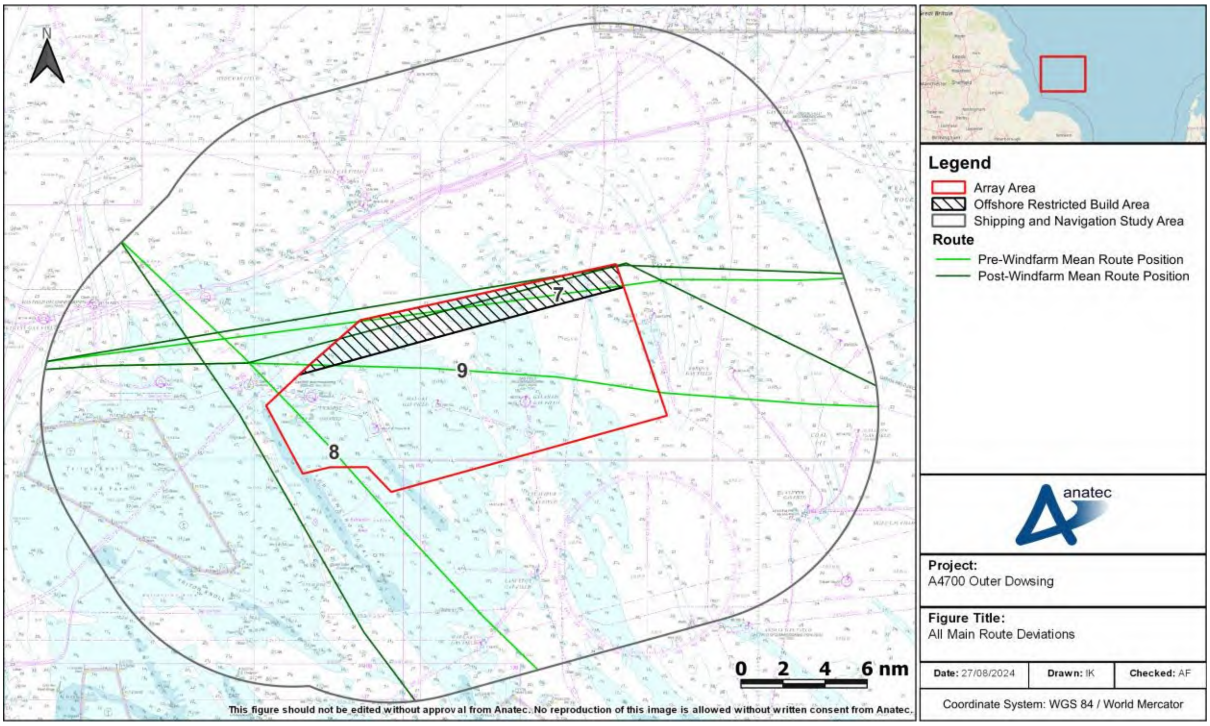


Figure F.4 All Main Route Deviations

Table F.1 Main Route Deviations Across Scenarios

Route	Description	Vessels per Day	Distance pre-Windfarm (nm)	Distance post-Windfarm (nm)	Distance post-Windfarm with ORBA (nm)	Change in post-Windfarm with ORBA routeing from post-Windfarm (nm)	Percentage Change
7	Humber ports - Cuxhaven	1	289.39	289.80	289.51	-0.29	-0.10%
	Cuxhaven – Humber ports		289.10	289.51	289.22		-0.10%
9	Humber ports – Bremerhaven / Hamburg	<1	288.62	291.22	290.69	-0.53	-0.18%
	Bremerhaven / Hamburg – Humber ports		288.25	290.86	290.33		-0.18%
12	Tees – Amsterdam	<1	251.48	251.71	251.48	-0.23	-0.09%
	Amsterdam - Tees		250.84	251.07	250.84		-0.09%

912. It is noted that, in addition to Route 12, Route 7 was also raised by DFDS during consultation as an adverse weather route. This route is used when sea conditions further north are such that the typically used Immingham to Cuxhaven route (Route 3) would require additional time in port to secure cargo i.e., there would be a commercial impact on DFDS if Route 7 could not be used. As shown, overall impact on this route has been reduced further via the ORBA, however some minor deviation may still be required.

F.3.2 Cumulative Routeing

913. It is noted that cumulative impacts to Route 3 of which DFDS is a key operator have been raised as a key concern, in particular the need for vessels on that route to pass north of the array area and then deviate south of Hornsea Three. The cumulative Route 3 deviation required in the array area is presented in Figure F.5, alongside the predicted DFDS Seaways route post Hornsea Three based on their consultation input (referred to as the 'Pre-Windfarm Route' in Figure F.5), and the deviated route presented during the ES stage. it is noted that the routes shown account for charted oil and gas platforms in the area (platforms within 2nm of the routes are included in Figure F.5).

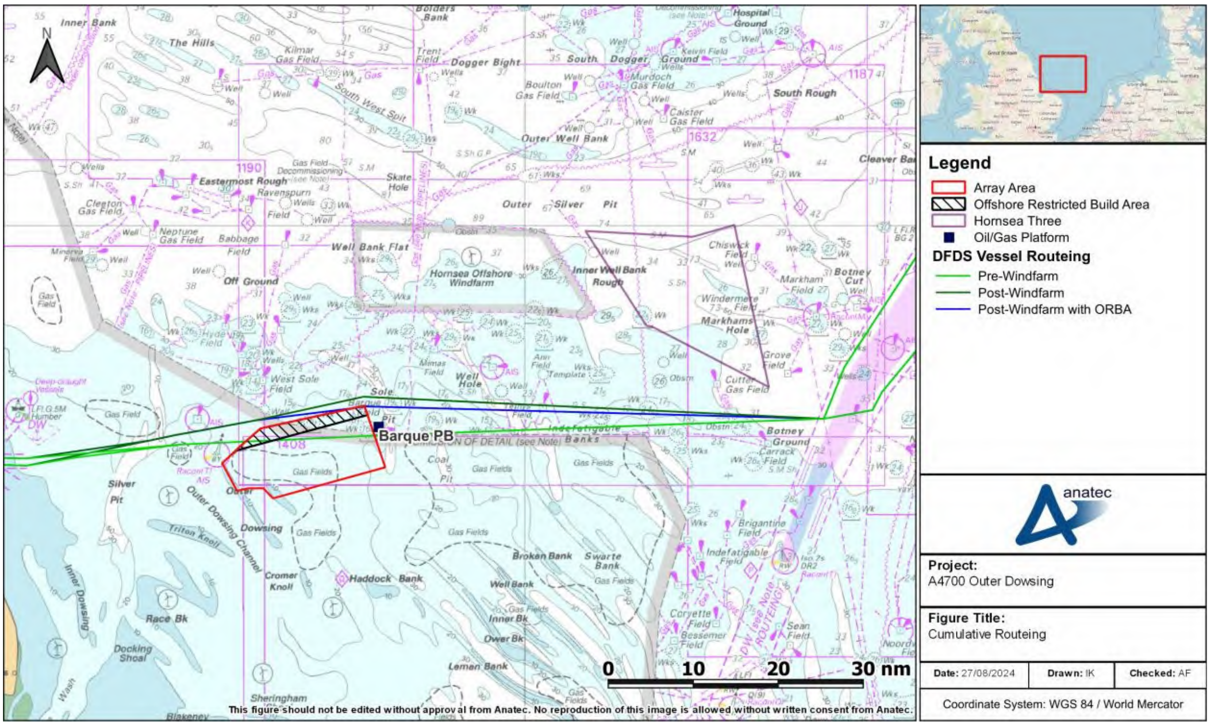


Figure F.5 Cumulative Routeing

914. The length of the route across the three scenarios is presented in Table F.2, alongside the resulting percentage increase compared to the pre-windfarm route (accounting for Hornsea Three).

Table F.2 Differences in Route 3 Cumulative Distance

Scenario	Length (nm)	Change from Pre-windfarm (with Hornsea Three)
Pre-windfarm (with Hornsea Three)	321.08	N/A
Post-windfarm route	322.59	0.5%
Post-windfarm with ORBA route	322.37	0.4%

F.4 Vessel to Vessel Collision Modelling

915. This section uses the updated main route deviations as presented in section F.3 to model vessel to vessel collision risk assuming the ORBA is implemented. This allows for approximate quantification of the change in collision risk resulting from the ORBA.

916. On a general basis, collision risk would be anticipated to reduce as a result of the ORBA given that searoom is increasing. This is illustrated in Figure F.6 which shows the distance between the array area and other local surface oil and gas and wind farm piercing infrastructure to the north against the corresponding distances with the ORBA in place.

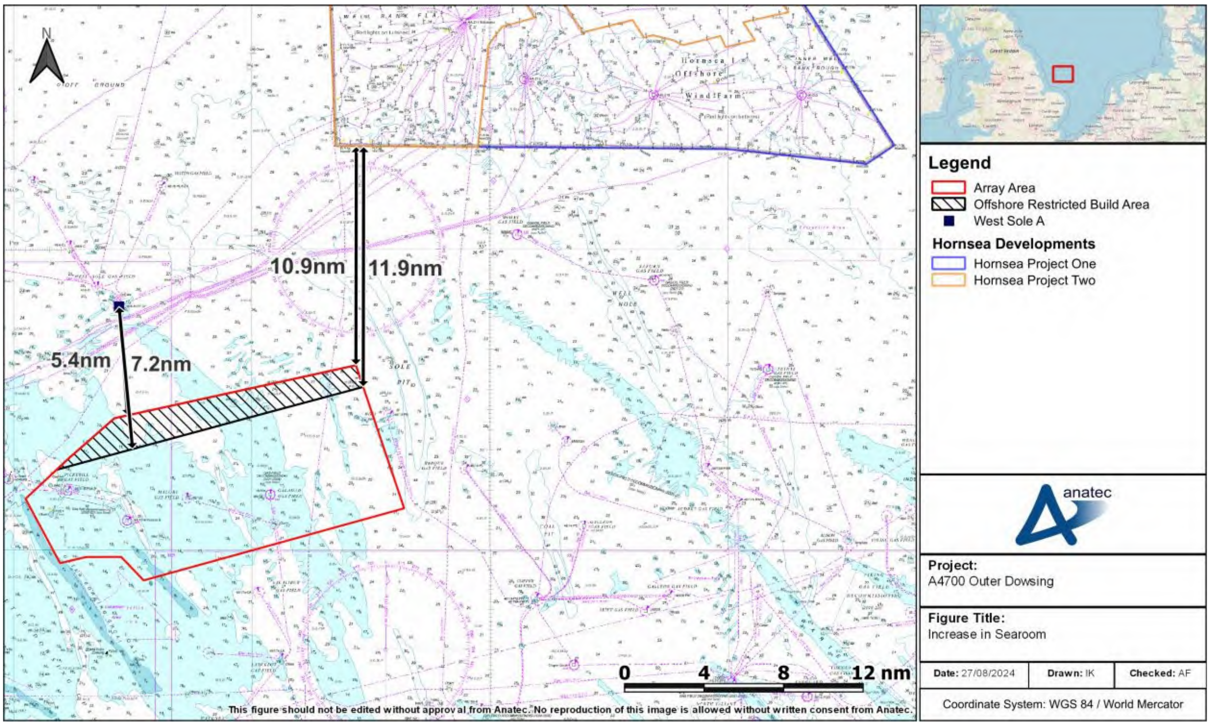


Figure F.6 Increase in Searoom

917. Using the updated post-windfarm routeing as input, Anatec's COLLRISK model has been run to estimate the anticipated vessel to vessel collision risk in proximity to the array area. It is noted that identical methodology was utilised for the NRA, allowing for direct comparisons to be carried out to both the pre-windfarm collision risk, as well as the post-windfarm collision risk at ES.

918. Based on the outputs of the post-windfarm with ORBA collision modelling, a heat map based upon the geographical distribution of collision risk within a 0.5×0.5nm grid is presented in Figure F.7.

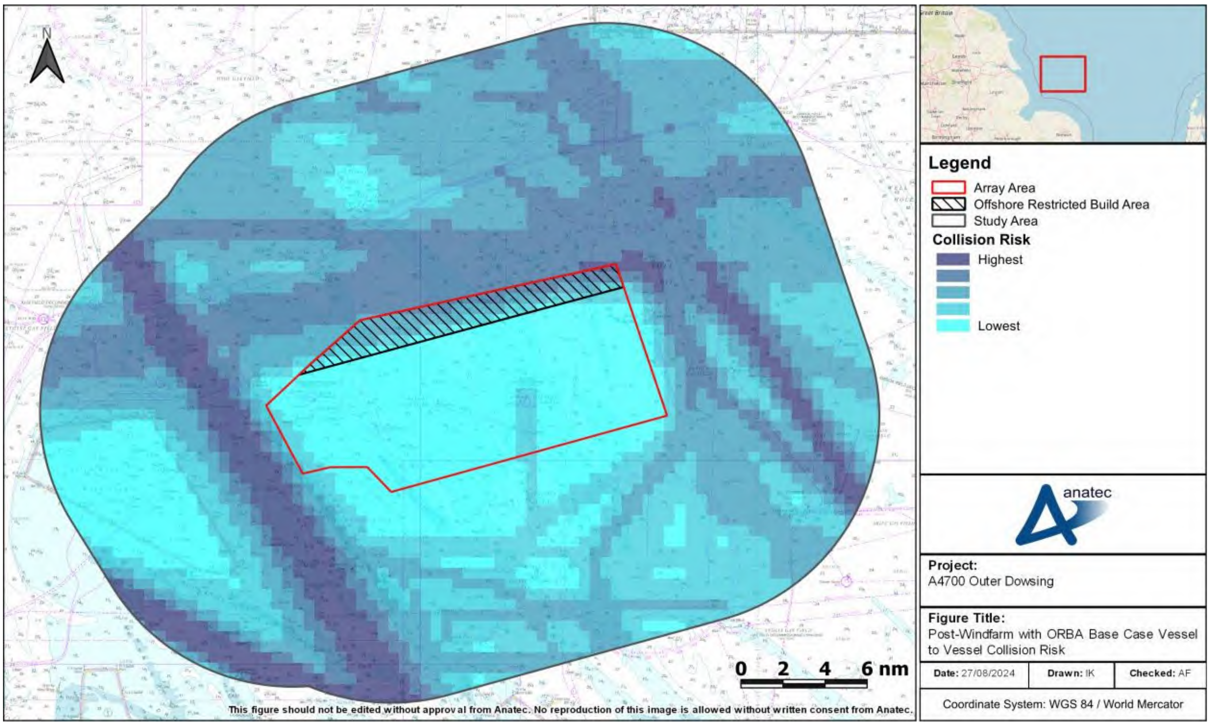


Figure F.7 Post-Windfarm with ORBA Base Case Vessel to Vessel Collision Risk

919. The annual collision frequency for the pre-windfarm, post-windfarm, and post-windfarm with ORBA base case scenarios within the study area is presented in Table F.3, alongside the percentage increase for the two post-windfarm scenarios compared to pre-windfarm.

Table F.3 Annual Collision Frequencies within the Study Area Across the Scenarios

Scenario	Collision Risk	Change from Pre-Windfarm
Pre-Windfarm	3.21×10^{-2} (one in 31.2 years)	N/A
Post-Windfarm	3.59×10^{-2} (one in 27.9 years)	11.7%
Post-Windfarm with ORBA	3.48×10^{-2} (one in 28.7 years)	8.5%

920. The above results consider the 10nm study area as a whole. It was estimated that collision risk is reduced by approximately 20% if only the section of the study area north of the ORBA[11] is considered.

F.5 Summary

921. As implementation of an ORBA will result in an additional 20.8nm^2 of searoom where no surface-piercing structures associated with the Project will be implemented,

[11] the section of the study area north of the ORBA, at an angle perpendicular to the ORBA northern boundary and bounded on the east and west by the ORBA.

meaning an effective reduction in spatial area impacted. This means vessel deviations will be reduced at the northern extent, with three of the four previously-affected main commercial routes anticipated to have lower deviations as a result of the ORBA.

25. Prior to the introduction of the ORBA, the post-windfarm collision risk was estimated as an increase of 11.7% compared to the pre-windfarm scenario. Due to the introduction of the ORBA this has since been reduced, with the post-windfarm with ORBA collision risk resulting in an increase of 8.5% compared to the pre-windfarm value. The risk of collisions occurring is therefore reduced as a result of the ORBA.

Annex G ANS Navigational Risk Assessment

1 Introduction

1. GT R4 Limited (trading as Outer Dowsing Offshore Wind (ODOW)) hereafter referred to as the 'Applicant', are seeking consent for up to two artificial nesting structures (ANS) within the North Sea as an ornithological compensation measure for the Outer Dowsing Offshore Wind Farm (OWF) ('the Project'). Two areas within which the ANS could be installed are under consideration - one located to the northwest of the Project array area (the 'NW ANS area'), with the other located to the southeast (the 'SE ANS area').

2. Anatec Limited ('Anatec') have been commissioned to carry out an independent, third-party review of the ANS with respect to shipping and navigation. The purpose of this technical note is to provide a review of shipping and navigation in the vicinity of the NW ANS and SE ANS areas. It is noted that the ANS were previously discussed within the NRA undertaken by Anatec covering the array area and ORCP of the Project (Chapter 15, Volume 3, Appendix 15.1: Navigational Risk Assessment) (APP-171). A section of the SE ANS area was identified as potentially being unacceptable from a shipping and navigation perspective for siting of ANS, and the Applicant therefore subsequently committed to not utilising that section. During consultation, key shipping and navigation stakeholders raised no concerns with the NRA provided at Appendix 15.1 (Chapter 15, Volume 3, Appendix 15.1: Navigational Risk Assessment) (APP-171), however this NRA aims to provide further detail on the usable areas remaining within the ANS areas.

3. A ten nautical mile (nm) buffer of each of the ANS areas (the 'NW ANS study area' and 'SE ANS study area') has been used for analysis of Automatic Identification System (AIS) vessel data and historical incident data.

1.1 Risk Assessment

4. This report uses baseline vessel traffic survey data (comprising AIS only), other desktop sources, and the in-house knowledge and experience of Anatec to risk assess the potential locations of the ANS from a shipping and navigation perspective. This risk assessment includes:

- Definition of the baseline;
- Collision and allision risk modelling;
- Identification of users and hazards; and
- A risk control log.

1.2 Guidance

5. Whilst there is no specific guidance relating to the navigational risk assessment of ANS, in line with Maritime and Coastguard Agency (MCA) requirements this risk assessment gives consideration to:

- **MCA Marine Guidance Note (MGN) 654 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Response (MCA, 2021).** General principles of undertaking an assessment of shipping and navigation users in proximity to a renewable energy installation.
- **Revised Guidelines for Formal Safety Assessment (FSA) for Use in the Rule-Making Process (International Maritime Organization (IMO), 2018).** Approved process for undertaking a risk assessment related to shipping and navigation.
- **International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Guideline G1162 The Marking of Offshore Man-Made Structures (IALA, 2021 (a)) and IALA Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA, 2021 (b)).** International lighting and marking requirement which are used and applied by Trinity House.
- **The Royal Yachting Association's (RYA) Position on Offshore Renewable Energy Developments: Paper 1 (of 4) – Wind Energy (RYA, 2019).** General principles of undertaking a risk assessment of recreational users in proximity to a renewable energy installation.

2 Methodology

6. This section gives an overview of the methodology used to undertake the risk assessment of shipping and navigation users within and in proximity to the ANS.

7. Where a shipping and navigation user is predicted to be exposed to a hazard, the overall significance of risk to the user needs to be determined. The following criteria are used to make this determination via the FSA.

- Baseline data and assessment (Section 5.4 and Section 7);
- Expert opinion;
- Level of stakeholder concern (Section 3);
- Time and/or distance of any deviation (if applicable); and
- Lessons learnt from existing offshore developments.

8. The NRA findings have been used to identify shipping and navigation users that may be impacted by the ANS.

9. It is noted that, with regards to commercial fishing vessels, the methodology and assessment has been applied to hazards considering commercial fishing vessels in transit.

2.1 Formal Safety Assessment Process

10. The IMO FSA process (IMO, 2018) as approved by the IMO in 2018 under Maritime Safety Committee (MSC) – Marine Environment Protection Committee (MEPC).2/circ. 12/Rev.2 will be applied to the risk assessment within this NRA.

11. The FSA process is a structured and systematic methodology based upon risk analysis and Cost Benefit Analysis (CBA) to reduce impacts to As Low as Reasonably Practicable (ALARP). There are five basic steps within this process as illustrated by Figure 2.1 and summarised in the following list:

- Step 1 – Identification of hazards (a list is produced of hazards prioritised by risk level specific to the problem under review);
- Step 2 – Risk assessment (investigation of the causes and initiating events and risks of the more important hazards identified in step 1);
- Step 3 – Risk control options (identification of measures to control and reduce the identified risks);
- Step 4 – CBA (identification and comparison of the benefits and costs associated with the risk control options identified in step 3); and
- Step 5 – Recommendations for decision-making (defining of recommendations based upon the outputs of steps 1 to 4).

Figure 2.1 Flow Chart of the FSA methodology

2.1.1 Hazard Workshop Methodology

12. Table 2.1 and Table 2.2 define the severity of consequence and the frequency of occurrence rankings that have been used to assess risks within Section 127.

Table 2.1 Severity of Consequence Ranking Definitions

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No perceptible impact	No perceptible impact	No perceptible impact	No perceptible impact
2	Minor	Slight injury(s)	Minor damage to property i.e., superficial damage	Tier 1 local assistance required	Minor reputational risks – limited to users
3	Moderate	Multiple minor or single serious injury	Damage not critical to operations	Tier 2 limited external assistance required	Local reputational risks
4	Serious	Multiple serious injuries or single fatality	Damage resulting in critical impact on operations	Tier 2 regional assistance required	National reputational risks
5	Major	More than one fatality	Total loss of property	Tier 3 national assistance required	International reputational risks

Table 2.2 Frequency of Occurrence Ranking Definitions

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably probable	1 per 1 to 10 years
5	Frequent	Yearly

13. The severity of consequence and frequency of occurrence are then used to define the significance of risk via a tolerability matrix approach as shown in Table 2.3. The significance of risk is defined as Broadly Acceptable (low risk), Tolerable (intermediate risk) or Unacceptable (high risk).

Table 2.3 Tolerable matrix and risk ranking

Severity of Consequence						
	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Frequency of Occurrence				

	Unacceptable (high risk)
	Tolerable (intermediate risk)
	Broadly Acceptable (low risk)

14. Once identified, the significance of risk will be assessed to ensure it is ALARP. Further risk control measures may be required to further mitigate a hazard in accordance with the ALARP principles. Unacceptable risks are not considered to be ALARP.

3 Consultation

Consultation undertaken as part of this assessment has been detailed within Table 3.1.

Table 3.1 Consultation Feedback

Consultee	Date	Key Points
MCA	13 September 2023	▪ The ANS were discussed in a post-Preliminary Environmental Information Report (PEIR) meeting with the MCA. ▪ 12 months of AIS data was considered as suitable by the MCA to assess impacts on shipping and navigation.
Trinity House	15 September 2023	▪ The ANS were discussed in a post-PEIR meeting with Trinity House. ▪ Trinity House agreed that 12 months of AIS data would be suitable for shipping and navigation assessment. ▪ Trinity House noted that they would likely seek to mark the ANS as isolated structures, with longer ranged lights than those used for the array area.
Various stakeholders (see Chapter 15, Volume 3, Appendix 15.1 [App-171] for full list)	23 November 2023	▪ The ANS were described to stakeholders within the second Hazard Workshop for the Project, noting that the areas presented were to be refined prior to the Development Consent Order (DCO) application. ▪ There were no concerns raised relating to the ANS structures.
MCA	15 August 2024	▪ The ANS were discussed during a Project update meeting with the MCA and UK Chamber of Shipping, with purpose, planned location, and design parameters of the structures described, as well as intent to create an NRA for the ANS. ▪ No specific concerns were raised by the MCA.
UK Chamber of Shipping		▪ During the meeting described above no specific concerns were noted by the UK Chamber of Shipping, as long as no structures are placed within the busy constrained routeing through the SE ANS area.
Trinity House	20 August 2024	▪ The ANS were discussed during a Project update meeting with Trinity House, with purpose, planned location, and design parameters of the structures described, as well as intent to create an NRA for the ANS. ▪ Trinity House noted that the location of the ANS structures should not be within areas of busy shipping lanes. ▪ Potential future oil and gas decommissioning works could lead to changes in nearby vessel traffic patterns. ▪ No specific concerns were raised by Trinity House.

Consultee	Date	Key Points
MCA, Trinity House and UK Chamber of Shipping	27 February 2025	▪ A summary of the baseline aspects of the ANS NRA was presented to the MCA, Trinity House and UK Chamber of Shipping. ▪ MCA noted the highest risk area was in the SW corner of the NW ANS area given its proximity to busy routeing to the west, and placement of an ANS this section would therefore require further discussion. Other than this MCA indicated they were broadly content. ▪ UK Chamber of Shipping noted that the future case should be considered i.e., whether routeing could change as a result of other developments. **See Section 7.3.4.**

4 Data Sources

15. The following section provides an overview of the data sources used. These include:

- AIS data (as per Section 4.1) covering a 12-month period over 2023.
- United Kingdom Hydrographic Office (UKHO) Admiralty Charts.
- The Crown Estate (2024). Aggregates Site Agreements (England, Wales & Northern Ireland).
- UKHO North Sea (West) Pilot NP54, 2021.
- Marine Accident Investigation Branch (MAIB) marine accidents database (2012 to 2022[1]).
- Royal National Lifeboat Institution (RNLI) incident data (2013 to 2022).

4.1 Study Areas

16. For the purposes of shipping and navigation assessment relating to the ANS structures, the study areas used are based upon a minimum 10nm buffer of each ANS area. The positions of the ANS areas are presented in Figure 4.1, along with each respective study area, in relation to the array area.

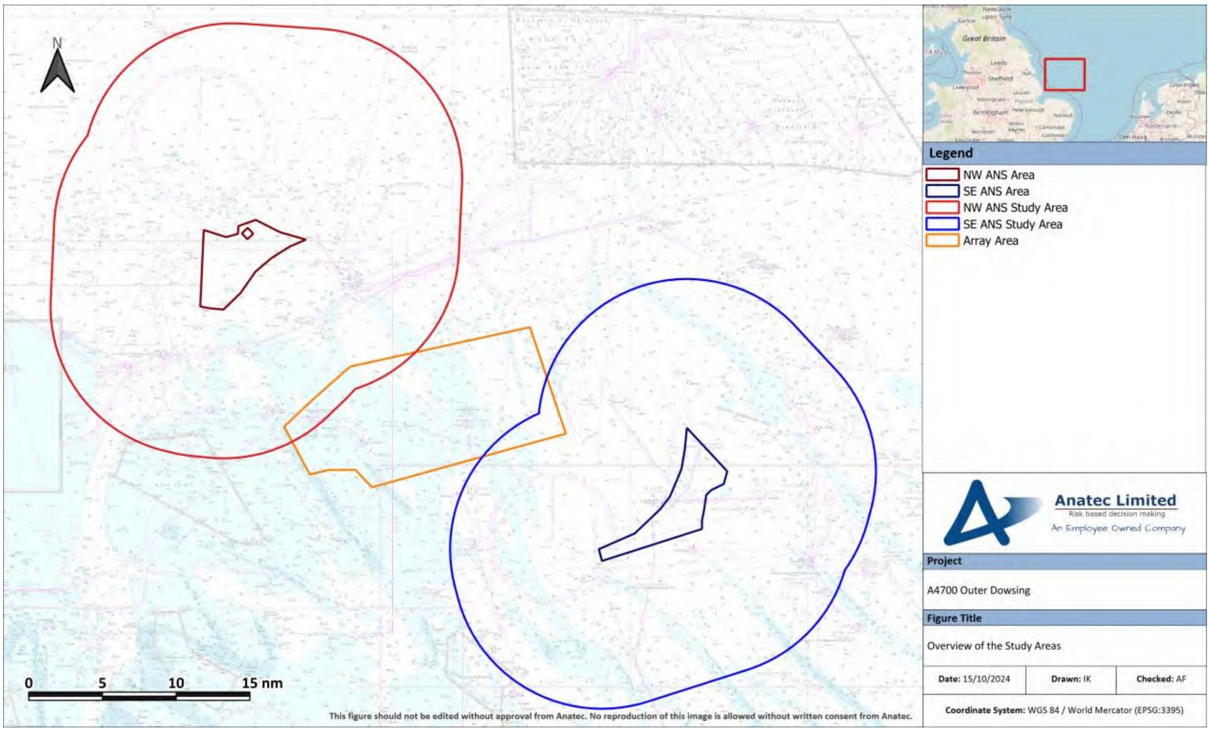


Figure 4.1 Overview of the Study Areas

[1] Period assessed matches that used for the full NRA (APP-171).

4.2 AIS Data Overview

17. For vessel traffic assessment within this report, 12 months of AIS data has been processed and analysed within the study areas, as has been considered sufficient by both the MCA and Trinity House (see Section 3). This data covers the period of 01 January 2023 to 31 December 2023.

18. The use of 12 months of AIS data assists in identifying any seasonal variations. It has been ensured that this survey period provides optimal available coverage relative to the ANS. Limitations with the AIS data are outlined in Section 4.3.

4.3 Data Limitations

19. Not all vessels are required to carry an AIS transceiver; AIS carriage is mandatory for all vessels of 300 Gross Tonnage (GT) and upwards on international voyages, cargo vessels of 500 GT and upwards not engaged on international voyages and all passenger vessels irrespective of size. In addition, fishing vessels with length of 15 metres (m) and greater must carry AIS. Smaller fishing vessels, recreational vessels and military vessels are not required to broadcast on AIS, but a proportion do so voluntarily.

20. Due to the AIS carriage requirements for smaller vessels, it is possible that activity from these vessels is underrepresented within the dataset presented. It is noted that the vessel traffic surveys carried out within the study area for the array area indicated that non-AIS vessel traffic in the area was relatively low, with less than 1% of the total traffic recorded captured from Radar.

5 ANS Parameters

5.1 ANS Areas

The key coordinates of the NW ANS area are presented in Figure 5.1, with the coordinates for the SE ANS area shown in Figure 5.2. A maximum of two ANS (total) will be constructed.

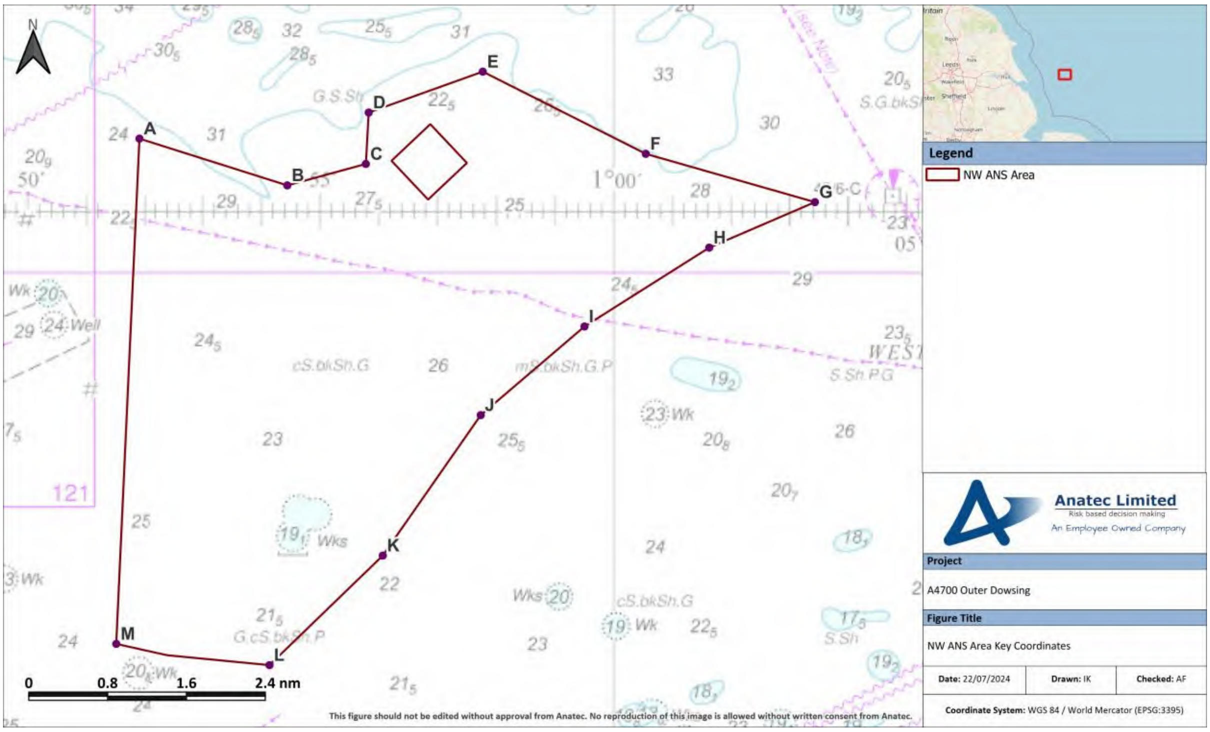


Figure 5.1 NW ANS Area Key Coordinates

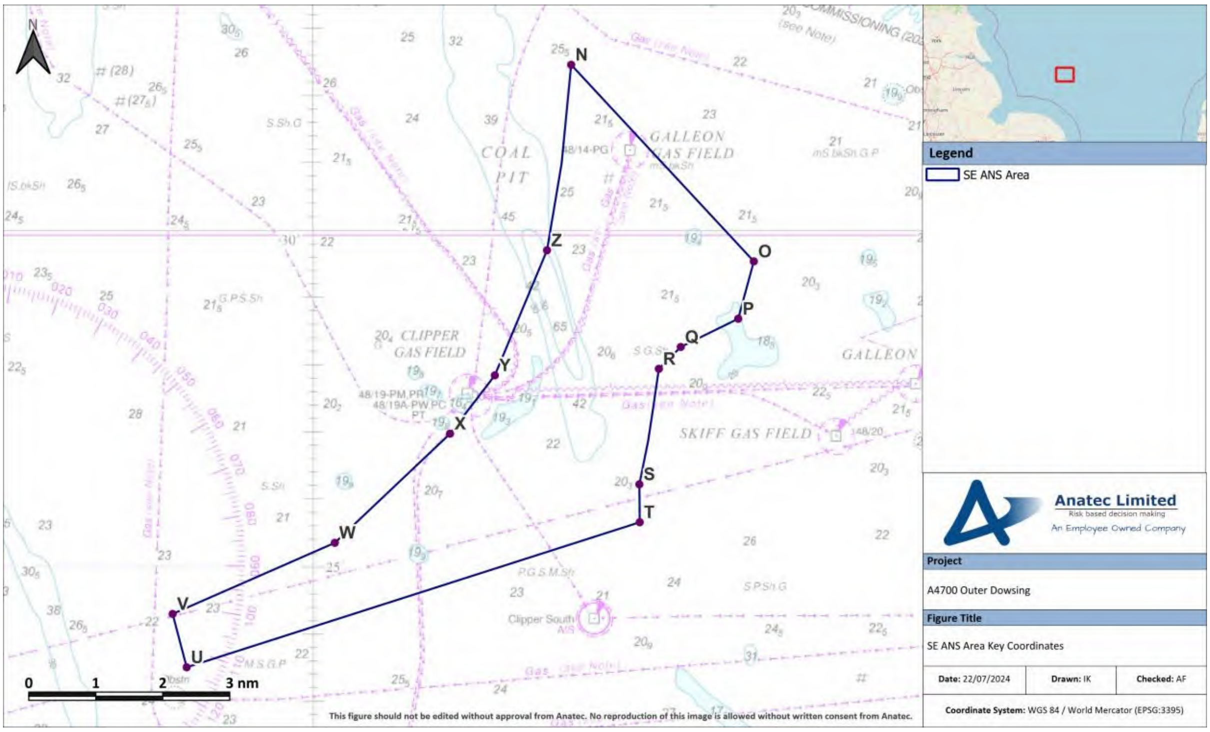


Figure 5.2 SE ANS Area Key Coordinates

21. The coordinates for both ANS areas are presented in Table 5.1.

Table 5.1 ANS Area Key Coordinates

NW ANS Area				SE ANS Area		
ID	Latitude	Longitude		ID	Latitude	Longitude
A	53° 45' 43.12" N	000° 51' 54.64" E		N	53° 32' 26.98" N	001° 46' 26.03" E
B	53° 45' 14.74" N	000° 54' 25.98" E		O	53° 29' 31.66" N	001° 50' 59.28" E
C	53° 45' 27.75" N	000° 55' 46.38" E		P	53° 28' 40.46" N	001° 50' 35.94" E
D	53° 45' 58.94" N	000° 55' 49.29" E		Q	53° 28' 15.25" N	001° 49' 10.02" E
E	53° 46' 23.76" N	000° 57' 46.04" E		R	53° 27' 55.71" N	001° 48' 37.21" E
F	53° 45' 33.89" N	001° 00' 32.91" E		S	53° 26' 12.58" N	001° 48' 08.06" E
G	53° 45' 04.59" N	001° 03' 26.06" E		T	53° 25' 38.65" N	001° 48' 08.59" E
H	53° 44' 36.96" N	001° 01' 37.84" E		U	53° 23' 28.97" N	001° 36' 50.88" E
I	53° 43' 49.11" N	000° 59' 30.16" E		V	53° 24' 16.72" N	001° 36' 29.87" E
J	53° 42' 55.28" N	000° 57' 43.98" E		W	53° 25' 20.28" N	001° 40' 32.49" E
K	53° 41' 29.96" N	000° 56' 03.72" E		X	53° 26' 57.79" N	001° 43' 24.85" E
L	53° 40' 23.37" N	000° 54' 07.75" E		Y	53° 27' 49.90" N	001° 44' 31.83" E
M	53° 40' 36.28" N	000° 51' 30.89" E		Z	53° 29' 41.53" N	001° 45' 49.90" E

5.2 ANS Parameters

22. The ANS structures will sit upon either monopile or jacket foundations. The topside, regardless of foundation type, will consist of a 23m x 23m square-based structure. The indicative topside height will be 60m above Lowest Astronomical Tide (LAT).

23. Examples of ANS designs, as per Chapter 3: Project Description, are presented in Figure 5.3.

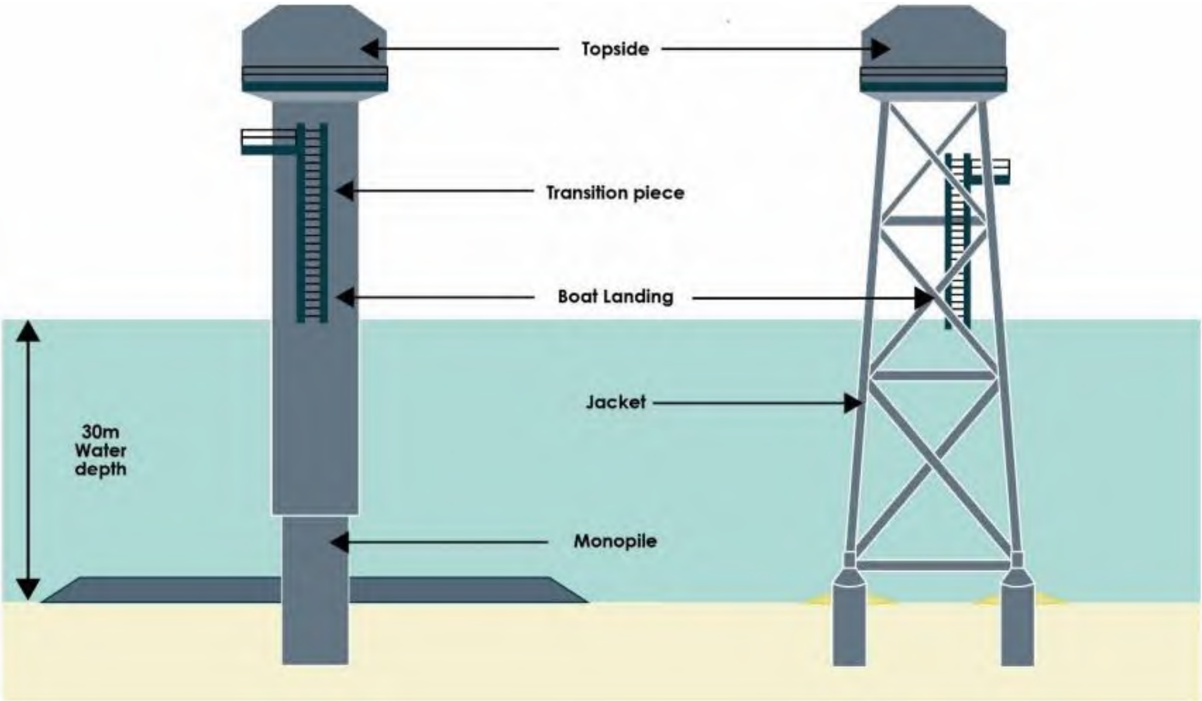


Figure 5.3 Examples of Potential ANS Designs

24. From consultation (see Section 3), it was established that the ANS should not be placed within areas of high-density routeing in the SE area, due to the limited available deviation options taking the sandbanks to the southeast into account. It was therefore committed that no structures will be constructed within a high-density section of the SE ANS area. Consultation from the MCA also indicated that due to heavy routeing to the west of the NW ANS area, agreement on placement of an ANS in the southwest corner of the NW ANS area may be difficult during the post consent process. A decision was therefore made to commit to note site an ANS in this area.

25. Although the ANS areas themselves are relatively large, only a maximum of two ANS structures will be constructed. For the purposes of this NRA, the worst-case locations for an ANS structure to be placed have been considered (based on traffic proximity) for use in collision/allision modelling and the resulting risk assessment. An overview of the worst-case locations is presented for the NW ANS area and SE ANS area in Figure 5.4 and Figure 5.5 respectively, with the areas in which no structures will be constructed also shown. It is noted that allision/collision modelling was undertaken

prior to the establishment of a restricted area in the NW ANS area – position B in Figure 5.4 has therefore been retained as a worst-case, noting this means any location chosen would be within the parameters already assessed.

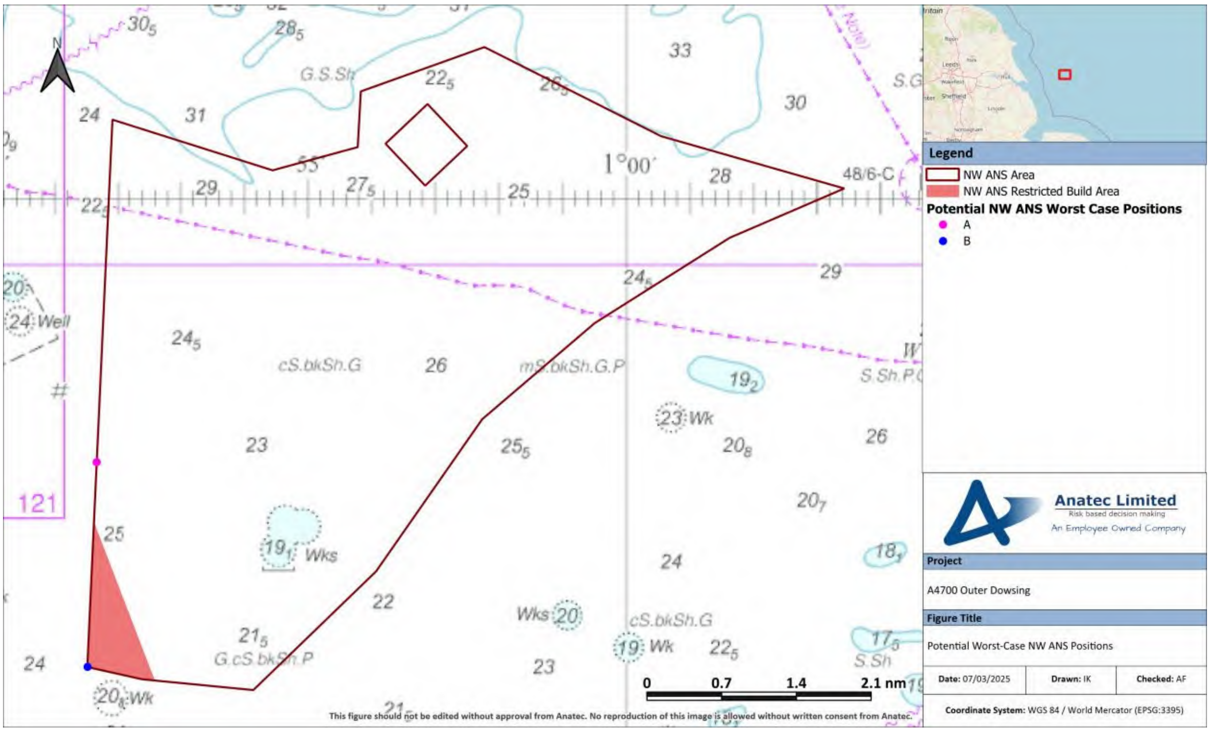


Figure 5.4 NW ANS Worst-case Positions

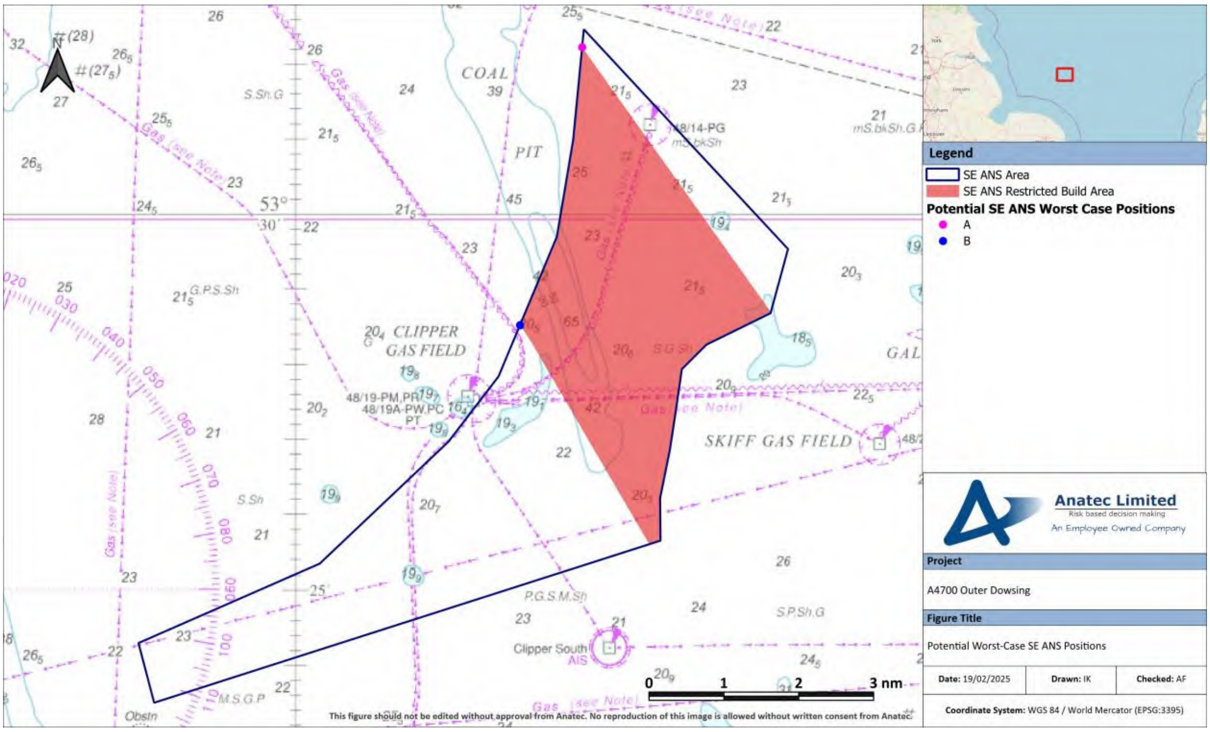


Figure 5.5 SE ANS Worst-case Positions

5.3 Construction Phase

26. As per the requirements of the ODOW DCO (REP3-006), the ANS must be in place for two full kittiwake breeding seasons before any WTGs become operational, then for the life of ODOW and for as long as the structure is colonised. Crew transfer vessels will take maintenance and monitoring crew to and from the ANS during the operational life. Further detail on construction vessel trips is included in Table 4.2

Table 5.2 Numbers and Types of Construction Vessels

Vessel Type	No. of Vessels	No. of Return Trips
ANS Foundation		
Installation vessel	2	8
Support vessel	12	32
Transport vessel	4	16
ANS Topside		
Installation vessel	2	8
Support vessel	12	16
Transport vessel	4	12

27. No helicopters are anticipated to be required during construction of the ANS structures.

5.4 Meteorological Data

5.4.1 Wind

28. The annual wind rose for the NW ANS area is presented in Figure 5.6. The wind data was collected 0.8nm east of the NW ANS area. It can be seen that the most likely wind direction is from the southwest.

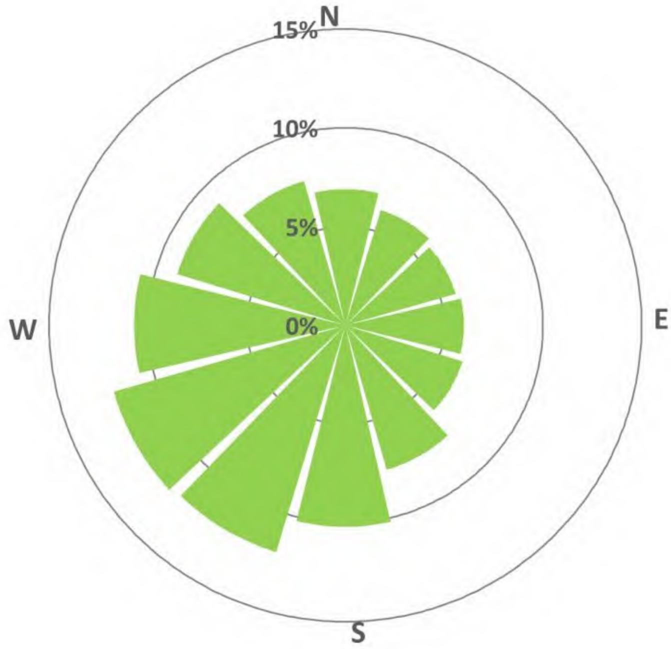


Figure 5.6 Wind Rose for the NW ANS

29. The annual wind rose for the SE ANS area is presented in Figure 5.7. The wind data was collected 3.8nm northeast of the SE ANS area. As with the wind data collected for the NW ANS, the most likely wind direction is from the southwest.

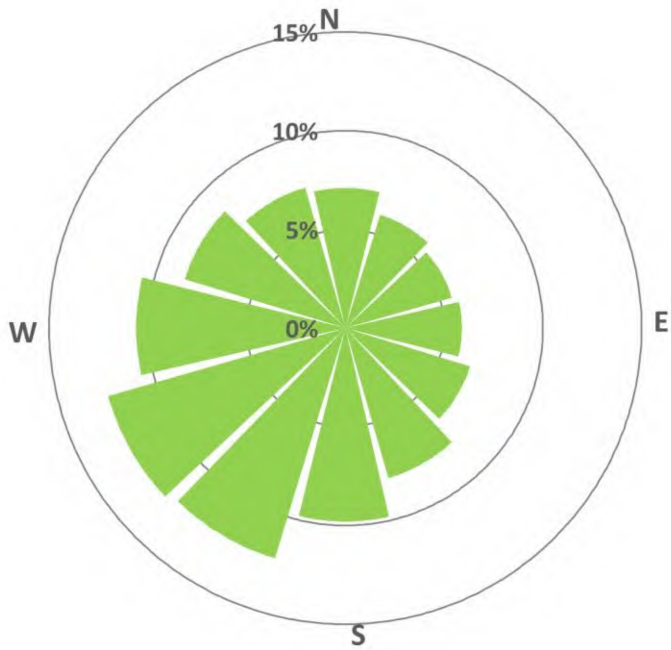


Figure 5.7 Wind Rose for the SE ANS

5.4.2 Wave

30. The proportion of the sea state within each of the three defined ranges for each ANS structure is presented in Table 5.3.

Table 5.3 Sea State Probability

Sea State	Proportion (%)	
	NW	SE
Calm (<1m)	36.6	37.1
Moderate (1–5m)	63.0	62.5
Severe (>5m)	0.4	0.4

5.4.3 Visibility

31. The annual average incidence of poor visibility (defined as less than 1 km) for the section of the North Sea within which the ANS areas are located has been taken from Admiralty Sailing Directions (NP54 North Sea (West) Pilot). On this basis the proportion of poor visibility (defined as the proportion of a year where the visibility can be expected to be less than 1km) for the NW ANS area is 5% for both areas.

5.4.4 Tide

32. Table 5.4 presents worst-case current data taken from UKHO Admiralty Charts 105, 107, 1187, and 1190. Each of these charts intersects with at least one of the closest tidal diamonds to the ANS study areas.

Table 5.4 Current Data

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (Knots (kt))	Direction (°)	Speed (kt)
105	A	331	1.7	142	1.6
	D	311	1.2	131	1.5
107	A	168	1.5	351	1.3
	C	159	2.3	342	1.9
	H	329	1.7	331	1.6
1187	A	134	1.4	137	1.4
	C	141	1.4	319	1.4
	F	136	2.0	307	1.7

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (Knots (kt))	Direction (°)	Speed (kt)
1190	E	168	1.9	345	1.8

6 Navigational Features and Historical Incident Data

6.1 Navigational Features

33. A plot of the navigational features in proximity to the ANS areas have been identified using the relevant UKHO Admiralty Sailing Directions (UKHO, 2021) and the UKHO Admiralty Charts (UKHO, 2023) as presented in Figure 6.1.

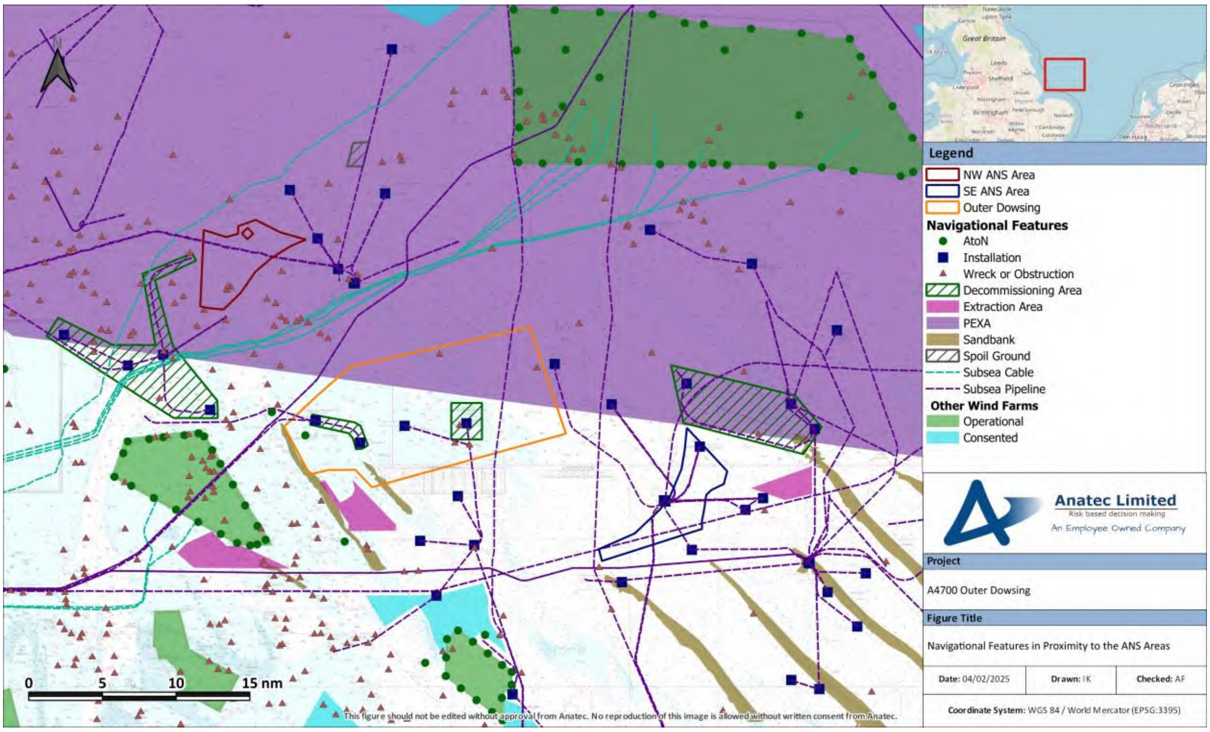


Figure 6.1 Navigational Features in Proximity to the ANS Areas

34. There are no key Aids to Navigation (AtoN) within close proximity to either ANS area, with AtoNs typically noted marking OWF boundaries. Gas fields within proximity of the ANS areas which are currently undergoing decommissioning include Amethyst, Audrey, Galahad, and Pickerill, with these areas charted. There are several OWFs in proximity to the ANS areas at varying stages of development, including the operational Triton Knoll and Dudgeon OWFs, and the planned extension to Dudgeon and Sheringham Shoal.

35. There are no wrecks or obstructions within the SE ANS area, with a charted cluster of wrecks present in southern portion of the NW ANS area.

36. Oil and gas associated installations are present within, and in proximity to, both ANS areas. Military Practice and Exercise Areas (PEXAs) are noted to the north, encompassing the NW ANS area where operations are undertaken using a clear range procedure (i.e., exercises and firing only take place when the area is considered to be clear of all shipping).

37. The sandbanks in the area are a key navigation feature, as the associated shallow water depths and overfalls define a proportion of the traffic routeing in the area. Of particular note are the sandbanks to the southeast of the SE ANS area. As noted within the vessel traffic analysis (see Section 7.2), these constrain routeing passing in a northwest-southeast direction through the SE ANS area (as captured within the pre ANS routeing in Section 7.3.2).

38. Subsea cables are typically seen connecting OWFs to the UK mainland, of which several are noted in proximity to the NW ANS area. A number of subsea pipelines are noted in the area connecting various oil and gas infrastructure, with several of these noted intersecting the ANS areas.

6.2 MAIB and RNLI Data

6.2.1 MAIB

39. The locations of accidents, injuries, and hazardous incidents reported to MAIB within the NW ANS study area between 2012 and 2022 are presented in Figure 6.2, colour-coded by incident type. Following this, Figure 6.3 shows the same data colour-coded by the type of vessels involved in each incident.

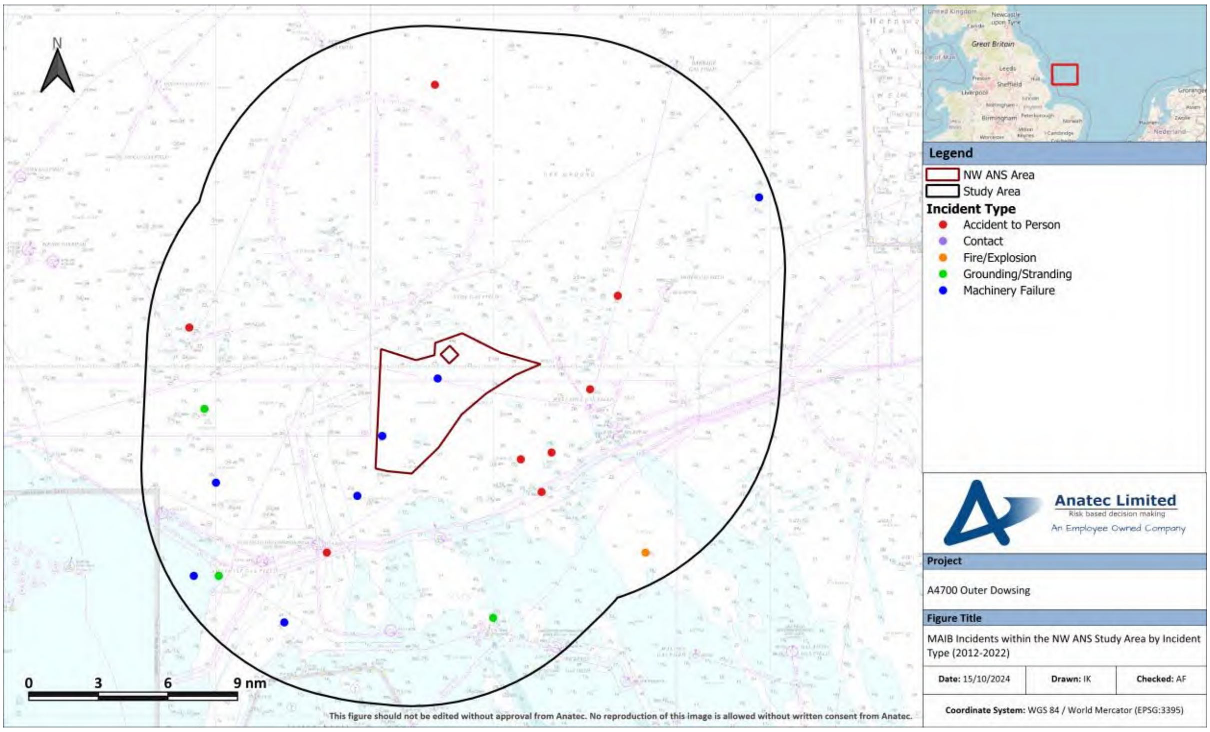


Figure 6.2 MAIB Incidents within the NW ANS Study Area by Incident Type (2012-2022)

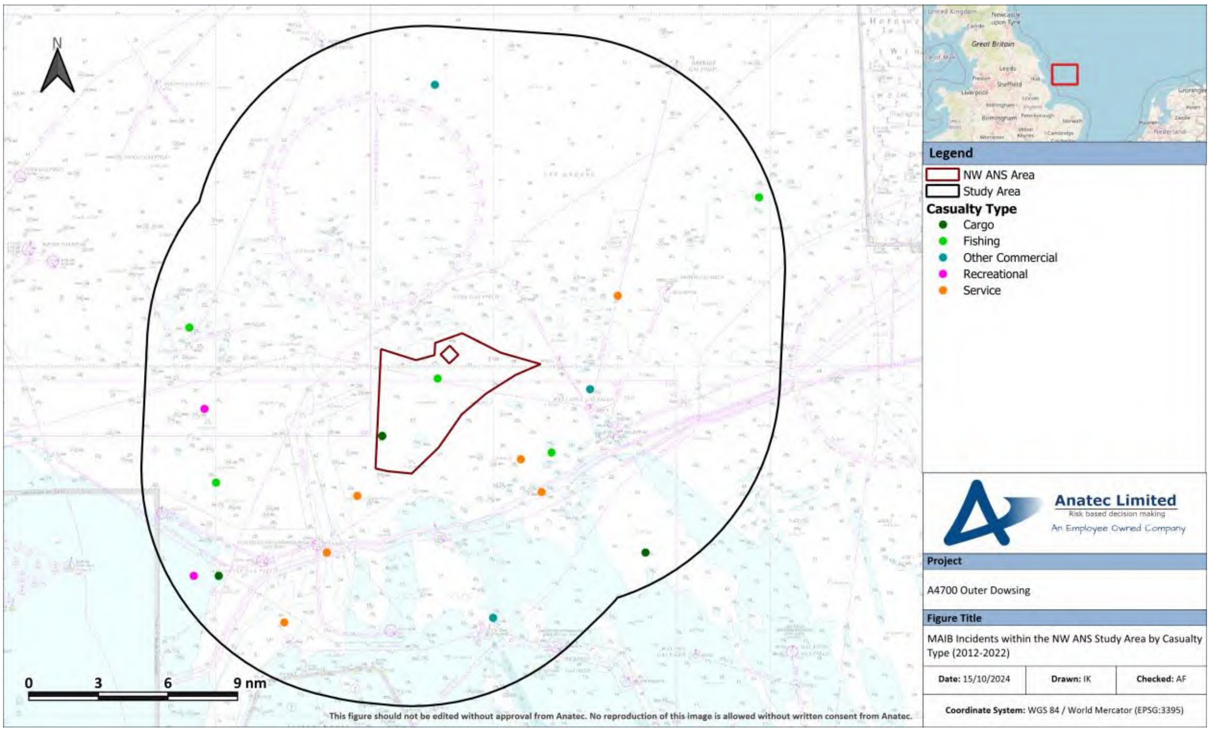


Figure 6.3 MAIB Incidents within the NW ANS Study Area by Casualty Type (2012-2022)

40. A total of 20 unique incidents were reported to the MAIB within the NW ANS study area between 2012 and 2022, which corresponds to an average of two incidents per year. Throughout the 11-year period, two incidents were reported within the NW ANS area itself.

41. The most common incident types recorded within the NW ANS study area were "accident to person" (37%) and "machinery failure" (37%), and the most frequently recorded vessel type involved in these incidents were service (32%), cargo (21%), and fishing vessels (21%).

42. The locations of accidents, injuries, and hazardous incidents reported to MAIB within the SE ANS study area between 2012 and 2022 are presented in Figure 6.4, colour-coded by incident type. Following this, Figure 6.5 shows the same data colour-coded by the type of vessels involved in each incident.

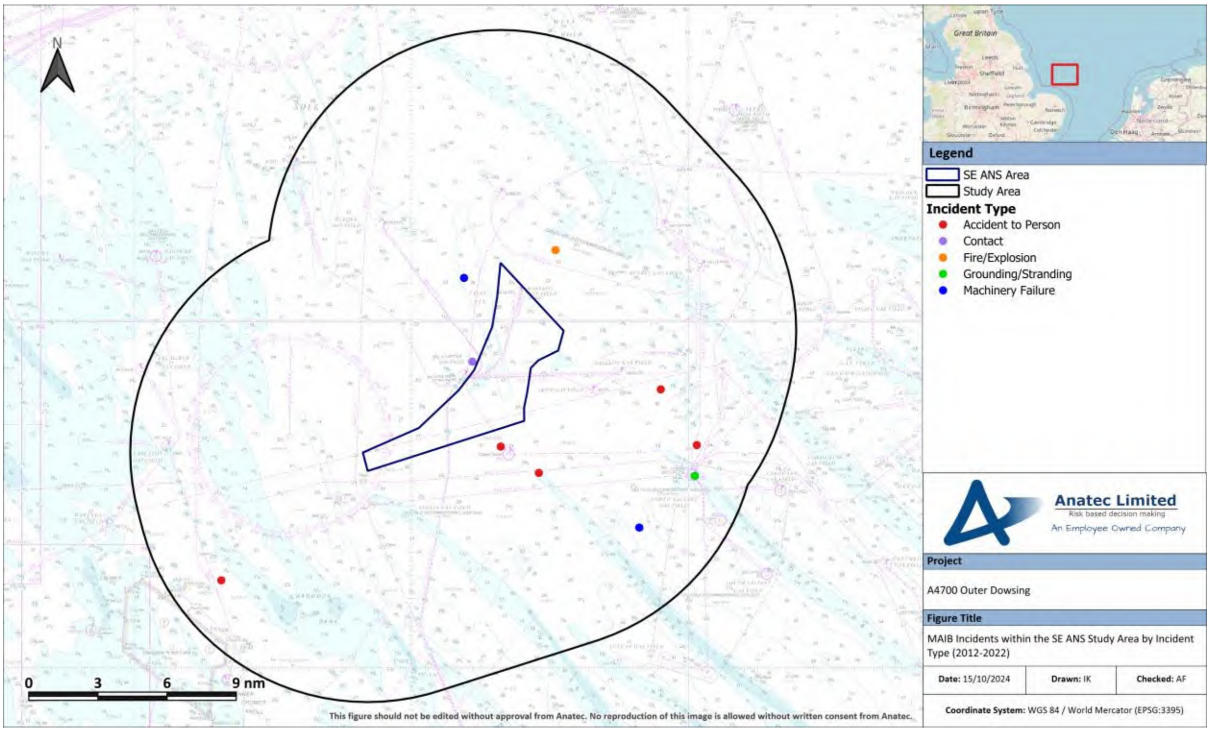


Figure 6.4 MAIB Incidents within the SE ANS Study Area by Incident Type (2012-2022)

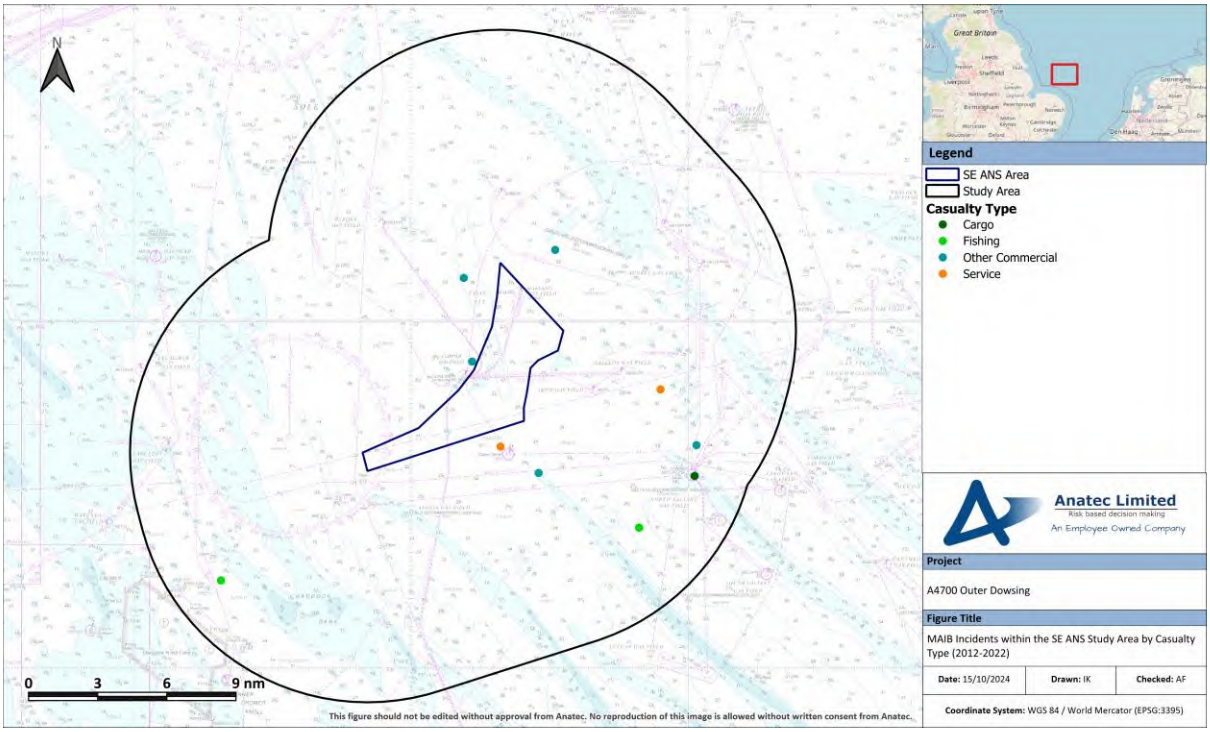


Figure 6.5 MAIB Incidents within the SE ANS Study Area by Casualty Type (2012-2022)

43. A total of ten unique incidents were reported to the MAIB within the SE ANS study area between 2012 and 2022, which corresponds to an average of one incident per

year. Throughout the 11-year period, no incidents were reported within the SE ANS area itself.

44. The most common incident types recorded within the SE ANS study area were "accident to person" (44%) and "machinery failure" (22%), and the most frequently recorded vessel type involved in these incidents were other commercial (56%) and fishing vessels (22%).

6.2.2 RNLI

45. RNLI incidents recorded within the NW ANS study area between 2013 and 2022 are presented in Figure 6.6 colour-coded by incident type. Following this, the same data is presented colour-coded by casualty type in Figure 6.7.

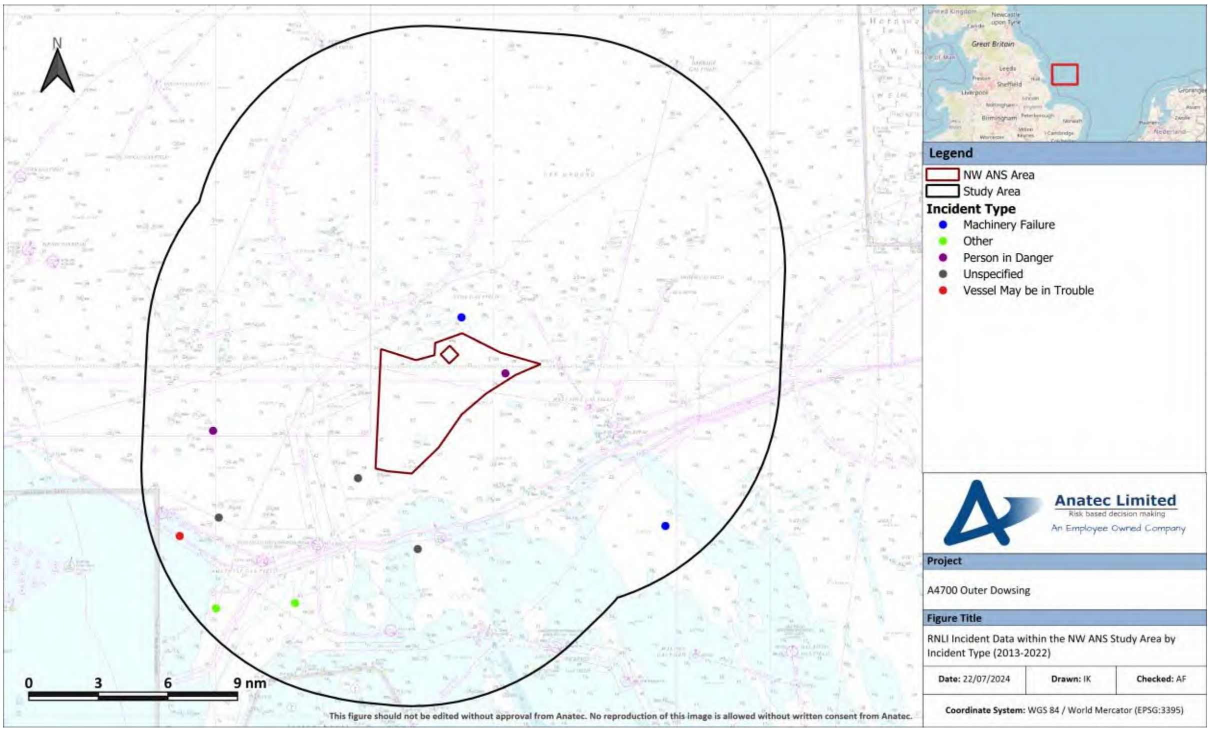


Figure 6.6 RNLI Incidents within the NW ANS Study Area by Incident Type (2013-2022)

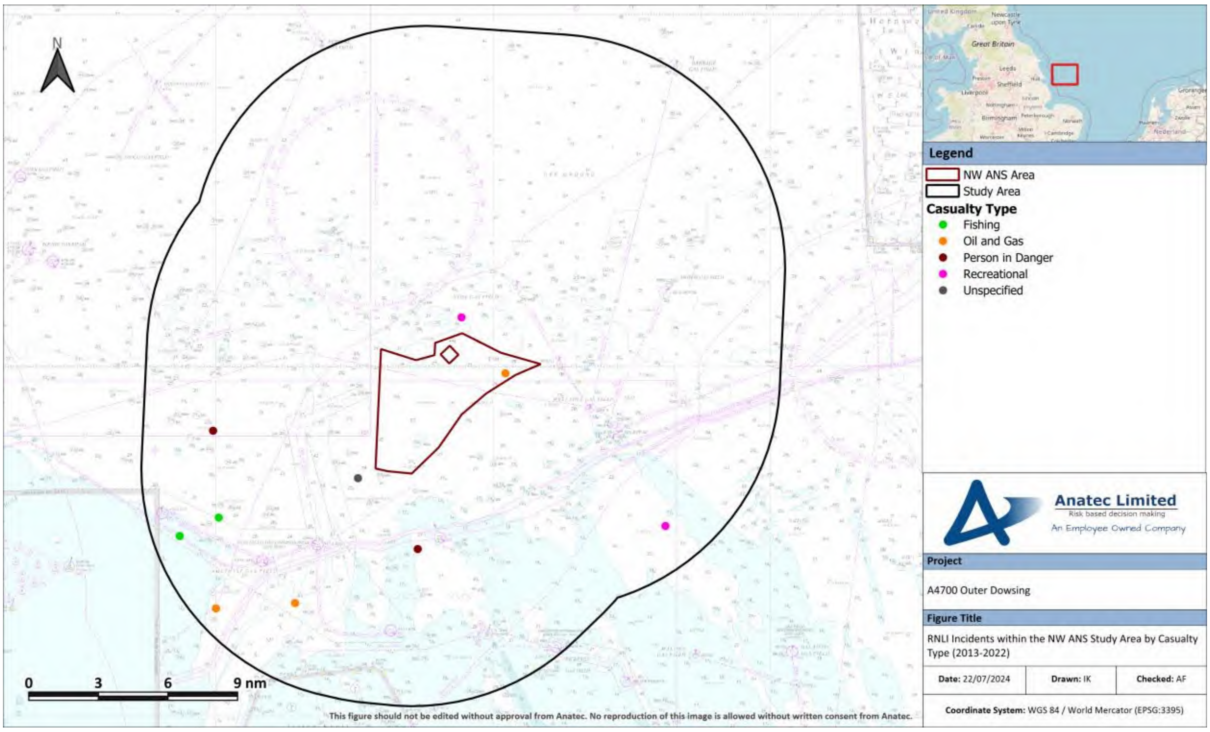


Figure 6.7 RNLI Incidents within the NW ANS Study Area by Casualty Type (2013-2022)

46. A total of 10 unique incidents were responded to by the RNLI within the NW ANS study area between 2013 and 2022, corresponding to an average of one incident per year. Over the 10-year period, one incident occurred within the NW ANS area itself.

47. Of all the unique incidents recorded within the NW ANS study area, the most frequently recorded incident types were "machinery failure", "other", and "person in danger" (29% each) with 30% of incidents being unspecified. The most common casualty type was oil and gas vessels (33%).

48. All RNLI base stations recorded for lifeboat launches for incidents in the NW ANS study area were from the Humber station.

49. RNLI incidents recorded within the SE ANS study area between 2013 and 2022 are presented in Figure 6.8 colour-coded by incident type. Following this, the same data is presented colour-coded by casualty type in Figure 6.9.

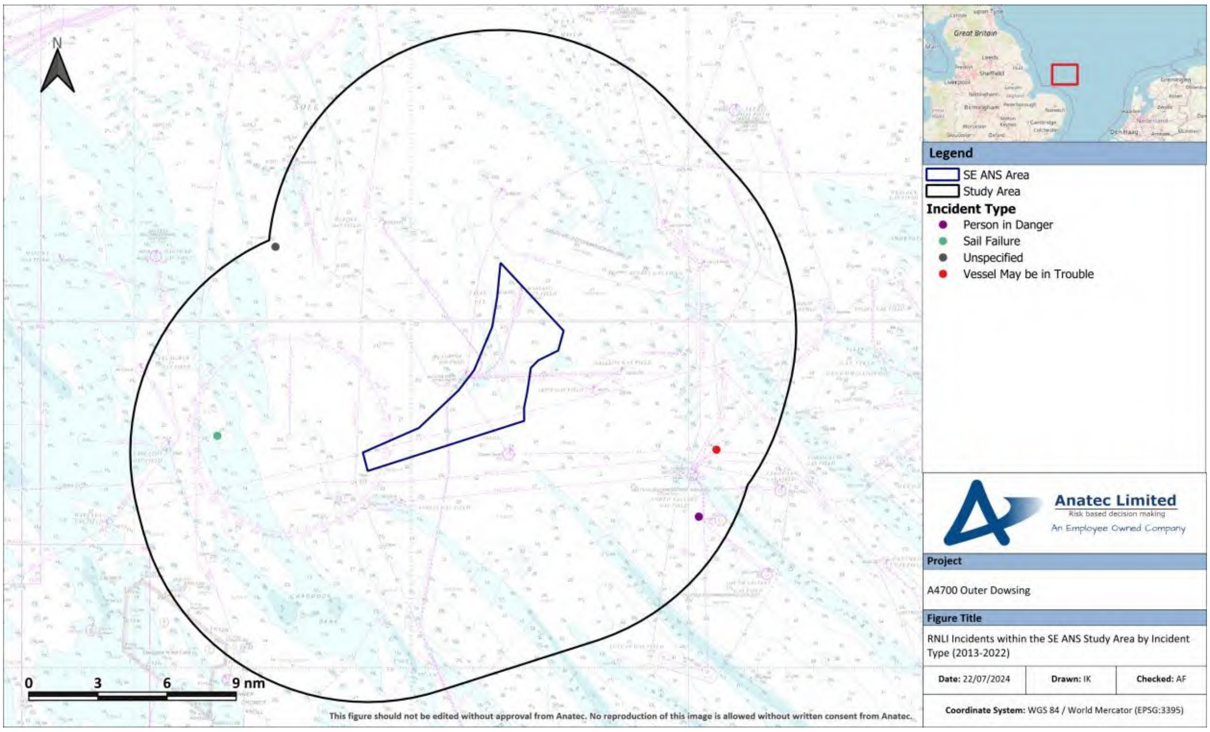


Figure 6.8 RNLI Incidents within the SE ANS Study Area by Incident Type (2013-2022)

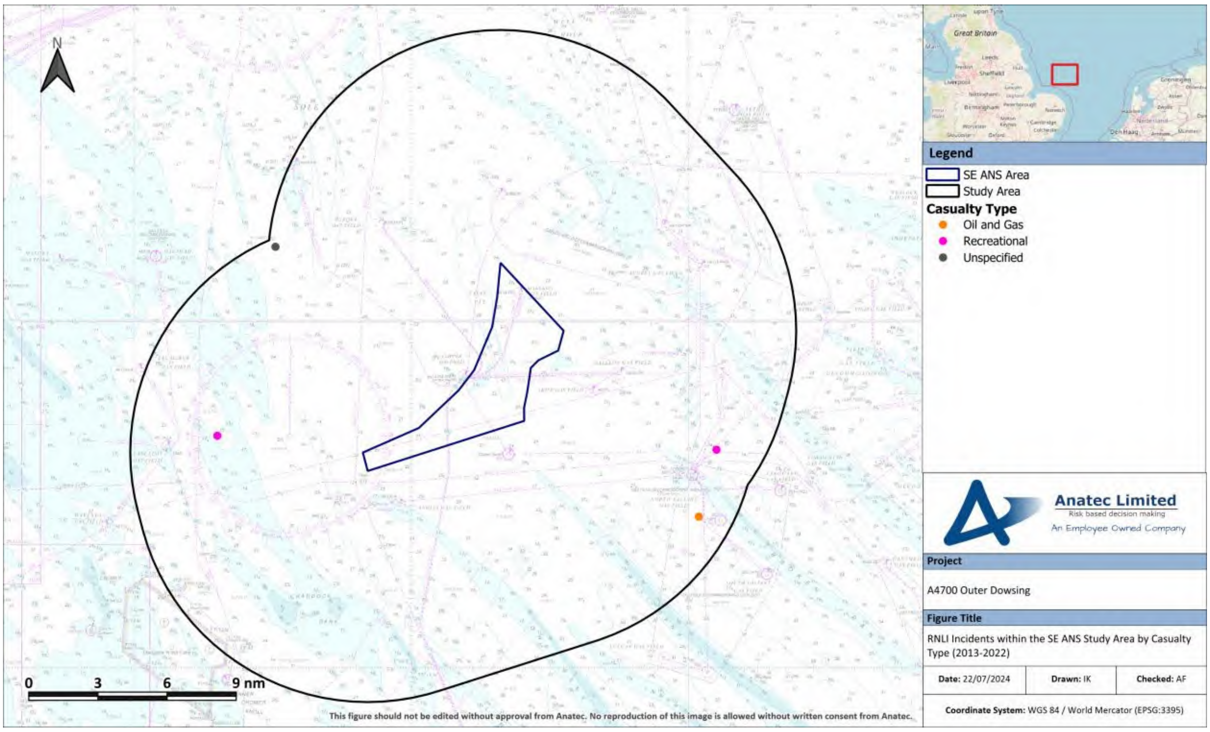


Figure 6.9 RNLI Incidents within the SE ANS Study Area by Casualty Type (2013-2022)

50. A total of four unique incidents were responded to by the RNLI within the SE ANS study area between 2013 and 2022, corresponding to an average of one incident every two

to three years. Throughout the 10-year period, no incidents occurred within the SE ANS area itself.

51. From the unique incidents recorded within the SE ANS study area, there was one recorded instance each of “person in danger”, “sail failure”, and “vessel may be in trouble”, with one other incident unspecified. Two of the casualty types were recreational vessels, with one other casualty type being an oil and gas vessel, and the other unspecified.

52. All RNLI base stations recorded for lifeboat launches for incidents in the SE ANS study area were from either Cromer (75%) or Great Yarmouth (25%).

7 Vessel Traffic Analysis

7.1 NW ANS Area

53. The vessel tracks recorded during 2023 within the NW ANS study area are colour-coded by vessel type and presented in Figure 7.1. Following this, Figure 7.2 presents the same data converted to a density heat map.

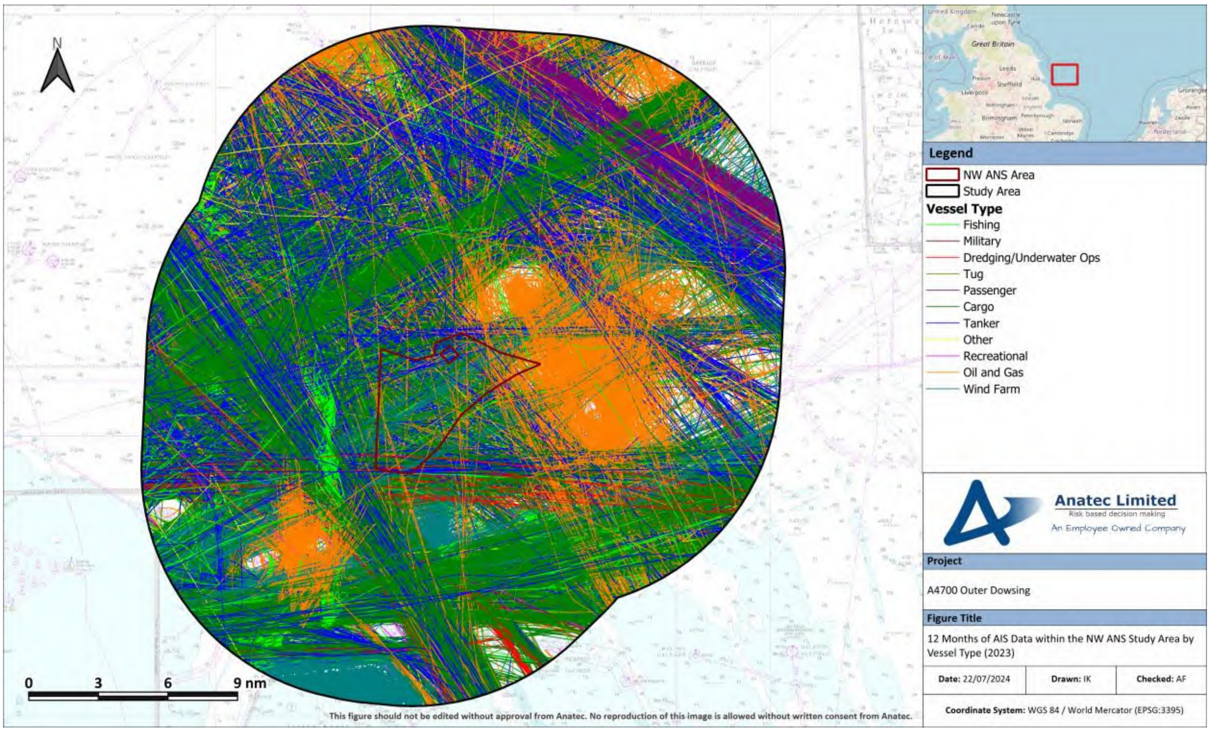


Figure 7.1 12 Months of AIS Data within the NW ANS Study Area by Vessel Type (2023)

54. Regular Roll-on/Roll-off cargo (RoRo) vessel routeing was noted between Immingham and Esbjerg to the north of the NW ANS area; between Teesport and Zeebrugge to the west; and between Immingham and Cuxhaven to the south. Oil and gas traffic associated with the West Sole field is prevalent directly to the east of the NW ANS area, with traffic related to Amethyst field to the southwest. DFDS Seaways-operated Roll-on/Roll-off passenger (RoPax) vessel traffic routeing between Newcastle and Ijmuiden is noted to the northeast of the NW ANS area, with alternate transits for this route also recorded to the southwest.

55. Dredging activity was noted as likely entirely involving vessel transits, with vessels likely to be fishing actively to the west and southwest. Wind farm vessels associated with Triton Knoll were also prevalent to the southwest.

56. Speed and vessel behaviour analysis was carried out on fishing vessels to indicate levels of potential fishing activity, with vessel tracks of fishing vessels transiting under 6kt investigated. From this, fishing vessels that were likely actively fishing, as opposed to undergoing transit, were identified to the southwest of the NW ANS area.

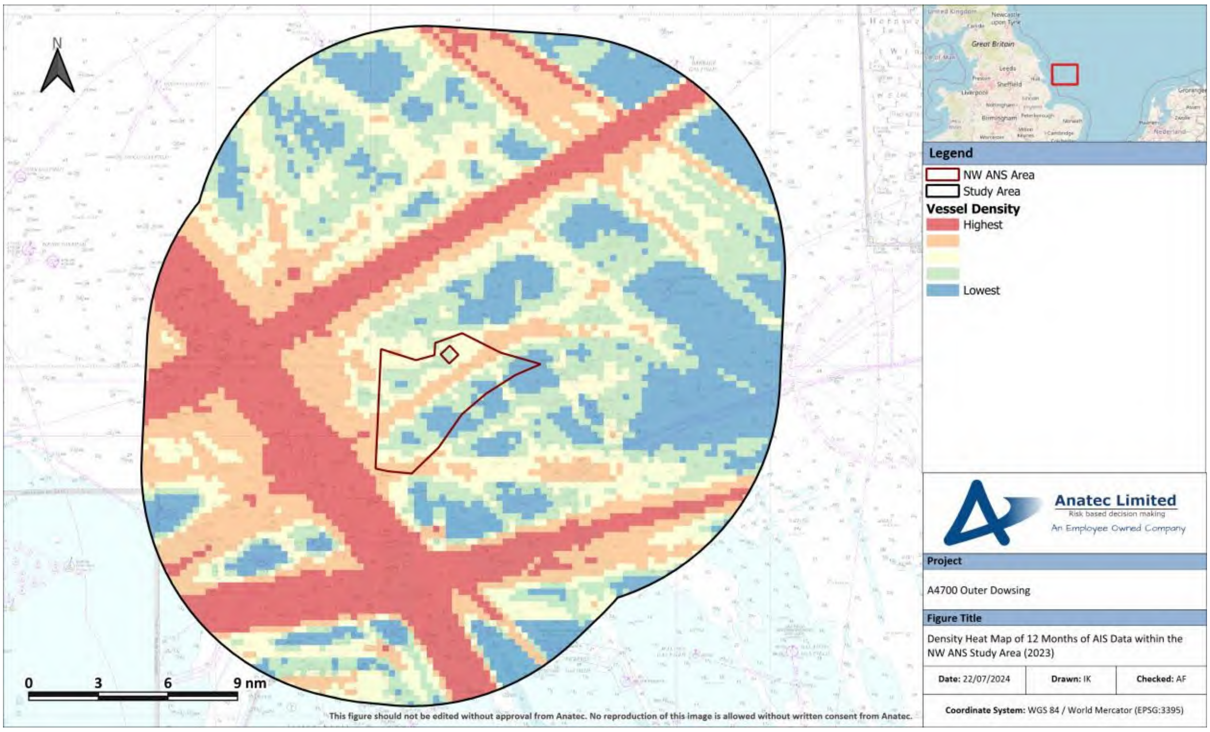


Figure 7.2 Density Heat Map of 12 Months of AIS Data within the NW ANS Study Area (2023)

7.1.1 Vessel Count

57. The daily number of unique vessels recorded within the NW study area, as well as intersecting the NW area, during 2023 are presented in Figure 7.3. Within the NW ANS study area approximately 11% of vessel traffic recorded intersected the NW ANS area.

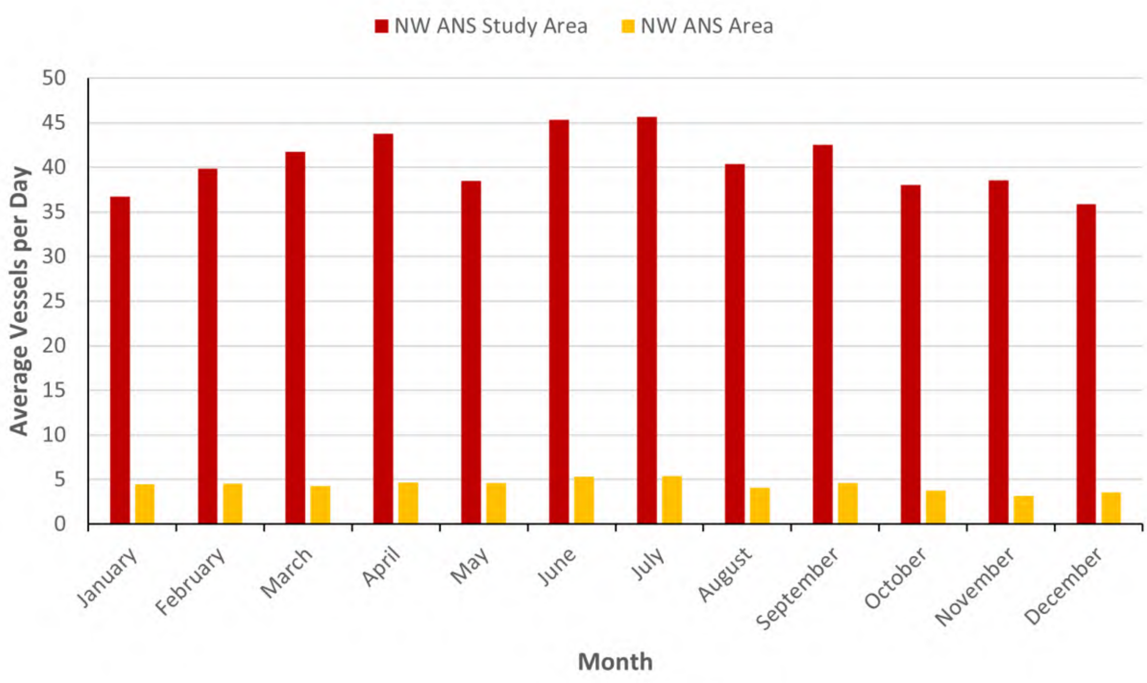


Figure 7.3 Distribution of Average Vessel Counts per Month (NW ANS Area)

58. For the 12 months of AIS data analysed within the NW ANS study area, there was an average of 41 unique vessels recorded per day. An average of four to five unique vessels per day intersected the NW ANS area itself, which indicates the busiest routes are not intersecting the NW ANS area.

59. The busiest month recorded within the NW ANS study area during 2023 was July, with an average of 46 unique vessels recorded per day. The busiest month recorded within the NW ANS area itself during 2023 was also July, with an average of five to six unique vessels recorded per day.

60. The quietest month recorded within the NW ANS study area during 2023 was January, with an average of 37 unique vessels recorded per day. The quietest month recorded within the NW ANS area itself during 2023 was November, with an average of three unique vessels recorded per day.

7.1.2 Vessel Type

61. The distribution of vessel types recorded within the NW study area, as well as intersecting the NW areas, during 2023 are presented in Figure 7.4.

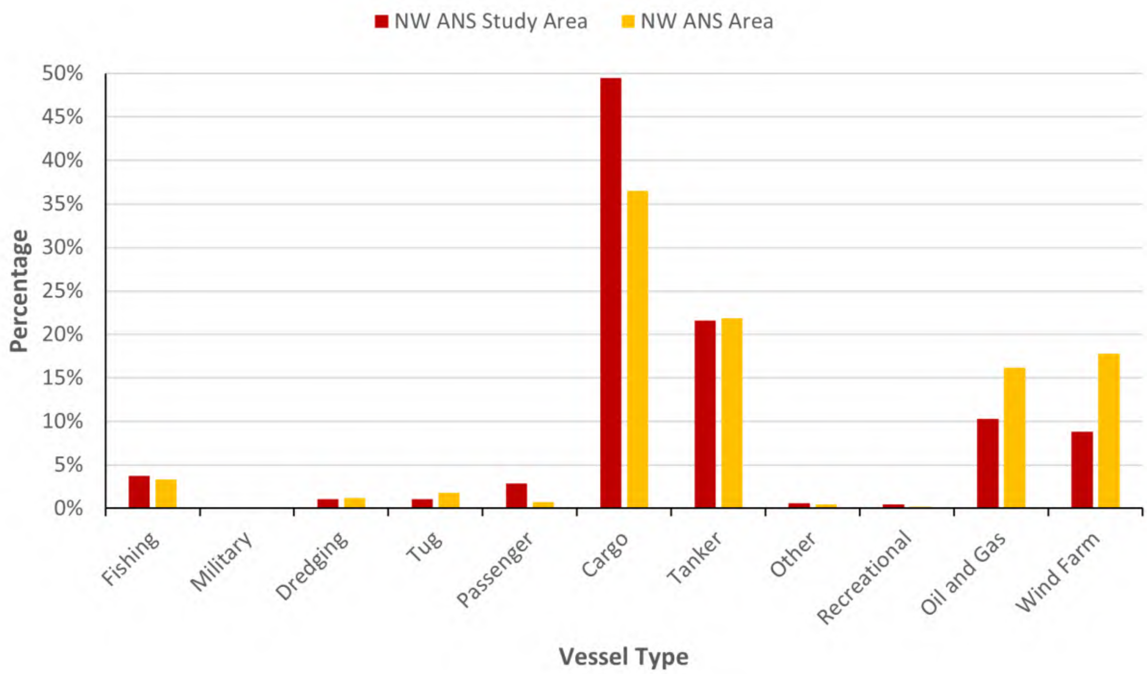


Figure 7.4 Distribution of Vessel Types (NW ANS Area)

62. Throughout 2023, the main vessel types within the NW ANS study area were cargo vessels (49%), tankers (22%), and oil and gas vessels (10%). The main vessel types within the NW ANS area itself were cargo vessels (36%), tankers (22%), and wind farm vessels (18%).

7.1.2.1 RYA Recreational Vessel Intensity

7.1.3 Vessel Size

7.1.3.1 Vessel Length

63. The vessel tracks recorded during 2023 within the NW ANS study area are colour-coded by vessel length and presented in Figure 7.5.

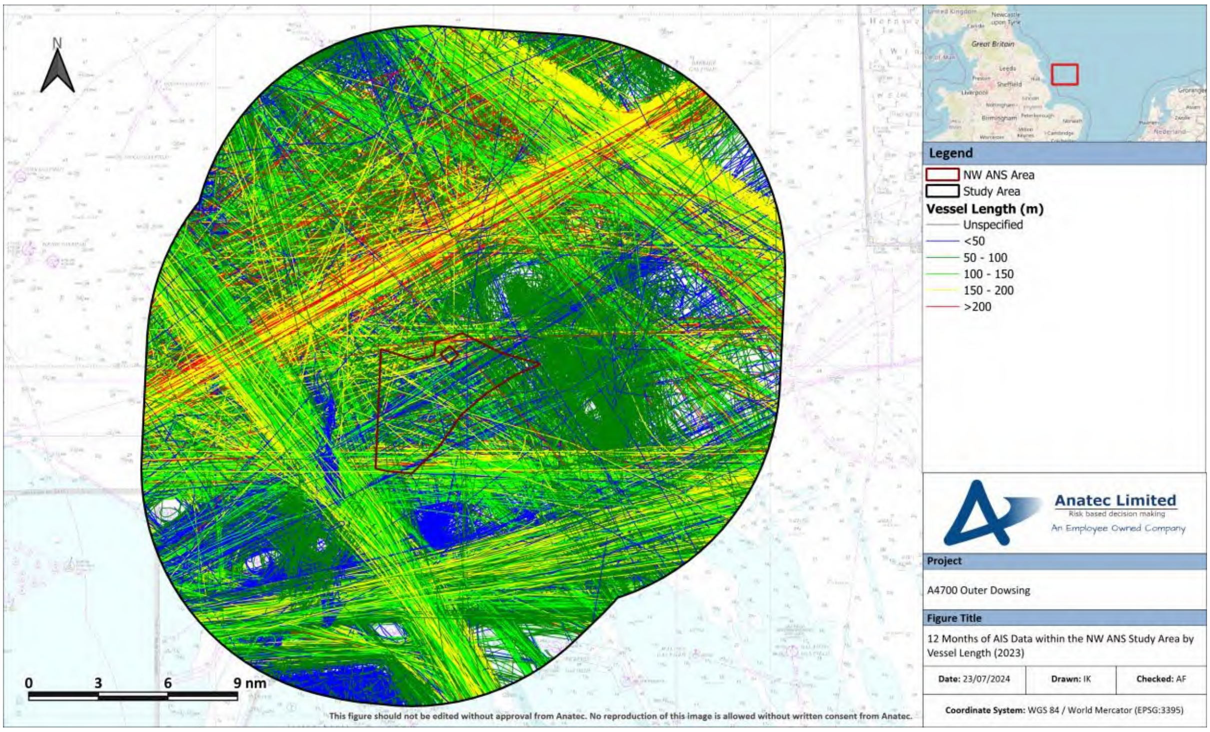


Figure 7.5 12 Months of AIS Data within the NW ANS Study Area by Vessel Length (2023)

64. Vessel length information was available for over 99% of all vessels recorded within the NW ANS study area. Vessels of greater length to the northwest of the NW ANS area were associated with cargo vessel routeing, with vessels of lesser length typically fishing and wind farm vessels.

65. Figure 7.6 illustrates the distribution of vessel lengths recorded throughout 2023 within the NW ANS study area.

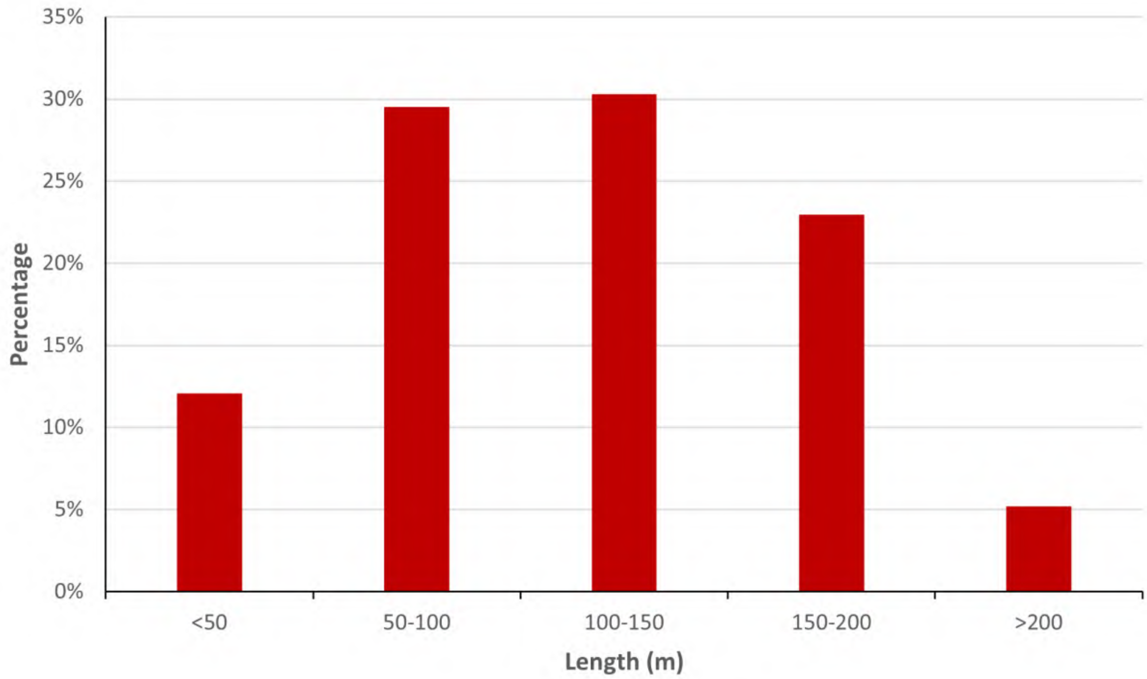


Figure 7.6 Distribution of Vessel Lengths (NW ANS Area)

66. Excluding the proportion of vessels for which a length was not available, the average length of vessels within the NW ANS study area throughout 2023 was 118m. The largest vessel recorded was a crude oil tanker at 336m heading to Hound Point Terminal (the UK).

7.1.3.2 Vessel Draught

67. The vessel tracks recorded during 2023 within the NW ANS study area are colour-coded by vessel draught and presented in Figure 7.7.

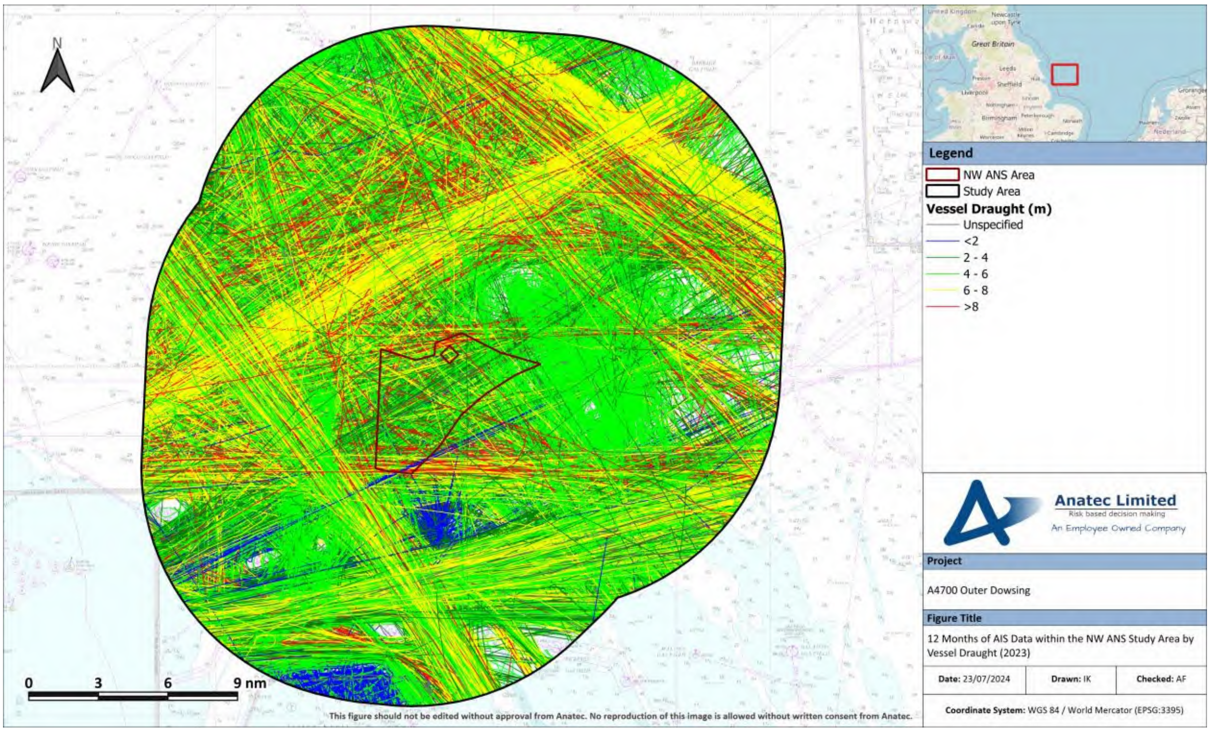


Figure 7.7 12 Months of AIS Data within the NW ANS Study Area by Vessel Draught (2023)

68. Vessel draught information was available for approximately 95% of all vessels recorded within the NW ANS study area. As with vessel length, vessels of greater draught to the northwest and south of the NW ANS area were associated with cargo vessel routeing, with vessels of lesser draught typically fishing and wind farm vessels.

69. Figure 7.8 illustrates the distribution of vessel draughts recorded throughout 2023 within the NW ANS study area.

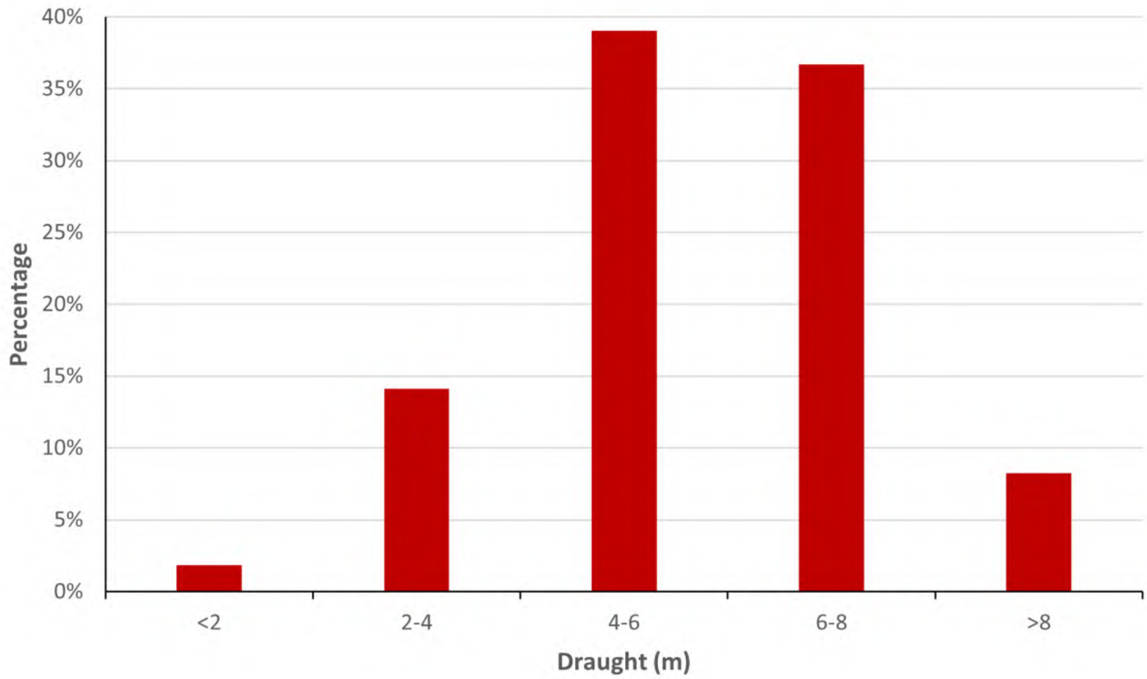


Figure 7.8 Distribution of Vessel Draughts (NW ANS Area)

70. Excluding the proportion of vessels for which a draught was not available, the average draught of vessels within the NW ANS study area throughout 2023 was 5.6m. The vessels of greatest draught recorded were two crude oil tankers at 14m heading to Tetney Terminal (the UK) and Rotterdam.

7.1.4 Anchored Vessels

71. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

72. For this reason, those vessels which travelled at a speed of less than 1kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity.

73. The vessels identified as likely to be at anchor within the NW ANS study area within 2023 are colour-coded by vessel type and presented in Figure 7.9.

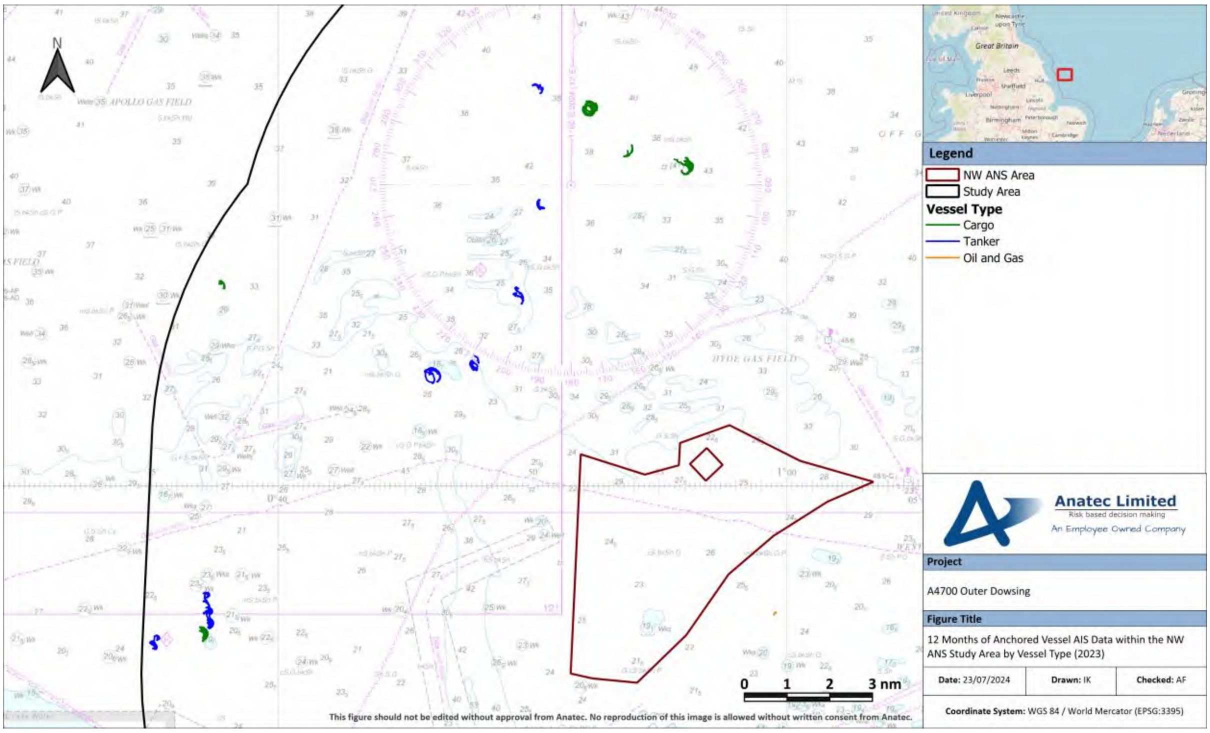
74. 

Figure 7.9 12 Months of Anchored Vessel AIS Data within the NW ANS Study Area by Vessel Type (2023)

75. An average of one unique vessel every six days was identified as likely at anchor within the NW ANS study area. These were comprised of tankers (56%), cargo vessels (41%), and oil and gas vessels (3%). There were no vessels identified as likely being at anchor within the NW ANS area, with the closest being a tanker 3.1nm to the northwest.

7.2 SE ANS Area

76. The vessel tracks recorded during 2023 within the SE ANS study area are colour-coded by vessel type and presented in Figure 7.10. Following this, Figure 7.11 presents the same data converted to a density heat map.

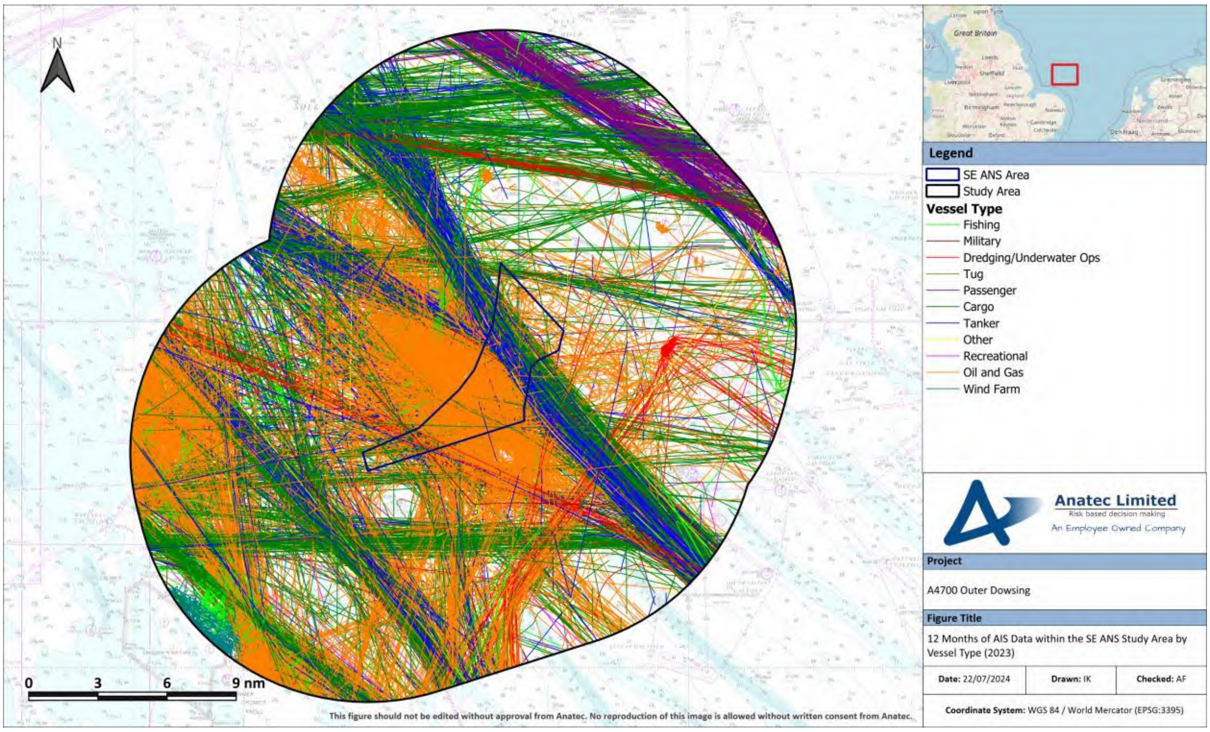


Figure 7.10 12 Months of AIS Data within the SE ANS Study Area by Vessel Type (2023)

77. In general, vessel traffic was noted in routes passing between the sandbanks referenced in Section 6.1. Other than minority of the routeing Immingham-Cuxhaven RoRo traffic transiting to the north of the SE ANS area, no other regular cargo RoRo routes were identified within the SE ANS study area. Oil and gas traffic is prevalent within the SE ANS area, with associated platforms including Clipper field within the SE ANS area, and the Laps field to the west. The DFDS Seaways-operated RoPax route noted to the northeast of the NW ANS area is also present to the northeast of the SE ANS area.

78. Dredging vessels associated with dredging area 484 are noted to be active to the east of the SE ANS area, with the remainder of the dredging traffic transiting. Wind farm vessels associated with Dudgeon were noted to the southwest.

79. As with the NW ANS area (see Section 7.1.1), fishing vessel activity was estimated within the SE ANS area. Vessels were noted to be likely actively fishing directly to the west of the SE ANS area, as well as at the southwest perimeter of the SE ANS study area.

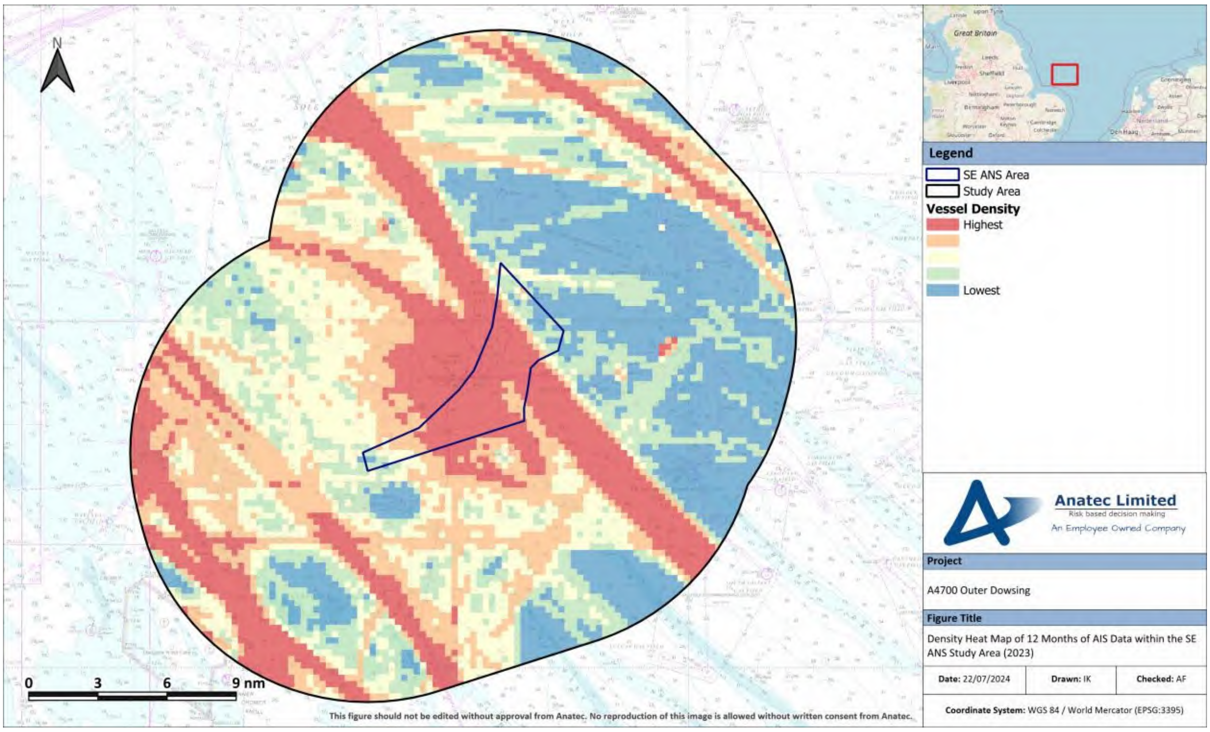


Figure 7.11 Density Heat Map of 12 Months of AIS Data within the SE ANS Study Area (2023)

7.2.1 Vessel Count

80. The daily number of unique vessels recorded within the SE study area, as well as intersecting the SE ANS area, during 2023 are presented in Figure 7.3. Within the SE ANS study area approximately 34% of vessel traffic recorded intersected the SE ANS area.

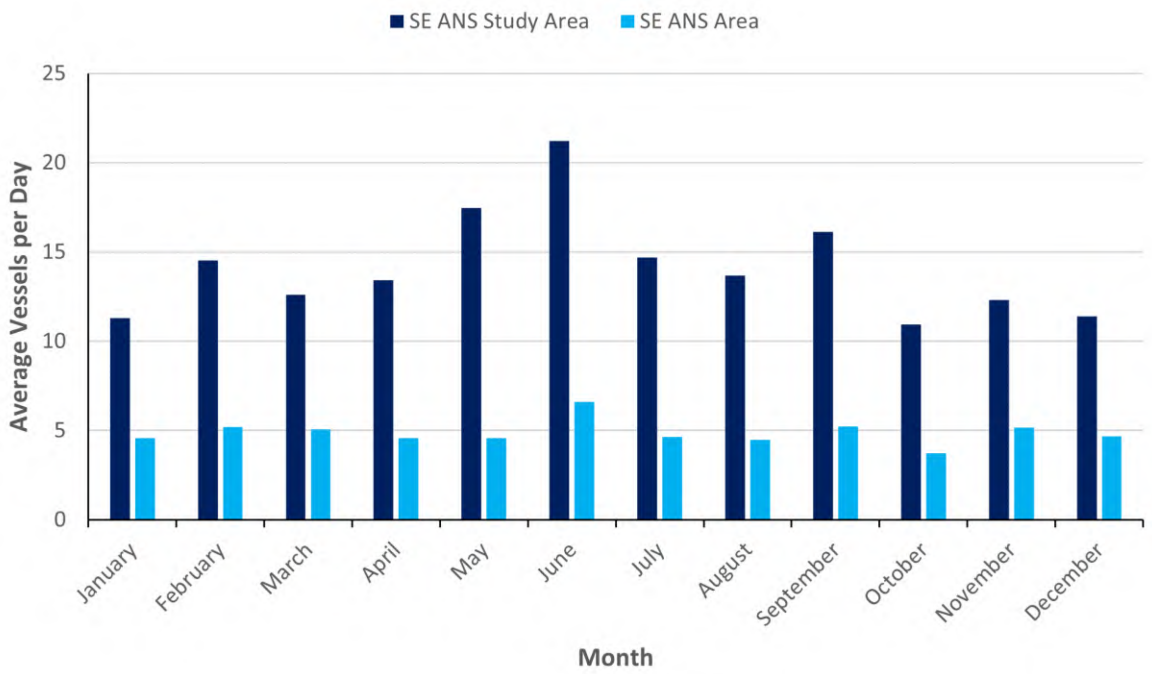


Figure 7.12 Distribution of Average Vessel Counts per Month (SE ANS Area)

81. For the 12 months of AIS data analysed within the SE ANS study area, there was an average of 14 unique vessels recorded per day. An average of five unique vessels per day intersected the SE ANS area itself.

82. The busiest month recorded within the SE ANS study area during 2023 was June, with an average of 21 unique vessels recorded per day. The busiest month recorded within the SE ANS area itself during 2023 was also June, with an average of six to seven unique vessels recorded per day.

83. The quietest month recorded within the SE ANS study area during 2023 was October, with an average of 11 unique vessels recorded per day. The quietest month recorded within the SE ANS area itself during 2023 was also October, with an average of three to four unique vessels recorded per day.

7.2.2 Vessel Type

84. The distribution of vessel types recorded within the SE study area, as well as intersecting the SE ANS area, during 2023 are presented in Figure 7.4.

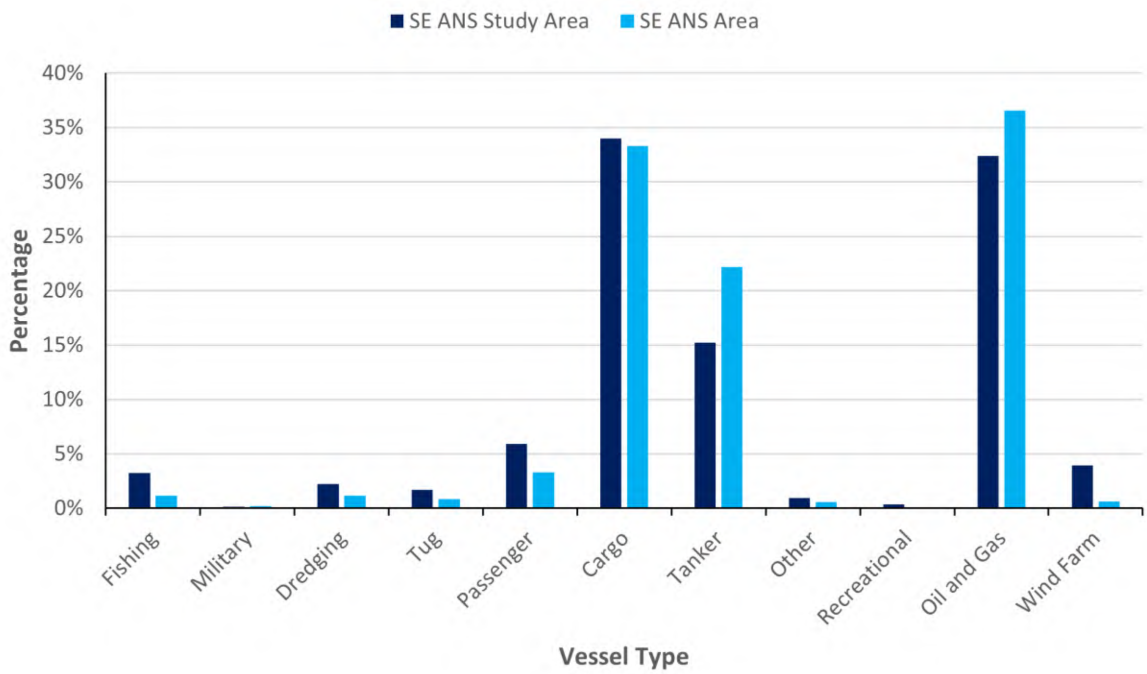


Figure 7.13 Distribution of Vessel Types (SE ANS Area)

85. Throughout 2023, the main vessel types within the SE ANS study area were cargo vessels (34%), oil and gas vessels (32%), and tankers (15%). The main vessel types within the SE ANS area itself were oil and gas vessels (37%), cargo vessels (33%), and tankers (22%).

7.2.2.1 RYA Recreational Intensity

86. As noted within Section 7.1.2.1, the Coastal Atlas indicates that recreational activity is limited in the entirety of the SE ANS area. It is noted that the Coastal Atlas may underrepresent recreational activity further offshore, however the general findings align with the 12 months of AIS data i.e., recreational traffic is limited further offshore. These datasets only account for AIS traffic, however the vessel traffic surveys carried out within the study area for the array area indicated that non-AIS vessel traffic in the area was relatively low, with less than 1% of the total traffic recorded captured from Radar.

7.2.3 Vessel Size

7.2.3.1 Vessel Length

87. The vessel tracks recorded during 2023 within the SE ANS study area are colour-coded by vessel length and presented in Figure 7.14.

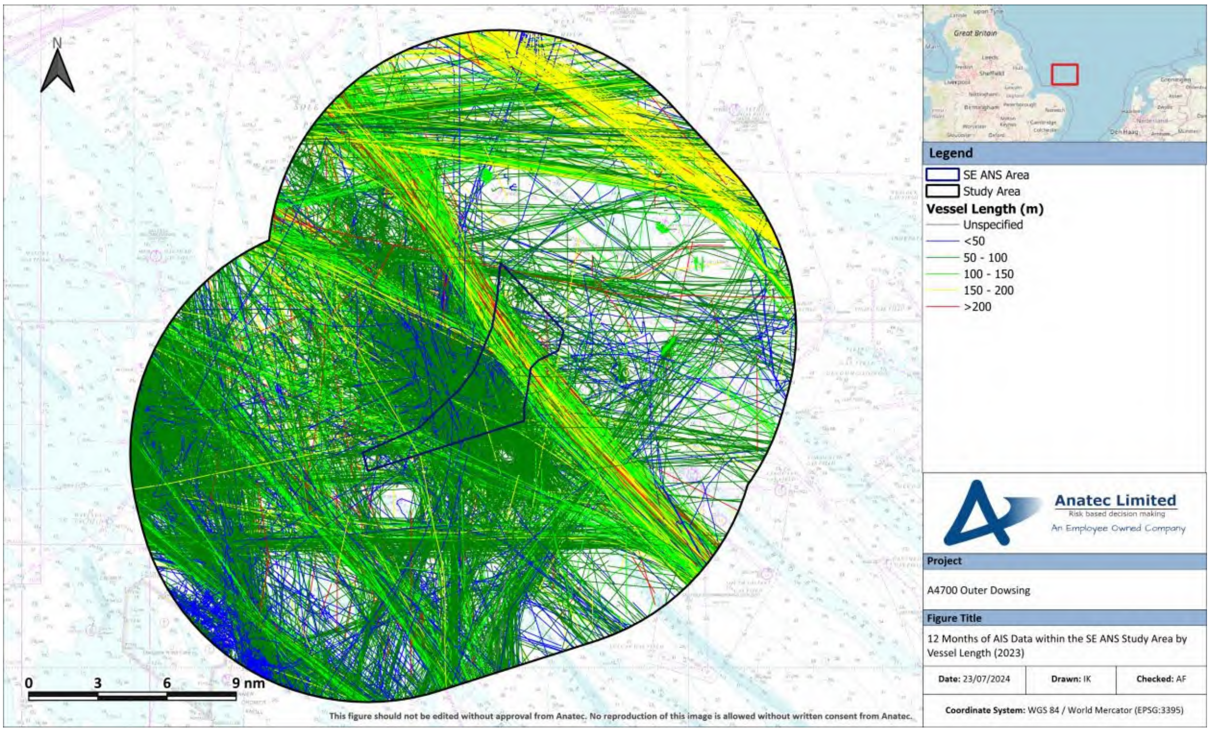


Figure 7.14 12 Months of AIS Data within the SE ANS Study Area by Vessel Length (2023)

88. Vessel length information was available for over 99% of all vessels recorded within the SE ANS study area. Vessels of greater length to the northeast of the SE ANS area were associated with RoPax routeing, with vessels of lesser length typically wind farm vessels.

89. Figure 7.6 illustrates the distribution of vessel lengths recorded throughout 2023 within the SE ANS study area.

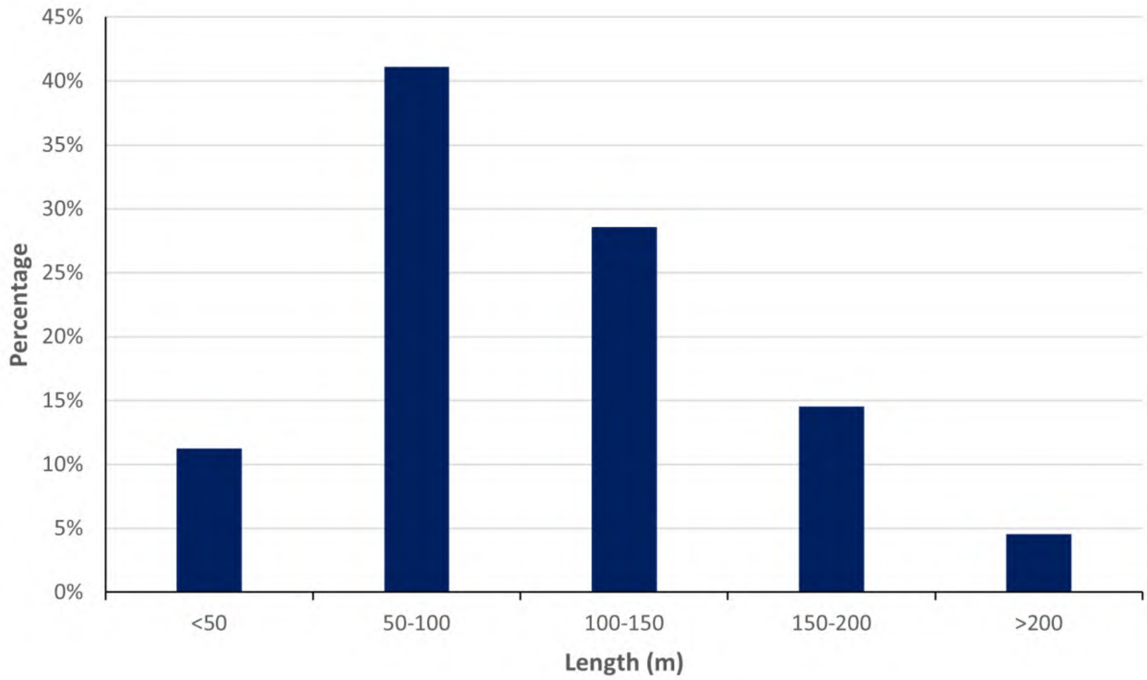


Figure 7.15 Distribution of Vessel Lengths (SE ANS Area)

90. Excluding the proportion of vessels for which a length was not available, the average length of vessels within the SE ANS study area throughout 2023 was 106m. The largest vessels recorded were two containerships at 400m heading to Antwerp (Belgium) and Rotterdam (the Netherlands).

7.2.3.2 Vessel Draught

91. The vessel tracks recorded during 2023 within the SE ANS study area are colour-coded by vessel draught and presented in Figure 7.16.

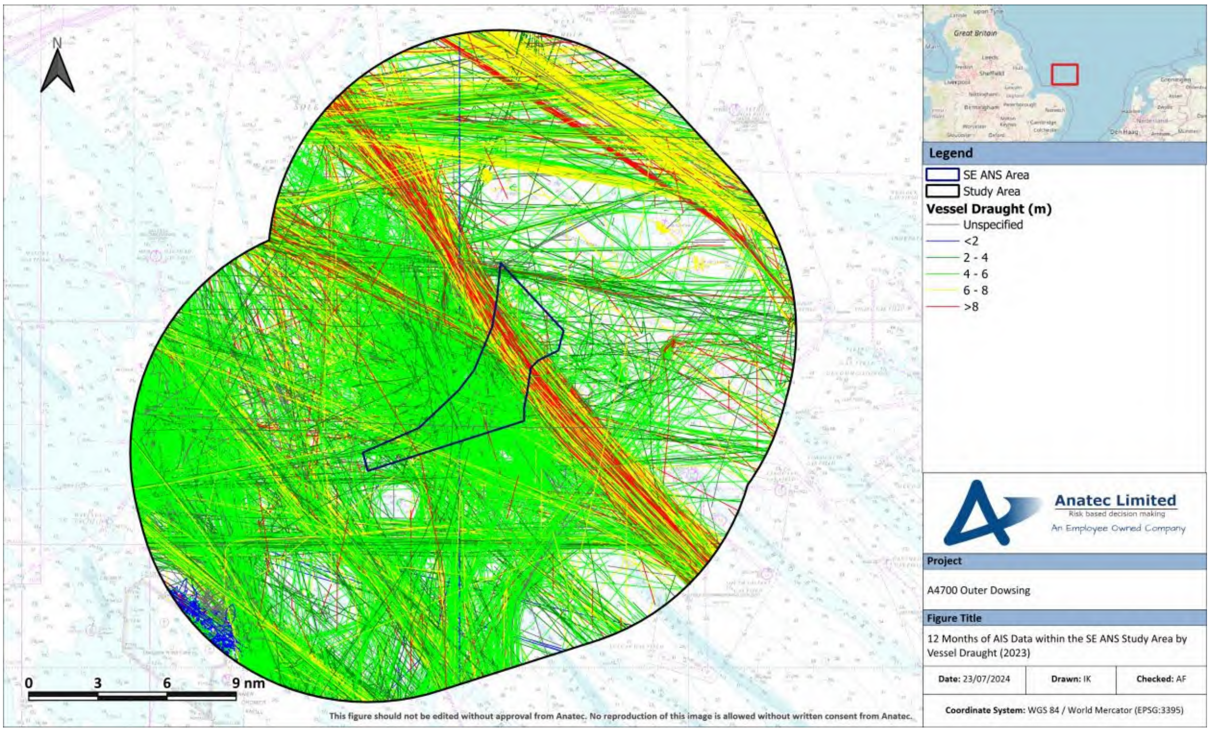


Figure 7.16 12 Months of AIS Data within the SE ANS Study Area by Vessel Draught (2023)

92. Vessel draught information was available for approximately 92% of all vessels recorded within the SE ANS study area. Vessels of greater draught routeing through the SE ANS area were predominantly tankers and cargo vessels, with those to the northeast associated with RoPax routeing. As with vessel length, vessels of lesser draught were typically wind farm vessels.

93. Figure 7.8 illustrates the distribution of vessel draughts recorded throughout 2023 within the ANS study area.

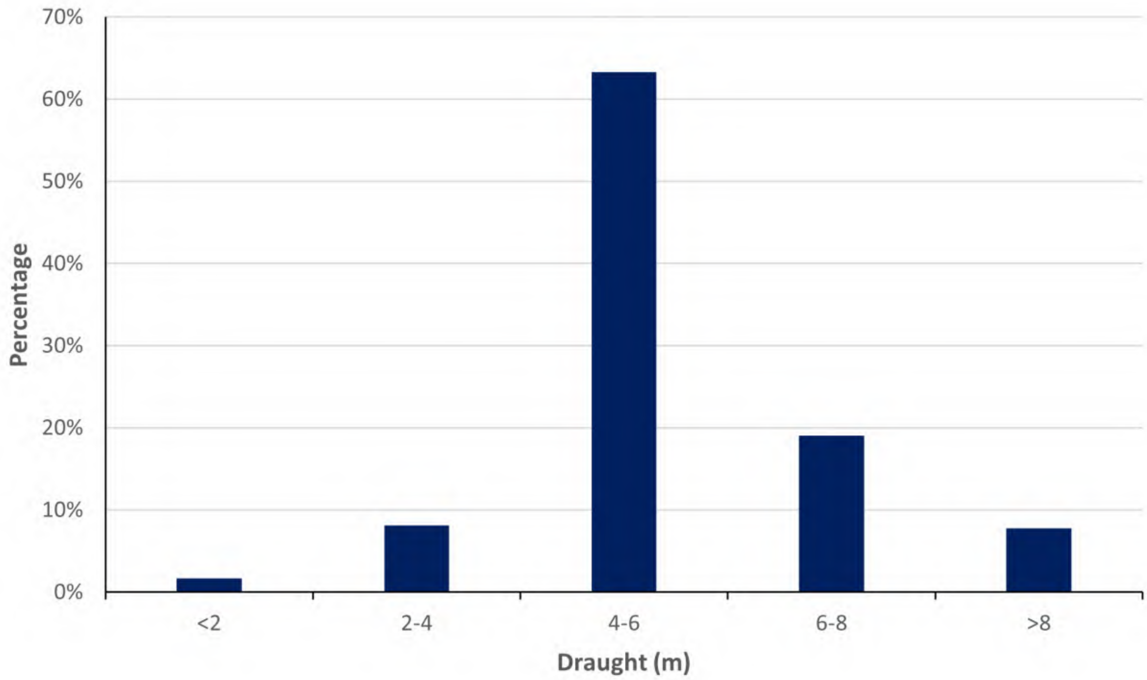


Figure 7.17 Distribution of Vessel Draughts (SE ANS Area)

94. Excluding the proportion of vessels for which a draught was not available, the average draught of vessels within the SE ANS study area throughout 2023 was 5.4m. The vessel of greatest draught recorded was a crude oil tanker at 16.8m heading to Santa Panagia (Italy).

7.2.4 Anchored Vessels

95. Using the methodology established within Section 7.1.4, the vessels identified as likely to be at anchor within the SE ANS study area within 2023 are colour-coded by vessel type and presented in Figure 7.18.

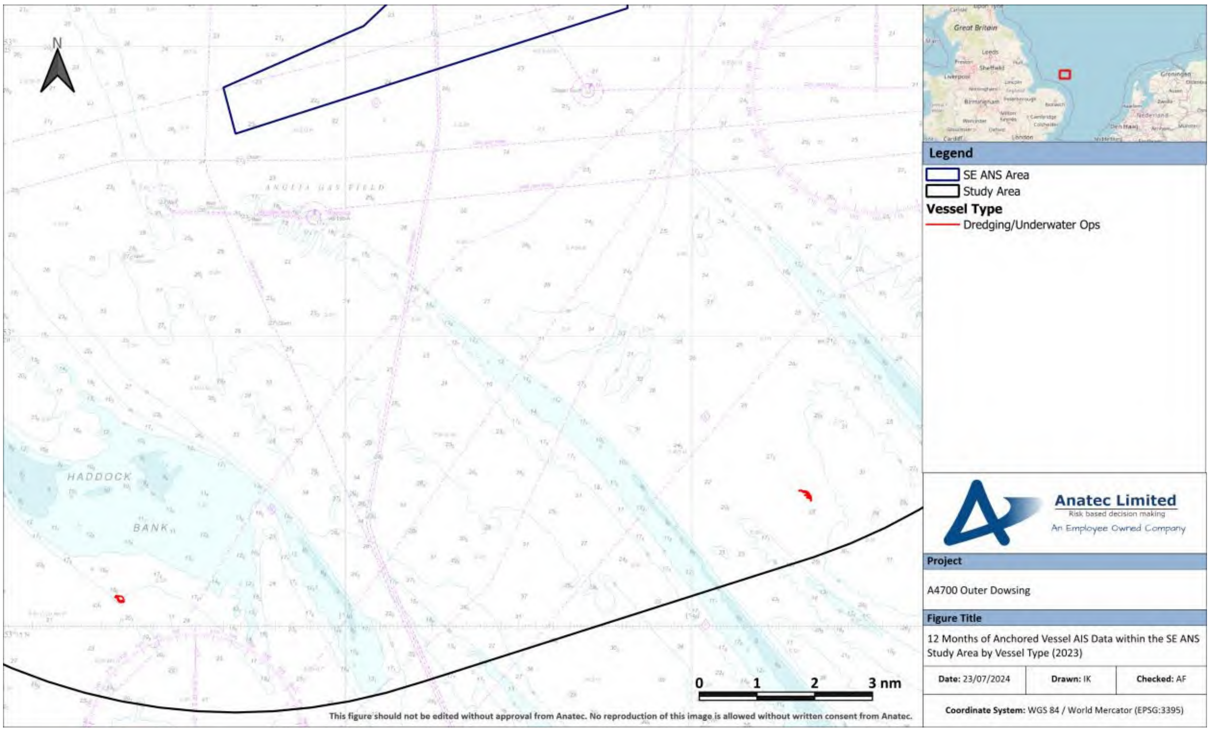


Figure 7.18 12 Months of Anchored Vessel AIS Data within the SE ANS Study Area by Vessel Type (2023)

96. An average of one unique vessel every three months was identified as likely at anchor within the SE ANS study area. These were comprised solely of dredging/underwater operations vessels. There were no vessels identified as likely being at anchor within the SE ANS area, with the closest being a dredger 8.2nm to the south.

7.3 Vessel Routes

7.3.1 Vessel Route Description

97. Main commercial routes have been identified using the principles set out in MGN 654 (MCA, 2021). Vessel traffic data are assessed and vessels transiting at similar headings and locations are identified as a main route. To help identify main routes, vessel traffic data can also be interrogated to show vessels (by name and/or operator) that frequently transit those routes. The route width is then calculated using the 90th percentile rule from the median line of the potential shipping route as shown in Figure 7.19.

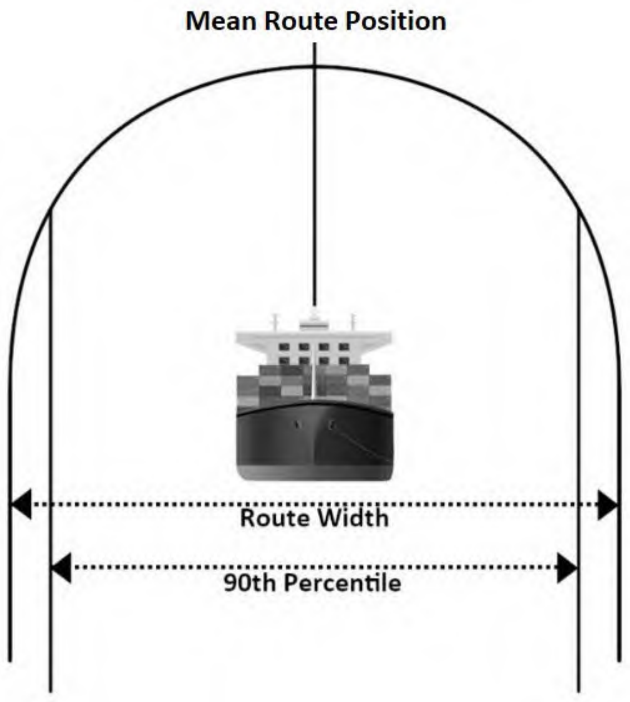


Figure 7.19 Illustration of Main Route Calculation

7.3.2 Base Case Vessel Routes

98. A total of 18 main commercial routes across both ANS study areas were identified from the vessel traffic data. These main commercial routes within the bounds of each study area are shown relative to the NW and SE ANS areas in Figure 7.20 and Figure 7.21 respectively. Following this, a description of each route is provided in Table 7.1, including the average number of vessels per day, route terminus locations, and main vessel types, as well as which of the ANS study areas the route intersects. It is noted that the terminus points shown are based on the most common destinations transmitted via AIS by vessels on those routes.

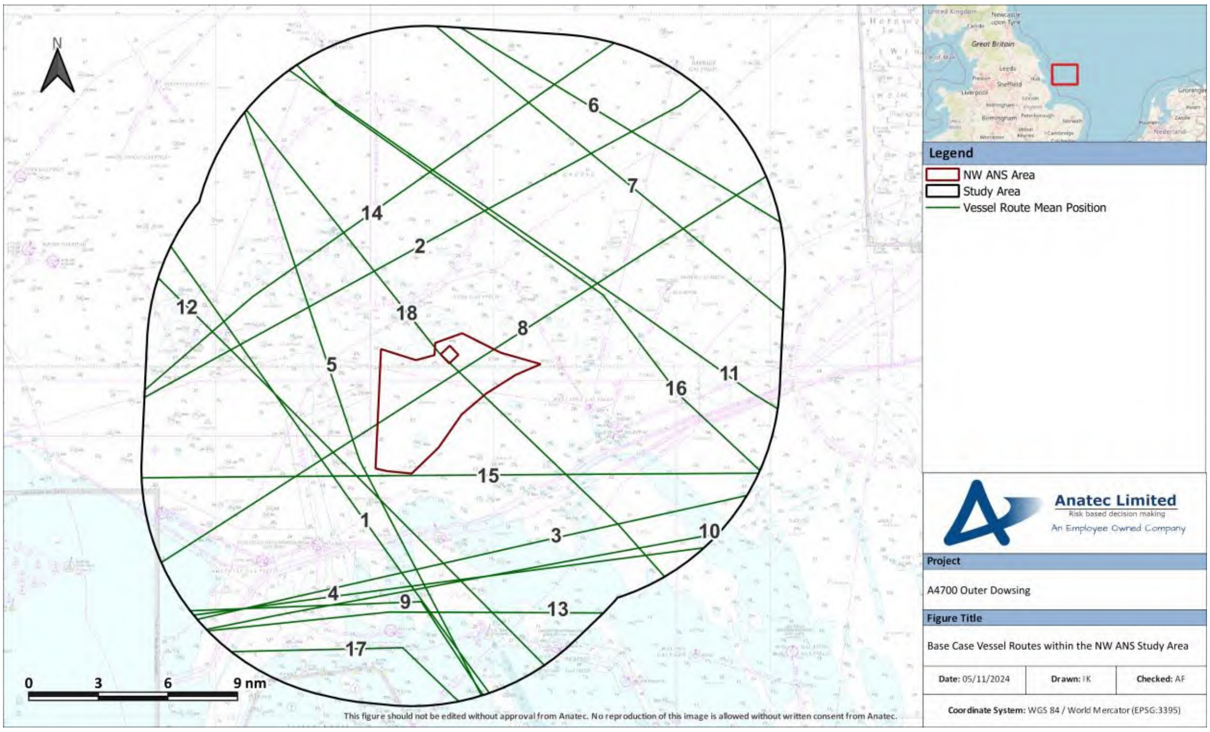


Figure 7.20 Base Case Vessel Routes within the NW Study Area

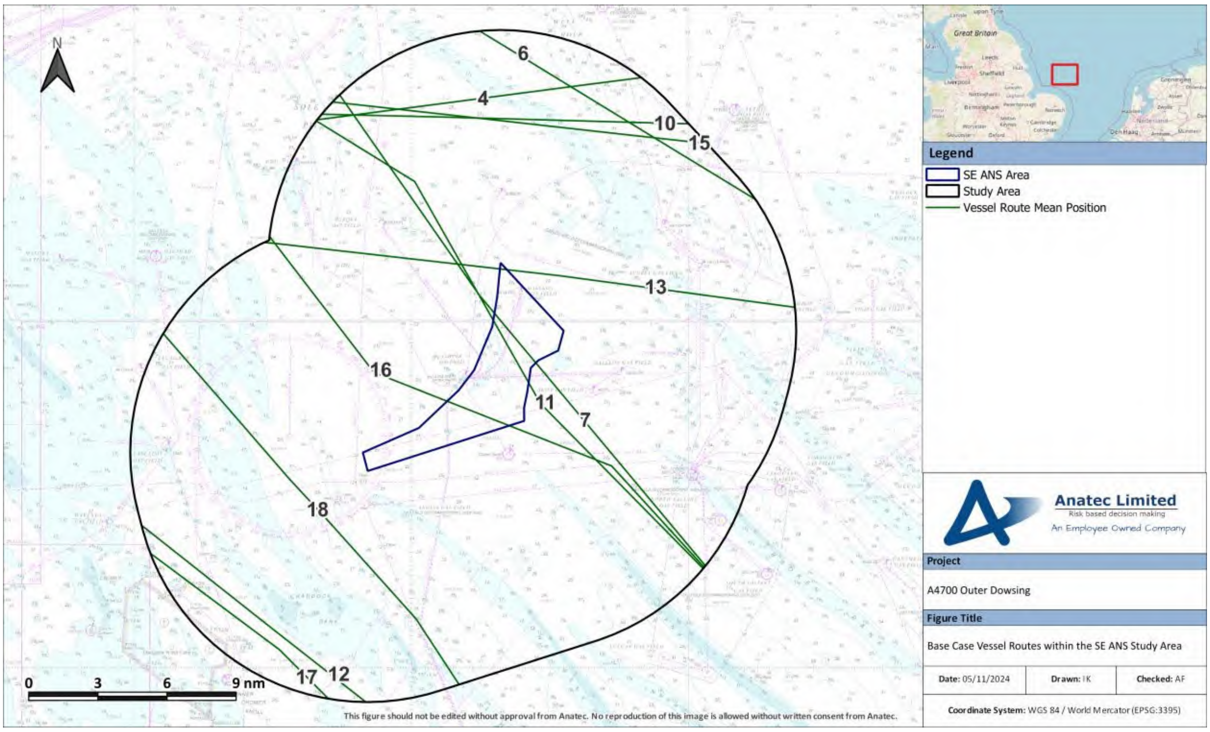


Figure 7.21 Base Case Vessel Routes within the SE Study Area

Table 7.1 Description of Base Case Vessel Routes

Route No.	Intersects				Average Vessels per Day	Description
	NW ANS Study Area	NW ANS Area	SE ANS Study Area	SE ANS Area		
1	Yes	No	No	No	8-9	**Tees – Zeebrugge**. Primarily cargo vessels (64%) and tankers (29%). Includes RoRo vessels operated by P&O Ferries and CLdN; and RoPax vessels operated by DFDS Seaways on alternate routeing (see Route 6).
2	Yes	No	No	No	3	**Immingham – Esbjerg**. Primarily cargo vessels (91%). Includes RoRo vessels operated by DFDS Seaways and Finnlines.
3	Yes	No	No	No	2	**Immingham – Cuxhaven**. Primarily cargo vessels (92%). Includes RoRo vessels operated by DFDS Seaways.
4	Yes	No	Yes	No	2	**Immingham – Cuxhaven**. Primarily cargo vessels (74%), with oil and gas vessels (14%) and tankers (12%) also recorded.
5	Yes	No	No	No	1-2	**Tees – Rotterdam**. Cargo vessels (40%), tankers (35%), and oil and gas vessels (23%).
6	Yes	No	Yes	No	1-2	**Newcastle – Ijmuiden**. Mainly passenger vessels (71%), with tankers (16%) and cargo vessels (10%) also recorded. Includes RoPax vessels operated by DFDS Seaways on primary route.
7	Yes	No	Yes	Yes*	1	**Grangemouth – Rotterdam**. Mainly cargo vessels (61%) and tankers (31%).
8	Yes	Yes	No	No	<1	**Grimsby – Hornsea Two**. Mainly wind farm vessels (78%).
9	Yes	No	No	No	<1	**Immingham – Antwerp**. Mainly tankers (79%) and cargo vessels (20%).

Route No.	Intersects				Average Vessels per Day	Description
	NW ANS Study Area	NW ANS Area	SE ANS Study Area	SE ANS Area		
10	Yes	No	Yes	No	<1	**Immingham – Cuxhaven.** Primarily cargo vessels (91%).
11	Yes	No	Yes	Yes*	<1	**Torlakshofn – Rotterdam.** Mainly cargo vessels (62%) and tankers (26%). Includes RoPax vessels operated by DFDS Seaways on alternate routeing (see Route 6).
12	Yes	No	Yes	No	<1	**Tees – Rotterdam.** Primarily cargo vessels (96%).
13	Yes	No	Yes	Yes	<1	**Hull – Bremerhaven.** Primarily cargo vessels (88%).
14	Yes	No	Yes	No	<1	**Immingham – Gdansk.** Mainly cargo vessels (64%) and tankers (28%).
15	Yes	No	Yes	No	<1	**Immingham – Hamburg.** Mainly cargo vessels (57%) and tankers (35%).
16	Yes	No	Yes	Yes	<1	**Tees – Rotterdam.** Oil and gas vessels (36%), tankers (35%), and cargo vessels (27%).
17	Yes	No	Yes	No	<1	**Immingham – Rotterdam.** Mainly cargo vessels (50%) and tankers (46%).
18	Yes	Yes	Yes	No	<1	**Tees – Rotterdam.** Mainly cargo vessels (63%) and tankers (23%).

*Route intersects only with the portion of the ANS area in which a commitment to restrict structures has been agreed.

7.3.3 Post ANS Routeing

99. It is not possible to consider all potential alternative routeing options for commercial traffic and therefore worst-case alternatives have been considered. Assumptions for re-routeing include:

- All alternative routes maintain a minimum mean distance of 1nm from offshore installations and existing OWF boundaries in line with industry experience. This distance is considered for shipping and navigation from a safety perspective as explained below; and
- All mean routes take into account sandbanks, AtoNs, and known routeing preferences.

100. This NRA also aims to establish the worst-case scenario based on navigational safety parameters, and when considering this the most conservative realistic scenario for vessel routeing is considered to be when main commercial routes pass 1nm off developments. Evidence collected during numerous assessments at an industry level confirms that it is a safe and reasonable distance for vessels to pass; however, it is likely that a large number of vessels would instead choose to pass at a greater distance depending upon their own passage plan and the current conditions.

101. Each of the main routes identified (see Section 7.3.2) has been assessed for the potential to deviate considering the above methodology. It is recognised that the routes which intersect with (see Table 7.1), or are located within 1nm of, the ANS areas may necessitate deviation to a degree.

102. The post-ANS routeing within the NW ANS study area, considering the worst-case positions identified in Section 5.2, is presented in Figure 7.22. Following this, the equivalent routes within the SE ANS study area are presented in Figure 7.23.

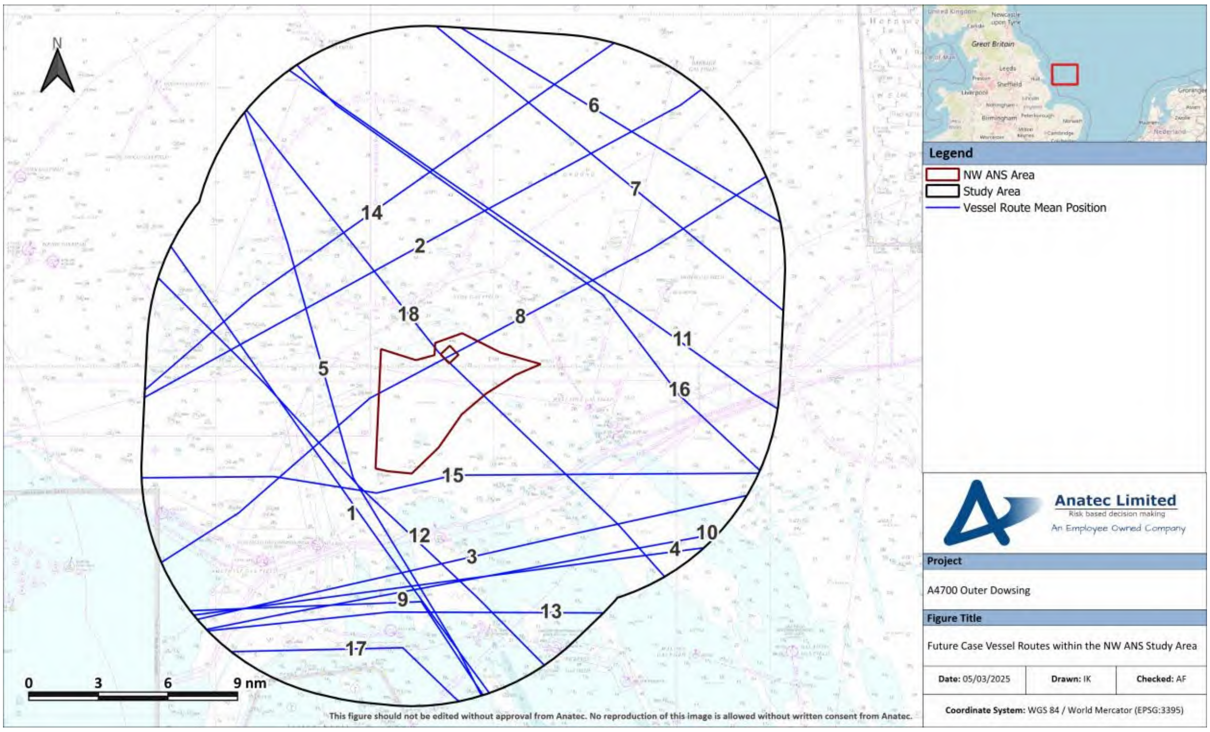


Figure 7.22 Future Case Vessel Routes within the NW ANS Study Area

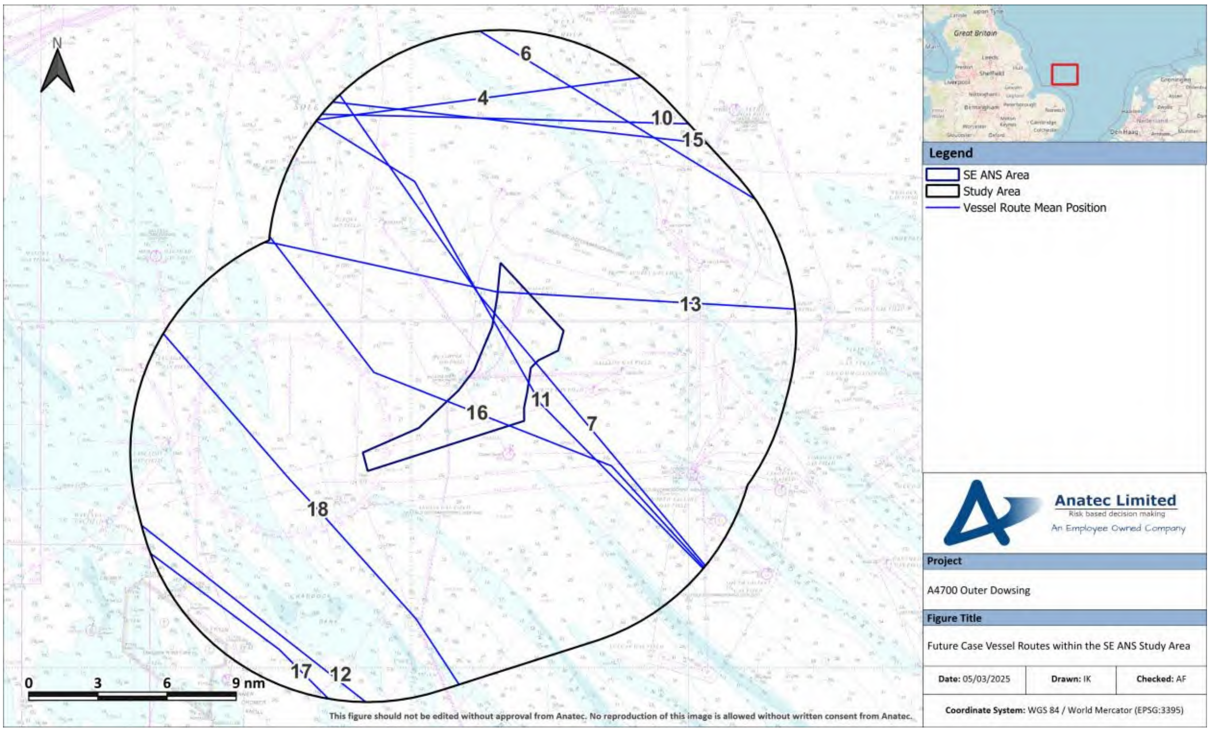


Figure 7.23 Future Case Vessel Routes within the SE ANS Study Area

103. A summary of the routes and any potential deviations is provided in Table 7.2.

Table 7.2 Deviation Summary

Route	Average Vessels per Day	Deviation
1	8-9	Route is not expected to deviate due to the ANS areas.
2	3	Route is not expected to deviate due to the ANS areas.
3	2	Route is not expected to deviate due to the ANS areas.
4	2	Route is not expected to deviate due to the ANS areas.
5	1-2	Shifted slightly west of NW ANS worst-case position B (deviation of 0.1nm).
6	1-2	Route is not expected to deviate due to the ANS areas.
7	1	Route intersects with the SE ANS, but only in the restricted build area; no deviations are therefore expected.
8	<1	Shifted slightly north of NW ANS worst-case position A (deviation of 0.1nm).
9	<1	Route is not expected to deviate due to the ANS areas.
10	<1	Route is not expected to deviate due to the ANS areas.
11	<1	Route intersects with the SE ANS, but only in the restricted build area; no deviations are therefore expected.
12	<1	Shifted slightly west of NW ANS worst-case position B (deviation of <0.01nm).
13	<1	Shifted slightly south of SE ANS worst-case position A (deviation of < 0.1nm).
14	<1	Route is not expected to deviate due to the ANS areas.
15	<1	Shifted slightly south of NW ANS worst-case position B (deviation of 0.1nm).
16	<1	Route was not deviated under the worst-case positions, but as this route intersects with the SE ANS area if a separate position is chosen then a minor deviation may occur (in line with other deviations as presented in this table).
17	<1	Route is not expected to deviate due to the ANS areas.
18	<1	Route was not deviated under the worst-case positions, but as this route intersects with the NW ANS area if a separate position is chosen then a minor deviation may occur (in line with other deviations as presented in this table).

104. The post ANS routeing is shown in Figure 7.24.

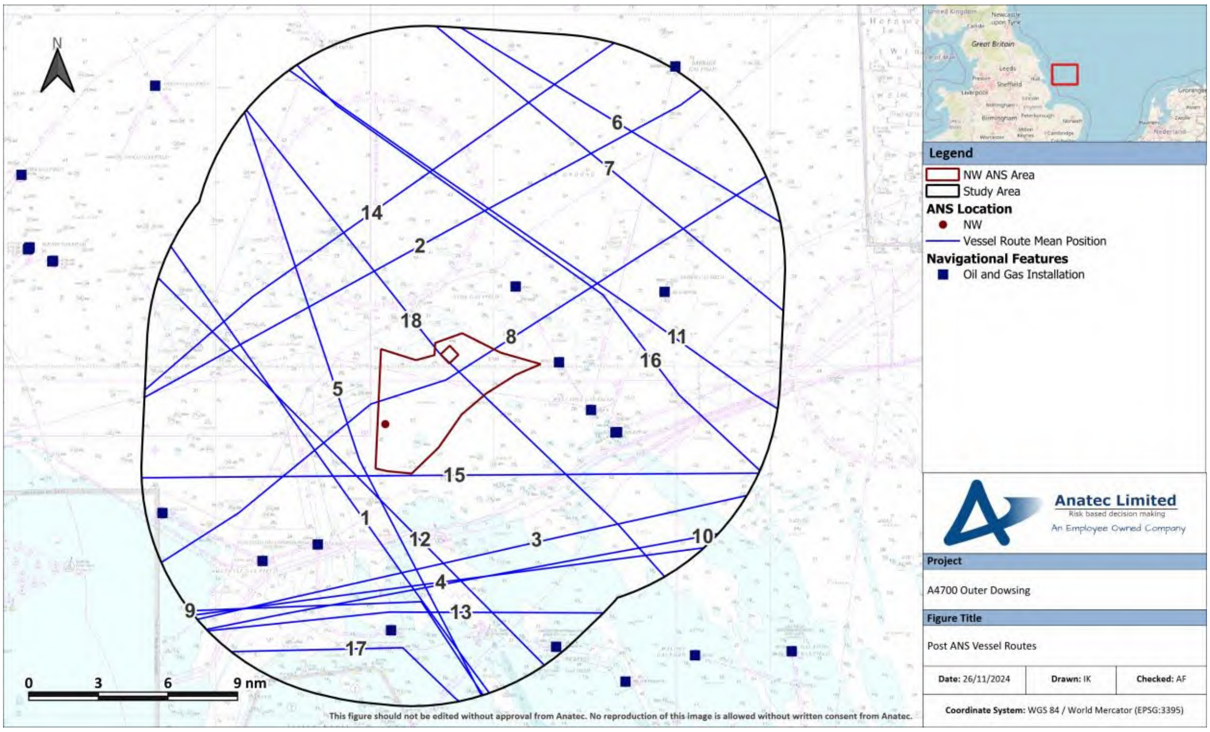


Figure 7.24 Post ANS Vessel Routes

105. The only main commercial route affected by the location of the ANS structures is Route 8 (the majority of vessels on this route were transiting between Grimsby and the Hornsea projects, with less than one vessel transit per day overall). This route deviated north of the NW ANS and increased in route length by 0.16nm (or 0.3% of its total). It is noted that this route is also transited by approximately one cargo vessel not associated with either of the Hornsea developments per week – as these vessels follow the route position until the eastern periphery of the NW ANS study area before turning north past Hornsea, the required deviation will be the same i.e., limited.

106. The position of Route 8 is currently influenced by oil and gas installations in proximity. From Figure 7.24 it is noted that, despite a necessary deviation, there will be sufficient searoom available for vessels on this route to still safely transit between the installations.

7.3.4 Cumulative

107. The offshore wind farm developments within 50nm of the ANS areas are presented in Figure 7.25, with the post-ANS routes within the ANS study areas as described in Section 7.3.3 also provided for context. Following this, a description of the effects that these developments will likely have on the routeing highlighted is presented in Table 7.3.

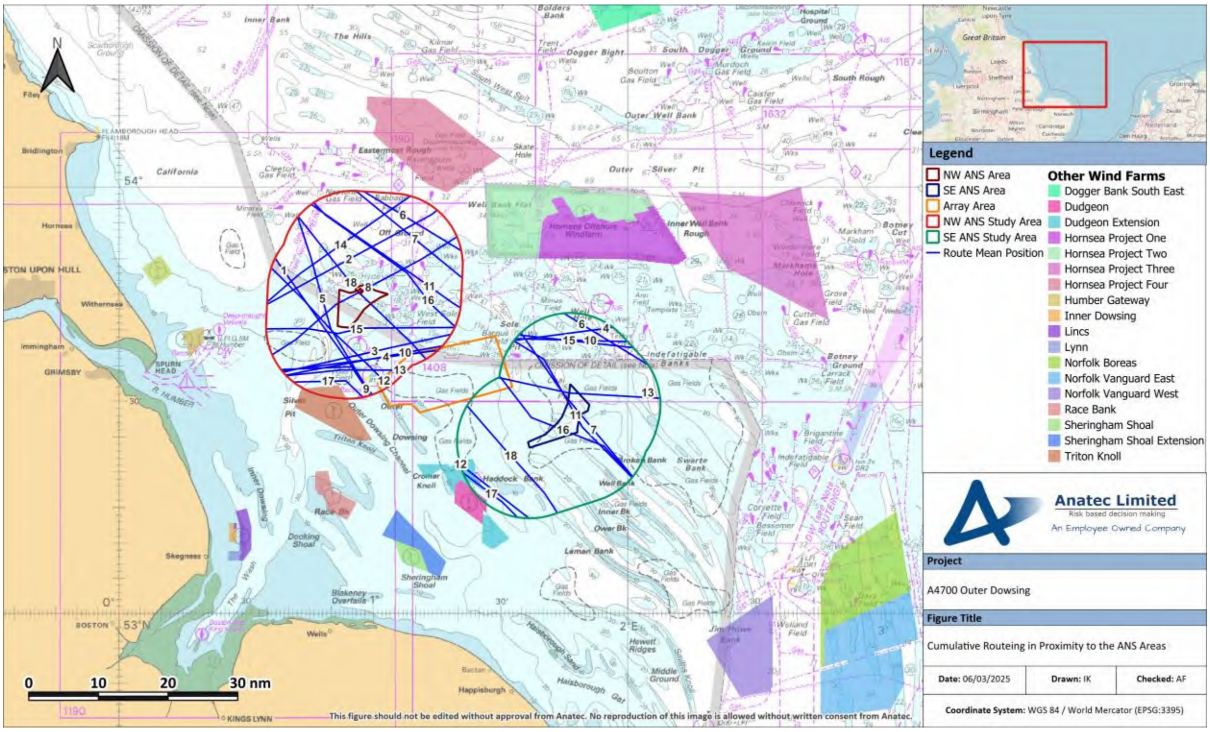


Figure 7.25 Cumulative Routeing in Proximity to the ANS Areas

Table 7.3 Summary of Cumulative Future Route Deviations

Route	Average Vessels per Day	Description of Cumulative Deviations
1	8-9	Routeing is currently constrained by shallows and existing infrastructure and so will likely not change.
2	3	Route will pass between Hornsea Project Two and Hornsea Project Four, so will likely not shift closer to the ANS areas.
3	2	There may be minor shift in vessels passing north closer to the NW ANS area due to the array area, but route will then pass south of Hornsea Three.
4	2	Routeing is not expected to be affected by any future developments.
5	1-2	Routeing is not expected to be affected by any future developments.
6	1-2	Routeing is not expected to be affected by any future developments.
7	1	This route is unlikely to change within the ANS areas, noting it may pass the array area further east.
8	<1	Routeing is not expected to be affected by any future developments.
9	<1	Routeing is not expected to be affected by any future developments.
10	<1	Routeing is not expected to be affected by any future developments.

Route	Average Vessels per Day	Description of Cumulative Deviations
11	<1	This route is unlikely to change within the ANS areas, noting it may pass the array area further east.
12	<1	Routeing is not expected to be affected by any future developments.
13	<1	Routeing is not expected to be affected by any future developments.
14	<1	Routeing is not expected to be affected by any future developments.
15	<1	Routeing is not expected to be affected by any future developments.
16	<1	Routeing is not expected to be affected by any future developments.
17	<1	Routeing is not expected to be affected by any future developments.
18	<1	When the Project is developed it is likely that this route will be displaced. However, it is noted that this route is low use.

8 Allision and Collision Modelling

108. A quantitative assessment of the major allision and collision hazards associated with the ANS structures has been undertaken, with vessel traffic in proximity to each structure considered. The following subsections outline the inputs and methodology used for the collision and allision risk modelling.

8.1.1 Scenarios Under Consideration

109. For each element of the quantitative assessment, both a pre and post ANS scenario has been considered.

8.1.2 Hazards Under Consideration

110. Hazards considered in the quantitative assessment are as follows:

- Increased vessel to vessel collision risk;
- Increased powered vessel to structure allision risk; and
- Increased drifting vessel to structure allision risk.

111. The pre ANS assessment has been informed by the vessel traffic data (see Section 7) and other baseline data sources (such as Anatec's ShipRoutes database (Anatec, 2024)).

8.2 Vessel to Vessel Collision Risk

112. Using the pre ANS vessel routeing as input (see Section 7.3.2), Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risk in proximity to the ANS areas. The route positions and widths are based on the vessel traffic data sources considered (see Section 7).

113. Using the post ANS routeing as input (see Section 7.3.3), Anatec's COLLRISK model was then run to estimate the change in anticipated vessel to vessel collision risk.

114. It was estimated that the frequency of a vessel being involved in a collision would rise from one in 65 years to one in 62 years within the NW ANS study area. The majority of the change in risk was observed to be associated with vessels assumed to deviate south of NW ANS worst-case location B, and hence closer to Route 1. It is noted that this was the area which the MCA noted as likely being the highest risk due to traffic levels (see Section 3); and that it has been committed that no structures will be placed herein, as described in Section 5.2.

115. Overall risk was lower in the SE ANS area, with the frequency of a vessel being involved in a collision increasing from one in 474 years to one in 469 years within the SE ANS study area.

8.3 Powered Vessel to Structure Allision Risk

116. Based upon the vessel routeing identified in study areas, the anticipated re-routeing as a result of the presence of the ANS worst-case locations as per Section 5.2, and assumptions that relevant embedded mitigation measures are in place (see Section 9.1), the frequency of an errant vessel under power deviating from its route to the extent that it came into proximity with an ANS structure is considered to be very low.

117. Using the post ANS routeing as input, together with the worst-case indicative ANS locations and local MetOcean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the ANS structures whilst under power.

118. The annual powered vessel allision frequency post ANS for the NW and SE ANS structures is presented in Table 8.1.

Table 8.1 Post ANS Powered Vessel to Structure Allision Frequency

Structure	Allision Frequency	Return Period
NW ANS worst-case location A	1.71×10^{-4}	1 in 5,845 years
NW ANS worst-case location B	2.03×10^{-3}	1 in 493 years
SE ANS worst-case location A	4.83×10^{-4}	1 in 2,068 years
SE ANS worst-case location B	3.88×10^{-4}	1 in 2,580 years

119. The greatest powered vessel to structure allision risk was associated with the southernmost ANS of the NW ANS area (worst-case location B), at $2.03\text{x}10^{-3}$, or one in 493 years. This is the location that the MCA indicated would likely be the highest risk area given its proximity to the busy routeing to the west (see Section 3), and where it has been committed that no structures will be placed (see Section 5.2). The results as a worst-case can therefore be seen as overly conservative.

120. It is noted that the vast majority of the allision risk was observed to be associated with Route 1 (see Figure 7.20). The allision modelling has assumed that this route will not deviate, however it should be considered that there is searoom available for vessels to increase passing distance by transiting further west and as such the modelling is considered conservative.

8.4 Drifting Vessel to Structure Allision Risk

121. Using the post ANS routeing as input, together with the worst-case indicative ANS locations and local MetOcean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the ANS structures. The model is based on the premise that propulsion on a vessel must fail before drifting will

occur. The model takes account of the type and size of the vessel, the number of engines and the average time required to repair but does not consider navigational errors caused by human actions.

122. The exposure times for a drifting scenario are based upon the vessel hours spent in proximity to the ANS. These have been estimated based on the vessel traffic levels, speeds, and revised routeing patterns. The exposure is divided by vessel type and size to ensure that these specific factors which, based upon analysis of historical incident data have been shown to influence incident rates, are taken into account for the modelling.

123. Using this information, the overall rate of mechanical failure in proximity to the ANS structures was estimated. The probability of a vessel drifting towards an ANS structure and the drift speed are dependent on the prevailing wind, wave, and tidal conditions at the time of the incident. Therefore, three drift scenarios were modelled, each using the MetOcean data provided in Section 5.4:

- Wind;
- Peak spring flood tide; and
- Peak spring ebb tide.

124. After modelling the three drifting scenarios, it was established that the flood tide dominated scenario produced the worst-case results.

125. It is noted that the probability of vessel recovery from drift is estimated based upon the speed of the drift and hence the time available before arriving at a structure. Vessels which do not recover within this time are assumed to allide.

126. The annual drifting vessel allision frequency post ANS for the NW and SE ANS structures is presented in Table 8.2.

Table 8.2 Post ANS Drifting Vessel to Structure Allision Frequency

Structure	Allision Frequency	Return Period
NW ANS worst-case location A	2.34×10^{-5}	1 in 42,748 years
NW ANS worst-case location B	7.47×10^{-5}	1 in 13,381 years
SE ANS worst-case location A	1.58×10^{-5}	1 in 63,375 years
SE ANS worst-case location B	1.03×10^{-5}	1 in 96,676 years

127. As with the powered vessel to structure allision risk, the greatest drifting vessel to structure allision risk was associated with the southernmost ANS of the NW ANS area (worst-case location B). This was at 7.47×10^{-5}, or one in 13,381 years. As with the previous modelling results, this result is conservative due to the commitment to not construct an ANS within the southwest corner of the NW ANS area (as per Section 5.2).

9 Hazard Identification and Mitigation

128. Following assessment of the baseline sources within Sections 5.4 and 7, and consultation within Section 3, the following shipping and navigation users have been identified:

- Commercial vessels;
- Commercial fishing vessels; and
- Recreational craft (2.5m to 24m).

129. Using this same data, the hazards identified include:

- Displacement from main/historical routes;
- Increased vessel to vessel collision risk; and
- Allision risk with the ANS.

130. Hazards associated with the movements of project vessels including third party to project vessel collision risk have already been assessed as part of the full NRA [APP-171].

9.1 Embedded Mitigations

131. The embedded mitigation measures implemented to reduce risk to all vessels include:

- Promulgation of information via Notice to Mariners (NtM) during the survey, construction phases and major maintenance phases. This should include to relevant vessel operators e.g., those associated with the Hornsea projects (see Section 7.3.3) (see condition 5(8), Part 2, Schedules 12-15, DCO (document ref 3.1).
- Charting of the location(s) on nautical charts via UKHO (see condition 5(10), Part 2, Schedules 12-15, DCO (document ref 3.1).
- Appropriate lighting and marking of the installations in line with Trinity House requirements as discussed within Section 3. Likely requirements include special mark lighting (as an isolated structure) with a yellow flashing light with a minimum 10nm range (360 degrees visibility) and a yellow foundation (RAL 1023). A Hazard warning (fog signal) will also be required. The topside will likely be submarine grey (RAL 7035) (see conditions 6 and 7, Part 2, Schedules 12-15, DCO (document ref 3.1)).
- Consultation with the MCA and Trinity House and local gas platform and wind farm operators will continue as the Project progresses. This NRA has modelled worst case locations within the ANS areas, and any additional information or assessment requested by the MCA or Trinity House would be provided in the event that the final locations are located elsewhere in the ANS areas.
- Agreement with MCA on the final location of the ANS as required under MGN 654, noting the final location must be approved by the MMO in consultation

with MCA and Trinity House (see condition 11, Part 2, Schedules 12-15, DCO (document ref 3.1)).
- Guard vessels if required via risk assessment.
- Implementation of a section of each of the ANS areas either encompassing or in proximity to nearby busy shipping routes in which the Project has committed to not constructing an ANS (see Section 5.1 for location).

10 Risk Control Log

132. The risk control log demonstrates how the methodology detailed in Section 2 has been applied to the identified users and hazards (Section 127). It aims to clearly demonstrate that all hazards when considered with embedded mitigations in place are within acceptable parameters and no additional control measures (mitigations) are required.

Table 10.1 Risk Control Log

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Displacement from main routes/historical routes	Commercial Vessels	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s) ▪ Construction/ decommissioning vessels	Displacement with manageable effects on schedule	Reasonably probable	Minor	Tolerable with Mitigation	N/A	Tolerable with Mitigation
Displacement from main routes/historical routes	Commercial Vessels	O	▪ Consideration of final location ▪ Charting of the location(s) ▪ Lighting and marking ▪ Consultation ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s)	Displacement with manageable effects on schedule	Reasonably probable	Minor	Tolerable with Mitigation	N/A	Tolerable with Mitigation

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Increased vessel-to-vessel collision risk	Commercial Vessels	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s) ▪ Construction/ decommissioning vessels	Displacement results in increased encounters and potential for low impact collision to occur	Extremely unlikely	Moderate	Tolerable with Mitigation	N/A	Tolerable with Mitigation
Increased vessel-to-vessel collision risk	Commercial Vessels	O	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with	▪ Presence of ANS(s)	Displacement results in increased encounters and potential for low impact collision to occur	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
			MCA and Trinity House.							
Allision risk with the ANS	Commercial Vessels	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of partially constructed ANS(s)	Allision event occurs with an ANS, involving vessel damage, injury to person and/or pollution	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Allision risk with the ANS	Commercial Vessels	O	▪ Consideration of final location ▪ Charting of the location(s) ▪ Lighting and marking ▪ Consultation ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s)	Allision event occurs with an ANS, involving vessel damage, injury to person and/or pollution	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable
Displacement of commercial fishing vessels in transit	Commercial Fishing Vessels in Transit	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s) ▪ Construction/ decommissioning vessels	Displacement with manageable effects on schedule	Extremely unlikely	Minor	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Displacement of commercial fishing vessels in transit	Commercial Fishing Vessels in transit	O	▪ Consideration of final location ▪ Charting of the location(s) ▪ Lighting and marking ▪ Consultation ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s)	Displacement with manageable effects on schedule	Extremely unlikely	Minor	Broadly Acceptable	N/A	Broadly Acceptable
Increased vessel-to-vessel collision risk	Commercial Fishing Vessels in Transit	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s) ▪ Construction/ decommissioning vessels	Displacement results in increased encounters and potential for low impact collision to occur	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Increased vessel-to-vessel collision risk	Commercial Fishing Vessels in Transit	O	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s)	Displacement results in increased encounters and potential for low impact collision to occur	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable
Allision risk with the ANS	Commercial Fishing Vessels in Transit	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with	▪ Presence of partially constructed ANS(s)	Allision event occurs with an ANS, involving vessel damage, injury to person and/or pollution	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
			MCA and Trinity House.							
Allision risk with the ANS	Commercial Fishing Vessels in Transit	O	▪ Consideration of final location ▪ Promulgation of information ▪ Charting of the location(s) ▪ Lighting and marking ▪ Consultation ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s)	Allision event occurs with an ANS, involving vessel damage, injury to person and/or pollution	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Displacement of recreational craft in transit	Recreational Craft	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s) ▪ Construction/ decommissioning vessels	Displacement with manageable effects on routine	Extremely unlikely	Minor	Broadly Acceptable	N/A	Broadly Acceptable
Displacement of recreational craft	Recreational Craft	O	▪ Consideration of final location ▪ Charting of the location(s) ▪ Lighting and marking ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s)	Displacement with manageable effects on routine	Extremely unlikely	Minor	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
Increased vessel-to-vessel collision risk	Recreational Craft	C/D	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of ANS(s) ▪ Construction/ decommissioning vessels	Displacement results in increased encounters and potential for low impact collision to occur	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable
Increased vessel-to-vessel collision risk	Recreational Craft	O	▪ Promulgation of information ▪ Lighting and marking (of ANS and construction /decommissioning vessels) ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with	▪ Presence of ANS(s)	Displacement results in increased encounters and potential for low impact collision to occur	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
			MCA and Trinity House.							
Allision risk with the ANS	Recreational Craft	C/D	▪ Promulgation of information ▪ Lighting and marking of ANS ▪ Guard vessels as required ▪ Final approval of ANS locations by the MMO in consultation with MCA and Trinity House.	▪ Presence of partially constructed ANS(s)	Allision event occurs with an ANS, involving vessel damage, injury to person and/or pollution	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable
Allision risk with the ANS	Recreational Craft	O	▪ Consideration of final location ▪ Promulgation of information ▪ Charting of the location(s) ▪ Lighting and marking ▪ Final approval of ANS locations by the MMO in consultation with	▪ Presence of ANS(s)	Allision event occurs with an ANS, involving vessel damage, injury to person and/or pollution	Extremely unlikely	Moderate	Broadly Acceptable	N/A	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
			MCA and Trinity House.							

11 Summary and Conclusions

11.1 Navigational Features

133. Navigational features in proximity to the ANS areas include offshore infrastructure such as OWFs or oil and gas installations, as well as sandbanks and subsea cables. These navigational features influence routeing in the area, with vessel traffic to/from oil and gas platforms and OWFs prevalent, and vessel transits avoiding the developments as well as the sandbanks to the southeast of the SE ANS area. Other than those denoting OWFs, there are no key AtoNs within close proximity to either ANS area.

11.2 Vessel Traffic Data

134. Based on a review of 12 months of AIS data within a minimum of 10nm of the NW and SE ANS areas, vessel traffic within the area is typically influenced by nearby navigational features such as sandbanks and oil and gas installations. There was a higher density of vessel traffic noted within the NW ANS study area, with all 18 main commercial routes recorded passing through here. The highest use of these main routes was between Tees and Zeebrugge, with an average of eight to nine unique vessel transits per day.

11.3 Mitigation Measures

135. Mitigation measures to reduce risk to all vessel types are noted in Section 9.1 and are embedded as part of the Project.

11.4 Allision and Collision Risk

136. From the vessel to vessel collision modelling undertaken, it is estimated that the increase in collision frequency due to the presence of the ANS structures will be negligible. Assuming base case levels, the pre ANS vessel-to-vessel collision risk for the NW ANS area was estimated at 1.53×10^{-2}, with a return period of one incident every 65 years for the pre ANS scenario, and 1.59×10^{-2}, or one in 62 years post ANS. The pre ANS vessel-to-vessel collision risk for the SE ANS area was estimated at 2.11×10^{-3}, or one incident every 474 years, and 2.13×10^{-3}, or one in 469 years post ANS.

137. The results of the powered allision risk assessment shows that the greatest risk of allision is to the NW ANS worst-case location B (the southernmost position in the NW ANS area), due to the proximity to high-use routes including Route 1. This powered allision risk was estimated at 2.03×10^{-3}, or one in 493 years. The other locations were all less than one in 2,000 years.

138. Due to the tidal conditions in addition to the nearby high-use routeing, the results of the drifting allision risk assessment show the greatest risk of allision to also

be for NW ANS worst-case location B. The drifting allision risk here was estimated at 7.47×10^{-5}, or one in 13,381 years.

139. The majority of change in risk was observed to be associated with NW ANS area Position B. This aligns with MCA input during consultation that the south west section of the NW ANS area would likely be the highest risk area due to its proximity to the busy traffic passing to the west. It is noted that a commitment to not construct within the southwest corner of the NW ANS area has been made due to this consultation as per Section 5.2.

11.5 Risk Rankings

140. When assessing hazards in line with the methodology detailed in Section 2, the majority of identified risks are found to be **Broadly Acceptable** with the embedded mitigations (Section 9.1) in place. Displacement from main routes/historical routes for commercial vessels during all phases, and vessel-to-vessel collision risk for commercial vessels during construction/decommissioning only were identified as being **Tolerable with Mitigation**. All risks are therefore noted as being ALARP.

141. It is noted that these risk rankings all assume the final location of the ANS will be agreed upon with the MCA as per MGN 654 (noting the final location must be approved by the MMO in consultation with the MCA and Trinity House under the DCO).

12 References

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