Offshore Wind Power Limited

West of Orkney Offshore EIA Report

Volume 2, Supporting Study 14: Navigational Risk Assessment

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West of Orkney Offshore Windfarm Navigational Risk Assessment

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1 Introduction

1.1 Background

Anatec was commissioned by West of Orkney Windfarm (hereafter 'the Project') to undertake a Navigational Risk Assessment (NRA) for the offshore elements of the proposed West of Orkney Wind Farm (hereafter 'the offshore Project'). The NRA has been undertaken with respect to the offshore components of the offshore Project comprising the Option Agreement Area (OAA) and offshore export cable corridor (ECC). This NRA presents information on the offshore Project relative to the existing and estimated future navigational activity and forms a supporting study to Offshore EIA Report chapter 15: Shipping and navigation.

1.2 Navigational Risk Assessment

Environmental Impact Assessment (EIA) is a process which identifies the environmental effects of a project, both adverse and beneficial. An important requirement of the EIA for offshore projects is the NRA. Following the Maritime and Coastguard Agency's (MCA) Marine Guidance Note (MGN) 654 (MCA, 2021), this NRA includes:

- Outline of methodology applied in the NRA including relevant guidance;
- Summary of consultation undertaken with shipping and navigation stakeholders;
- Lessons learnt from previous offshore wind farm developments;
- Summary of Project Design Envelope (PDE) relevant to shipping and navigation;
- Overview of existing environment including:
  - Navigational features;
  - Meteorological and oceanographic conditions;
  - Emergency response resources;
  - Historical maritime incidents; and
  - Vessel traffic movements.
- Implications for marine navigation and communication equipment;
- Cumulative and transboundary overview;
- Overview of anticipated future case vessel traffic;
- Assessment of navigational risk pre and post construction of the offshore Project including collision and allision risk modelling;
- Hazard identification for further assessment in chapter 15 (of the EIAR): Shipping and navigation;
- Identification of embedded mitigation measures; and
- Completion of the MGN 654 Checklist (see 24).

Potential hazards have been considered for each stage of the offshore Project as follows:

- Construction (including pre-construction);
- Operations and maintenance; and
- Decommissioning.

The assessment of the offshore Project is based on a PDE (i.e., a range of design parameters within which the Project could be constructed), an approach which is standard practice for offshore wind farm developments given the potential for findings from further site investigations (to be undertaken post consent) and advancements in technology. The PDE includes conservative assumptions to form a Worst Case Scenario (WCS) which is considered and assessed for all hazards on the basis that any deviation from the WCS (but still within the parameters of the PDE) will result in the risk of any relevant hazards being no greater than that assessed using the WCS. Further details on the PDE are provided in Section 6.

2 Guidance and Legislation

2.1 Legislation

As part of the EIA Directive (2011/92/European Union (EU), as amended by Directive 2014/52/EU) (which remains applicable following EU Exit), an EIAR is required to support the application for the Section 36 consent for the offshore Project. The MCA require that, as part of the EIAR, an NRA is undertaken to "*inform the shipping and navigation chapter of the EIA Report*" (MCA, 2021).

2.2 Primary Guidance

The primary guidance documents used during the assessment are the following:

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

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

MGN 654 includes several annexes including the *Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI)* which the MCA require to be used as a template for preparing NRAs. The methodology 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). In both chapter 15 (of the EIAR): Shipping and navigation and the NRA, the base and future case levels of risk have been identified as well as the mitigation measures required to ensure the future case remains broadly acceptable, or tolerable with mitigation.

2.3 Other Guidance

Other guidance documents used during the assessment include:

- *MGN 372 (Merchant and Fishing) Offshore Renewable Energy Installations (OREI): Guidance to Mariners Operating in the Vicinity of UK OREIs* (MCA, 2008(b));
- *International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 on The Marking of Man-Made Offshore Structures* (IALA, 2021 (a));
- *IALA Guidance G1162 The Marking of Offshore Man-Made Structures* (IALA, 2021 (b)); and
- *The Royal Yachting Association's (RYA) Position on Offshore Renewable Energy Developments: Paper 1 (of 4) – Wind Energy* (RYA, 2019 (b)).

2.4 Lessons Learnt

There is considerable benefit for the Project in the sharing of lessons learnt within the offshore industry. The NRA, and in particular the risk assessment undertaken in Offshore EIA Report, chapter 15: Shipping and navigation, includes general consideration for lessons learnt and expert opinion from previous offshore wind farm developments and other sea users, capitalising upon the UK's position as a leading generator of offshore wind power.

Data sources for lessons learnt include the following:

- *Sharing the Wind – Recreational Boating in the Offshore Wind Strategic Areas* (RYA and Cruising Association (CA), 2004);
- *Results of the Electromagnetic Investigations* (MCA and QinetiQ, 2004);
- *Offshore Wind Farm Helicopter Search and Rescue Trials Undertaken at the North Hoyle Wind Farm* (MCA, 2005);
- *Interference to Radar Imagery from Offshore Wind Farms* (Port of London Authority (PLA) ,2005);
- *Strategic Assessment of Impacts on Navigation of Shipping and Related Effects on Other Marine Activities Arising from the Development of Offshore Wind Farms in the UK Renewable Energy Zone (REZ)* (Anatec and The Crown Estate (TCE), 2012);
- *Offshore Wind and Marine Energy Health and Safety Guidelines* (RenewableUK, 2014);
- *Influence of UK Offshore Wind Farm Installation on Commercial Vessel Navigation: A Review of Evidence* (Anatec, 2016); and
- *G+ Global Offshore Wind Health & Safety Organisation 2020 Incident Data Report* (G+, 2021).

3 Navigational Risk Assessment Methodology

3.1 Formal Safety Assessment Methodology

A shipping and navigation user can only be affected by a hazard if there is a pathway through which a hazard can be transmitted between the source activity (cause) and the user. In cases where a user is exposed to a hazard, the overall severity of consequence 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;
- Outputs of the Hazard Workshop;
- Level of stakeholder concern;
- Time and/or distance of any deviation;
- Number of transits of specific vessel and/or vessel type; and
- Lessons learnt from existing offshore developments.

With regards to commercial fishing vessels, the methodology and assessment considers hazards to commercial fishing vessels in transit. A separate methodology and assessment have been applied in Offshore EIA Report, chapter 14: Commercial fisheries to consider hazards to commercial fishing vessels related to commercial fishing activity (rather than commercial fishing vessels in transit).

3.2 Formal Safety Assessment Process

The IMO Formal Safety Assessment (FSA) process (IMO, 2018) (the FSA process) as approved by the IMO in 2018 under Maritime Safety Committee (MSC) – Marine Environment Protection Committee (MEPC).2/circ. 12/Rev.2 has been applied to the risk assessment in Offshore EIA Report, chapter 15: Shipping and navigation and Section 18 of the NRA.

The FSA process is a structured and systematic methodology based upon risk analysis and Cost Benefit Analysis (CBA) (if applicable) to reduce risks to As Low as Reasonably Practicable (ALARP). There are five basic steps within this process as illustrated in 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 analysis (investigation of the causes and initiating events and consequences of the more important hazards identified in Step 1);
- **Step 3** – risk control options (identification of measures to control and reduce the identified hazards);
- **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 (IMO, 2018)

3.2.1 Hazard Workshop Methodology

A key tool used when undertaking an NRA is the Hazard Workshop which ensures that all risks are identified and qualified in agreement with relevant consultees prior to assessment within the EIAR. Risks (and the determined qualification) are recorded via the hazard log which is presented in full in Appendix B.

Table 3.1 and Table 3.2 identify how the severity of consequence and the frequency of occurrence has been defined within the hazard log, respectively.

Table 3.1 Severity of Consequence Ranking Definitions

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No perceptible risk	No perceptible risk	No perceptible risk	No perceptible risk
2	Minor	Slight injury(ies)	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 risk to 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	Less than 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

An aggregate of the severity of consequence (Table 3.1) and frequency of occurrence (Table 3.2) provide the level of risk for each hazard; the method for undertaking this aggregation is through use of a tolerability matrix, as presented in Table 3.3. The risk of a hazard is defined as Broadly Acceptable (low risk), Tolerable (intermediate risk), or Unacceptable (high risk).

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

Outputs of the hazard log have been used as evidence to support and refine the assessment undertaken in Offshore EIA Report, chapter 15: Shipping and navigation and Section 18 of the NRA.

Table 3.3 Tolerability Matrix and Risk Rankings

Severity of Consequence						
	5	Tolerable	Tolerable	Unacceptable	Unacceptable	Unacceptable
	4	Broadly Acceptable	Tolerable	Tolerable	Unacceptable	Unacceptable
	3	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable	Unacceptable
	2	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable
	1	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable
		1	2	3	4	5
		Frequency of occurrence				

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

3.3 Cumulative Risk Assessment Methodology

The hazards identified in the FSA are also assessed for cumulative risks with other projects and proposed developments within the cumulative risk assessment. Given the varying type, status and location of developments, different scenarios have been considered in the cumulative risk assessment, which allocates developments into the scenarios depending upon the following criterion:

- Development status;
- Distance from the offshore Project;
- Level of interaction with baseline traffic relevant to the offshore Project;
- Level of concern raised during consultation; and
- Data confidence.

It is noted that given the unique nature of shipping and navigation, the tiering system applied in the NRA differs from that assumed in the overarching Offshore EIA Report (see chapter 7: EIA methodology).

The scenarios and associated level of assessment undertaken for each, are summarised in Table 3.4. Given the level of interest during consultation in the cumulative scenario, a detailed qualitative and quantitative (where applicable) approach to the cumulative risk assessment has been applied for each scenarios.

The maximum distance within which developments are considered for the cumulative risk assessment is 100 nautical miles (nm) from the OAA on the basis that there is not considered to be a direct pathway between the offshore Project and any development beyond 100 nm from the OAA. This distance is standard within NRAs and provides a good overview of cumulative traffic patterns.

An aggregate of the criterion can determine the relevant scenario(s) for each development. For example, if a development is located within 100 nm of the OAA but does not impact a main commercial route passing within 1 nm of the OAA and has low data confidence it may still be screened out of the cumulative risk assessment.

For the purpose of the cumulative assessment, the development status in the context of shipping and navigation has been defined as the following; the term 'consented' indicates that a development has been consented but does not have a Contract for Difference (CfD) secured, 'pre-construction' indicates that a development has been consented and has a CfD secured, and the term 'under construction' indicates that offshore construction was ongoing at the time of the baseline being established and a buoyed construction area is present.

Projects meeting the assessment criteria are detailed in Section 14.

Table 3.4 Cumulative Development Screening Summary

Tier	Minimum Development Status	Criterion	Data Confidence Level	Level of Cumulative Risk Assessment
1	Under construction, consented or under determination	▪ May impact a main commercial route passing within 1 nm of the OAA. ▪ Raised as having possible cumulative effect during consultation. *Offshore wind farms:* ▪ Up to 50 nm from the OAA; or ▪ Up to 2 nm from the offshore ECC. *Sub-sea cables:* ▪ Up to 2 nm from the OAA; or ▪ Up to 2 nm from the offshore ECC. *Other* ▪ Onshore Space Hub within 25 nm.	High or medium	Quantitative cumulative re-routeing of main commercial routes
2	Under construction, consented or under determination	▪ May impact a main commercial route passing within 1 nm of the OAA. *Offshore wind farms:* ▪ Between 50 nm and 100 nm from the OAA; or ▪ Between 2 and 5 nm from the offshore ECC. *Sub-sea cables:* ▪ Up to 2 nm from the OAA; or ▪ Up to 2 nm from the offshore ECC.	High or medium	Qualitative cumulative re-routeing of main commercial routes
3	Scoped or under examination	▪ Does not impact a main commercial route passing within 1 nm of the OAA. *Offshore wind farms:* ▪ Up to 100 nm from the OAA; or ▪ Up to 5 nm from the offshore ECC. *Sub-sea cables:* ▪ Up to 2 nm from the OAA; or ▪ Up to 2 nm from the offshore ECC.	Low	Qualitative assumptions of routeing only

3.4 Study Areas

A 10 nm buffer has been applied around the OAA (hereafter the 'offshore study area') as shown in Figure 3.2. This study area has been defined to provide local context to the analysis of risks by obtaining the vessel traffic movements within, and in proximity to, the OAA. A 10 nm study area has been used within the majority of UK offshore wind farm NRAs and is suitable for collection of Radio Detection and Ranging (Radar) data.

Based on consultation input, in addition to the 10 nm study area, a wider study area has been considered for vessel routeing (see Section 11) and the assessment of long term data (Appendix E) (hereafter referred to as the 'routeing study area'). The routeing study area was defined to capture traffic passing offshore of the Sule Skerry, noting that further details are provided in Section 4.

A 2 nm buffer has been applied around the offshore ECC (hereafter the 'offshore ECC study area') as shown in Figure 3.2. As with offshore study area, this study area has been defined to capture relevant users and their movements within, and near, the offshore ECC.

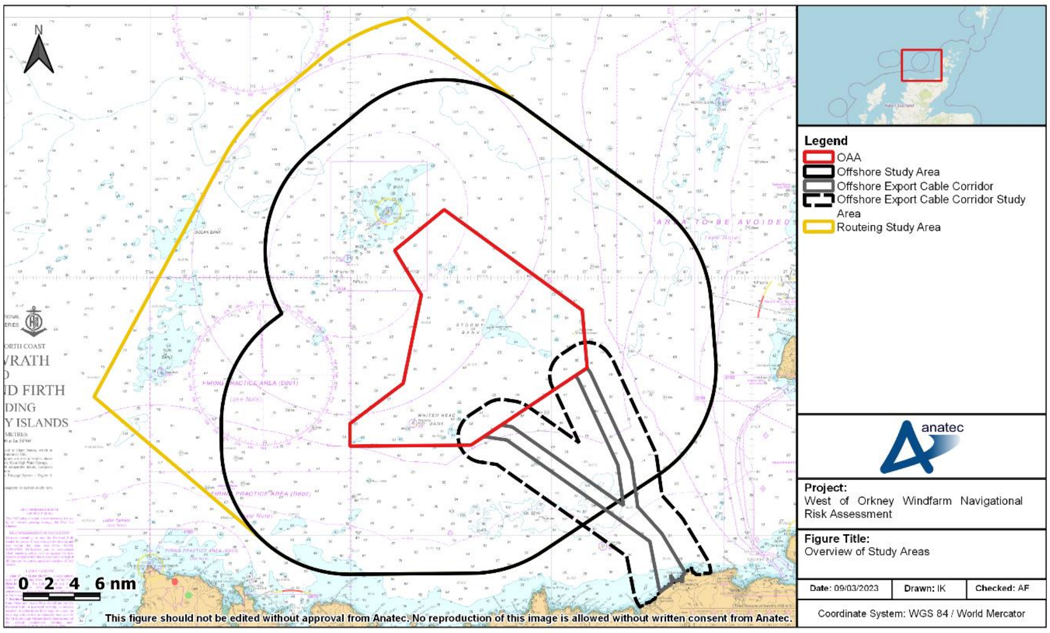

Figure 3.2 Overview of Offshore Project and Associated Study Areas

4 Consultation

4.1 Stakeholders Consulted in the Navigational Risk Assessment Process

Key shipping and navigation stakeholders have been consulted in the NRA process. The following stakeholders have been consulted via meetings including the hazard workshop:

- MCA;
- Northern Lighthouse Board (NLB);
- UK Chamber of Shipping;
- RYA Scotland;
- CA;
- Orkney Islands Council Harbour Authority;
- Scrabster Harbour;
- Orkney Fisheries Association;
- Scottish White Fish Production Association;
- Serco Northlink; and
- DFDS Seaways.

Meetings have included the Hazard Workshop (see Section 4.3) and standalone consultation meetings held both prior to, and following, the Scoping stage.

As well as consulting with the organisations outlined in Section 4.1, 24 Regular Operators identified from the vessel traffic surveys and long-term vessel traffic data were provided with an overview of the offshore Project and offered the opportunity to provide feedback. Specific questions were included to aid Regular Operators wishing to make a response, including in relation to changes in routeing or adverse weather routeing. The Regular Operator letter is presented in full in Appendix C.

The full list of Regular Operators identified and subsequently contacted is provided below:

- Aquaship;
- Arklow Shipping;
- Astrol LLC;
- Biofeeder;
- Cargow;
- DFDS Seaways;
- Eimskip;
- Exmar;
- Hav Shipping;
- James Fisher;
- Longship;
- Marnavi;
- Migdale Transport;
- Nordic Chartering;
- NTS Shipping;
- Ocean Farm Services;
- Samskip;
- Scotline;
- Serco Northlink;
- SMT Shipping;
- Smyril Line;
- Solvtrans;
- Stenersen;
- Tarbit Tankers; and
- Thun Tankers.

DFDS Seaways, Ocean Farm Services, BioFeeder, Godby Shipping, and Migdale Transport provided feedback directly, as summarised in the relevant entries in Table 4.1.

4.2 Consultation Responses

Various responses have been received from stakeholders during consultation undertaken in the NRA process including during the Hazard Workshop, other consultation meetings, via email correspondence, and through the Scoping Opinion. The key points and where they have been addressed in the NRA or Offshore EIA Report, chapter 15: Shipping and navigation are summarised in Table 4.1.

Table 4.1 Consultation Summary

Stakeholder	Date	Form of Correspondence	Remarks	Response and Where Addressed in the NRA
MS-LOT	29/06/2022	Scoping Opinion	The Scottish Ministers are broadly content with regards to the proposed study area identified in section 2.8 of the Scoping Report. However, the Scottish Ministers advise that the Developer must extend the routeing area beyond the 10 nm study area particularly at the Western extent to account for possible deviations around Skerry Rocks. This is a view supported by the UK Chamber of Shipping representation which must be addressed in full by the Developer. Additionally, in line with the representation from the RYA, the Scottish Ministers advise that the 10 nm buffer zone should be amended and extend from Cape Wrath to Sule Skerry to a point 5 nm of the northernmost point of the OAA, to ensure that the European Marine Energy Centre (EMEC) Billia Croo site, Space Hub Sutherland, and the MOD Cape Wrath Range are included and considered when assessing in-combination effects.	Based on UK Chamber of Shipping input, the NRA includes consideration of a wider study area as per Section 3.4. UK Chamber of Shipping, MCA and NLB confirmed content with this study area. The EMEC Billia Croo site and the MOD Cape Wrath Range have been captured within the Navigational Features in Section 7. Space Hub Sutherland has then been captured via the cumulative screening process in Section 14.
MS-LOT	29/06/2022	Scoping Opinion	With regards to the baseline data presented within table 2-47 of the Scoping Report, the Scottish Ministers direct the Developer to the representation from the UK Chamber of Shipping. The Scottish Ministers advise that the Marine Accident Investigation Branch ("MAIB") spatial accident data included within the EIAR must be increased from 10 years to 20 years to fully assess trends and historic collision incidents.	A total of 20 years of data has been assessed as per Section 5. The UKCoS has been consulted throughout the EIA process.
MS-LOT	29/06/2022	Scoping Opinion	In line with the representation from the MCA, the Scottish Ministers are content that that the two separate 14 day periods of Automatic Identification System ("AIS") data set out in the Scoping Report meets the standard MGN 654, however highlight the advice from the UK Chamber of Shipping that an additional full 12 months of AIS data should be included in the EIAR . The Scottish Ministers advise that the Developer must engage further with the MCA and UK Chamber of Shipping to reach a suitable agreement on the provision of AIS data and	The NRA has assessed 12 months of AIS data from 2021 (see Appendix E). Consultation has been undertaken with the MCA and other shipping and navigation stakeholders to agree the data required to support the NRA.

			document the rationale for the final approach within the EIAR. Only AIS data from either 2019 or 2021 must be utilised within the EIAR due to the impact of the Covid-19 pandemic on shipping, and in particular cruise and passenger traffic, during 2020.	
MS-LOT	29/06/2022	Scoping Opinion	The Developer is also directed to the representation from the RYA regarding impacts of construction activities should a cable landfall route through Hoy Sound be chosen. The Scottish Ministers advise the Developer that the EIAR and NRA must detail how the volume of traffic and timing of construction activities have been considered to avoid adverse tidal flows.	The referenced cable route has been considered cumulatively (see section 19). Associated impacts are assessed in the NRA and the Offshore EIA Report, chapter 15: Shipping and navigation. The comment in relation to tidal flows was made by RYA Scotland in relation to the Hoy Sound cable routeing which is no longer included as part of this consent application
MS-LOT	29/06/2022	Scoping Opinion	Table 2-50 of the Scoping Report summarises the potential impacts to shipping and navigation for each phase of the Proposed Development which the Developer proposes to scope into the EIAR . The Scottish Ministers agree with the impacts scoped into the EIAR, however advise that in line with the representation from OIC, impacts to ferry routes should be scoped into the EIAR.	No regular passenger ferry routes were captured within the study areas assessed for the NRA (see Section 3.4), noting that the Serco Northlink ferry route between Scrabster and Orkney passes to the east. Regardless Serco Northlink attended and inputted into the hazard workshop process (see Section 4.3) Vessel routes identified are shown in Section 11. This includes any passenger vessels recorded in the area and any regular commercial users. Associated impacts are assessed in Offshore EIA Report, chapter 15: Shipping and navigation and Section 18 of the NRA.

MS-LOT	29/06/2022	Scoping Opinion	With regards to cabling routes and cable burial, the Scottish Ministers advise that a Burial Protection Index should be completed and, subject to the traffic volumes, an anchor penetration study may be necessary. The Scottish Ministers advise that this should be fully addressed in the EIAR and highlight the MCA advice on a maximum 5% reduction in surrounding depth referenced to Chart Datum (CD) if cable protection measures are required and in particular where depths are decreasing towards shore.	As per Section 17, there will be full MGN 654 (MCA, 2021) compliance including in relation to anchor studies and water depth reductions. The cable burial risk assessment and anchor penetration study (if required) will be undertaken once geotechnical survey data is available
MS-LOT	29/06/2022	Scoping Opinion	The Scottish Ministers advise the Developer must give consideration within the EIAR for the potential effect of electromagnetic deviation on ships' compasses should High-Voltage Direct Current (HVDC) transmission infrastructure be installed. For completeness, the Scottish Ministers highlight the advice from MCA regarding maximum deviation from the cable route.	The effects of Electromagnetic Fields (EMF) have been considered within the NRA (see section 13.6), noting that High Voltage Directional Current (HVDC) is no longer included in the current Project Design Envelope (PDE).
MS-LOT	29/06/2022	Scoping Opinion	The Scottish Ministers also highlight the MCA representation regarding Search and Rescue ("SAR"), Emergency Response Co-operation Plans, levels of radar surveillance, AIS and shore-based Very High Frequency (VHF) radio coverage. The Scottish Ministers advise that the MCA representation must be fully addressed within the EIAR and that a SAR checklist must be completed by the Developer in consultation with the MCA.	As per Section 17, there will be full MGN 654 (MCA, 2021) compliance including in relation to MCA SAR requirements.
MS-LOT	29/06/2022	Scoping Opinion	The Developer has summarised potential cumulative effects in section 2.8.7 of the Scoping Report. The Scottish Ministers advise that the Developer must assess the potential cumulative and in combination effects on shipping routes due to the significant through traffic in the area of the Proposed Development, in line with the MCA representation.	See Section 15.5. Anticipated main commercial route deviations have been defined for the Project in isolation scenario and the cumulative scenario in full, noting this includes consideration of adverse weather routeing. Cumulative impacts due to vessel displacement and increased third party

				vessel to vessel collision risk impacts have been assessed in section 19.
MCA	29/04/2022	Scoping Opinion	The Environmental Statement 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 hazards have been assessed in the NRA including in Section 18 and in Offshore EIA Report, chapter 15: Shipping and navigation.
MCA	29/04/2022	Scoping Opinion	The development area carries a significant amount of through traffic to major ports, with a number of important shipping routes in close proximity, and attention needs to be paid to routing, particularly in heavy weather ensuring shipping can continue to make safe passage without large-scale deviations. The likely cumulative and in combination effects on shipping routes should also be considered, the impact on navigable sea room and include an appropriate assessment of the distances between wind farm boundaries and shipping routes as per MGN 654.	Anticipated main commercial route deviations have been defined for the offshore Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing. A completed MGN 654 checklist is provided in Appendix A.
MCA	29/04/2022	Scoping Opinion	An NRA will need to be submitted in accordance with MGN 654 and the MCA Methodology for assessing the Marine Navigation Safety & Emergency Response Risks of OREIs. This NRA should be accompanied by a detailed MGN 654 Checklist.	The relevant MCA guidance has been considered (see Section 2). A completed MGN 654 checklist is provided in 24.

MCA	29/04/2022	Scoping Opinion	I note, in paragraph 2.8.3.1, that vessel traffic surveys will be undertaken to the standard of MGN 654 i.e. at least 28 days which is to include seasonal data (two x 14-day surveys) collected from a vessel-based survey using AIS, radar and visual observations to capture all vessels navigating in the study area.	Vessel traffic methodology is agreed and in line with MGN 654 requirements (see Section 5.2). Two 14-day AIS, radar, and visual observation surveys undertaken in summer 2022 (17th to 31st August 2022) and winter 2022 (1st to 15th November 2022).
MCA	29/04/2022	Scoping Opinion	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 SAR aircraft operating within the site. Any additional navigation safety and/or SAR requirements, as per MGN 654 Annex 5, will be agreed at the approval stage.	All impacts assessed were determined to be As Low As Reasonably Practicable (ALARP) under the Formal Safety Assessment (FSA) assuming the implementation of additional mitigation in the form of additional post consent consultation with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate as per Section 17.
MCA	29/04/2022	Scoping Opinion	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 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, there will be full MGN 654 (MCA, 2021) compliance including in relation to anchor studies and water depth reductions. A Cable Burial Risk Assessment will be undertaken post consent.
MCA	29/04/2022	Scoping Opinion	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). Attention should be paid to the level of radar surveillance, AIS and shore-based 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	As per Section 17, there will be full MGN 654 (MCA, 2021) compliance including in relation to MCA SAR requirements.

			wind farm sites and their surrounding areas. A SAR Checklist will also need to be completed in consultation with MCA.	
MCA	29/04/2022	Scoping Opinion	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, there will be full MGN 654 (MCA, 2021) compliance including in relation to hydrographic surveys.
MCA	29/04/2022	Scoping Opinion	It is noted that HVDC transmission infrastructure maybe installed therefore consideration must be given to electromagnetic deviation on ships' compasses. The MCA would be willing to accept a three-degree deviation for 95% of the cable route. For the remaining 5% of the cable route no more than five degrees will be attained. The MCA would however expect a deviation survey post the cable being laid; this will confirm conformity with the consent condition. The developer should then provide this data to United Kingdom Hydrography Office (UKHO) via a hydrographic note (H102), as they may want a precautionary notation on the appropriate Admiralty Charts.	See. HVDC is no longer under consideration for the current application. EMF impacts have been assessed in the NRA (Section 13.6), noting that HVDC is no longer under consideration in the current PDE.
MCA	29/04/2022	Scoping Opinion	Paragraph 2.8.10 asks some scoping questions to which our responses are as follows: • Do you agree with the proposed study area (incorporating a 10 NM buffer around the array area)? Yes • Do you agree with the proposed approach to survey data collection? Yes	Methodology is as per set out in the Scoping Report. Mitigations are detailed in Section 17.

			• Do you agree the embedded mitigation is appropriate, or are there other measures that should be included? The full list of risk controls will be identified during the NRA process of consultation with navigation stakeholders and hazard analysis. • Do you agree with the list of scoped impacts? Yes, in combination with comments above. • Are there any additional shipping and navigation organisations that you would recommend be consulted? The list under paragraph 2.8.9.1 is appropriate. • Do you agree with the proposed assessment approach? Yes"	
MCA	29/04/2022	Scoping Opinion	On the understanding that the Shipping and Navigation aspects are undertaken in accordance with MGN 654, its annexes and the above comments, MCA is likely to be content with the approach.	A completed MGN 654 checklist is provided in Appendix A.
NLB	04/04/2022	Scoping Opinion	NLB note the inclusion of Section 2.8 (Shipping and Navigation) within the Scoping Report, and will continue to engage with the developer in all aspects of navigational safety with regard to the project. NLB will provide specific lighting and marking recommendations for both the offshore and landfall sites as the project develops. NLB have no objection to the content of the Scoping Report.	As per Section 17, lighting and marking will be agreed with the NLB.

NLB	04/04/2022	Scoping Opinion	NLB have no objection to the content of the Scoping Report.	Methodology is as per that set out in Scoping Report.
Orkney Islands Council Harbour Authority	2022	Scoping Opinion	"2.8.9 Approach to Analysis and Assessment Orkney Harbour Authority should be identified as the Statutory Harbour Authority for Scapa Flow."	Captured in baseline (Section 7).
Orkney Islands Council Harbour Authority	2022	Scoping Opinion	"Table 2-67 Summary of Key Datasets and Reports Include Orkney Islands Marine Region: State of the Environment Assessment 2020"	See Section 5 – report has been used to inform establishment of baseline.
Orkney Islands Council Harbour Authority	2022	Scoping Opinion	"Table 2-73 Summary of Key Datasets and Reports Include: • Orkney Harbours Masterplan – Phase 1 https://www.orkneyharbours.com/documents/orkney-harbours-masterplan-phase-1 • Scotland's Aquaculture | Home	The referenced literature has been considered where appropriate.

			• Clyde Cruising Club Sailing Directions and Anchorages: Orkney and Shetland Islands including North and Northeast Scotland: https://www.clyde.org/publications/ • The Kingfisher Information Service – Offshore Renewable and Cable Awareness (KIS-ORCA) http://www.kis-orca.eu/"	
Orkney Islands Council Harbour Authority	2022	Scoping Opinion	The Orkney Harbour Authority should be consulted to determine whether there are any wider Harbour Area operational issues to be considered over and above STS and the Flotta Oil Terminal in Scapa Flow.	Orkney Islands Council Harbour Authority attended the hazard workshop.
RYA Scotland	29/04/2022	Scoping Opinion	RYA Scotland has no objection to the proposed study area but considers it would be better for the buffer zone to go from Cape Wrath to Sule Skerry, to a point 5 nM of the northernmost point of the options area, to Bay of Skaill, to Dunnet Head following the coast of Hoy before following the coast back to Cape Wrath. This new area would include the EMEC Billia Croo site, the Sutherland Space Hub and the MoD Cape Wrath Range, all of which should be considered in terms of potential in combination effects.	The referenced developments have all been captured either in the baseline (see Section 7) or cumulatively (see Section 14).
RYA Scotland	29/04/2022	Scoping Opinion	I agree with the proposed collection of data on recreational boats but consider that there are already sufficient data on the routes taken by recreational craft in these waters. Note that Orkney islands Council on behalf of the Orkney Marine Planning Partnership is currently carrying out a survey of the use of the Orkney waters for recreation (mentioned in section 2.12). Note also that the location of recreational anchorages in Scapa Flow are shown in the OIC Supplementary Guidance for aquaculture and are held by the Orkney Marine Planning Partnership.	RYA Scotland confirmed content with data considered in NRA in meeting on 22nd March 2023. The connection to the Flotta Hydrogen Hub will be the subject of a separate application.

RYA Scotland	29/04/2022	Scoping Opinion	Local ports and harbours are mentioned. For Orkney the contacts should be the Orkney Islands Council Harbour Authority, Orkney Marinas and the Orkney Marine Planning Partnership. Sail Scotland should also be added to the list as the organisation promoting recreational boat cruising. There are several mentions of possible impacts on passengers on cruise vessels so it would also be appropriate to consult the industry body, Cruise Scotland.	The listed organisations have been consulted with during the EIA process and/or participated in (or invited to participate in) the hazard workshop. Letters have been written to the Orkney Marinas, Sail Scotland and Cruise Scotland organisations to ensure they have the opportunity to raise comments. Letters have been to ensure they have the opportunity to raise comments.
RYA Scotland	29/04/2022	Scoping Opinion	The approach follows best practice. In relation to the cable landfall routes, the potential impact during construction will be much higher if a route through Hoy Sound is chosen due to the amount of traffic and the importance of correct timing to avoid adverse tidal flows and the EIA and NRA will need to be structured to make that clear.	The offshore export cables to the Flotta Hydrogen Hub are not part of this consent application and not considered within this Offshore EIA Report. The details currently available for connection to the Flotta Hydrogen Hub have been considered in the cumulative assessment only.
RYA Scotland	29/04/2022	Scoping Opinion	Do you agree the embedded mitigation is appropriate, or are there other measures that should be included? I agree with the list of embedded mitigations, some of which are in any case legal requirements.	See Section 17.
UK Chamber of Shipping	29/06/2022	Scoping Opinion	"Recognising the considerable length to the Scoping Report, the Chamber has limited its consultation response to that within the Shipping and Navigation chapter of the report."	Noted.

UK Chamber of Shipping	29/06/2022	Scoping Opinion	"The Chamber is aware that the MAIB have spatial accident data extending back to 1992 and is of the view that for long term projects such as offshore wind farms, examining 10 years of accident data is not truly representative of trends and historic incidents. As such the Chamber recommends that 20 years of MAIB spatial accident data be included in the EIA baseline. This request the Chamber is making to all prospective developments and is being met with general agreement."	A total of 20 years of MAIB spatial accident data has been assessed as per Section 5. The UKCoS has been consulted throughout the EIA process, as detailed in this chapter.
UK Chamber of Shipping	29/06/2022	Scoping Opinion	"Given the large area of the proposed development the Chamber would strongly recommend at full 12 months AIS data be acquired in addition to the two – 14 days periods as required. This will fully factor in seasonal variation and occasional traffic. The Chamber would recommend either 2019 or 2021 as preferable years for this data, in recognition of the impact of Covid-19 on shipping, in particular cruise and passenger traffic."	The NRA has assessed 12 months of AIS data from 2021 (see Appendix E). Consultation has been undertaken with the MCA and other shipping and navigation stakeholders to agree the data required to support the NRA. In addition to the required two 14-day periods of radar and visual observation surveys were undertaken in summer 2022 (17th to 31st August 2022) and winter 2022 (1st to 15th November 2022).
UK Chamber of Shipping	29/06/2022	Scoping Opinion	"Serco Northlink are members of the UK Chamber and as such the Chamber represents them, however recognising the repeated references to the Hamnavoe ferry operated by them in the Scoping Report, the Chamber recommends that direct engagement with Serco Northlink be sought promptly."	Serco Northlink were invited to and subsequently attended the hazard workshop. However it should be noted that due to the fact this current application is for the export of power to a grid connection in Caithness, and the Flotta power export option will be the subject of a future sperate application, Serco Northlink ferry route do not overlap the shipping and navigation Study area.

UK Chamber of Shipping	29/06/2022	Scoping Opinion	"The Chamber would like to see an extended routeing area considered more widely than the 10 nm study area, in particular at the Western extent where the edge of the proposed development comes into close proximity with Skerry rocks as required deviations may have significant routeing implications given proximity to the rocks."	Based on UK Chamber of Shipping input, the NRA includes consideration of a wider routing study area as per Section 3.4. UK Chamber of Shipping, MCA and NLB confirmed content with this study area.
UK Chamber of Shipping	29/06/2022	Scoping Opinion	The Chamber otherwise finds the Scoping Report to contain what it would hope for and expect in terms of the data and methodology employed. The Chamber looks forward to early engagement with the development as the planning and consenting process continues	Noted. The UKCoS has been consulted throughout the EIA process, as detailed in this chapter.
MCA	15/06/2022	Meeting with the MCA	Content with the approach to extend the offshore study area to cover traffic potentially re-routeing around the Sule Skerry and Sule Stack.	Study areas used are as per those agreed (see Section 3.4).
UK Chamber of Shipping	29/06/2022	Email	Content with the offshore study area proposed.	Study areas used are as per those agreed (see Section 3.4).
Ocean Farm Services	15/09/2022	Regular Operator Response	▪ The development is situated where vessels routeing between Shetland and Orkney transit. ▪ In adverse weather conditions diversion of routes may be needed to avoid the wind farm. ▪ The decision as to whether or not to transit through will depend on the final layout.	Anticipated main commercial route deviations have been defined for the Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing.

			▪ If no additional buoyage then no additional risk when comparing floating to fixed installations.	
BioFeeder	17/09/2022	Regular Operators Response	▪ Vessels may choose to transit through the OAA if visibility/wind conditions are favourable.	Anticipated main commercial route deviations have been defined for the Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing.
MCA	14/09/2022	Meeting	▪ NRA should consider deviations. ▪ Layout design will need considering.	Anticipated main commercial route deviations have been defined for the Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing. The layout will be agreed through the DSLP process which will include consultation with the MCA as per Section 17.
Godby Shipping / DFDS	22/09/2022	Regular Operator Response	▪ The OAA will lead to a deviation of the routeing between Belfast and Norway. ▪ Noted that there would be less time to address vessel issues due to the presence of structures. ▪ The presence of structures will also reduce routeing options during adverse weather.	Anticipated main commercial route deviations have been defined for the Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing. Vessel drifting risk has been assessed in Section 16.3.4.

Scotline	26/09/2022	Regular Operator Response	▪ Typical routeing means vessels will pass in proximity, however transit through the OAA unlikely. ▪ In adverse weather conditions, vessels "tack" in the area meaning they pass further north than typical transits. ▪ Presence of work boats in the offshore ECC has potential to pose safety concerns for vessels.	Anticipated main commercial route deviations have been defined for the Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing. Hazards associated with project vessels are assessed in Section 18.
Migdale Transport	26/09/2022	Regular Operator Response	▪ It will be master decision as to whether to transit through the OAA. ▪ Array location will impact routeing of vessels as will need to deviate depending on weather conditions. ▪ Deviations would lead to additional distance i.e., additional time and costs.	Anticipated main commercial route deviations have been defined for the Project in isolation scenario (see Section 15.4) and the cumulative scenario (see Section 15.4.3). See Section 12 for adverse weather routeing.
UK Chamber of Shipping	27/10/2022	Hazard Workshop	Suggested NRA should include figure showing vessel direction / course.	Analysis of average vessel bearings has been included in Section 10.1.4.
Scottish White Fish Producers Association	27/10/2022	Hazard Workshop	Fishing vessels likely to be underrepresented in the AIS data sets.	Vessel Monitoring System (VMS) data has been included in the fishing vessel analysis for the offshore study area (see Section 10.1.2.2) and offshore ECC study area (see Section 10.2.2.2). The vessel traffic surveys are inclusive of non AIS traffic and input from consultation with commercial fisheries via the Project Fisheries Working Group (see Section 5).
Scottish White Fish Producers Association	27/10/2022	Hazard Workshop	Indicated other offshore wind farms including to the west should be considered in the NRA.	See Section 15.4.3.
CA	27/10/2022	Hazard Workshop	Indicated limited concern with the offshore export cables.	Associated hazards assessed in Section 18.

MCA	27/10/2022	Hazard Workshop	Pentland Floating Offshore Wind Farm (PFOWF) should be considered for route deviations in the NRA.	PFOWF has been considered in the cumulative scenario (see Section 15.4.3).
Orkney Islands Council Harbour Authority	27/10/2022	Hazard Workshop	Cruise liner traffic during 2021 may be underrepresented due to COVID.	Additional data sources have been considered to ensure appropriate modelling inputs including Anatec's ShipRoutes database (Anatec 2022) (see Section 5).
UK Chamber of Shipping	16/02/2023	Meeting	Commercial route information should display a breakdown of vessel type numbers and other destinations.	Vessel type breakdown, and other less-frequently broadcast destinations, are highlighted in Section 11.2.
RYA Scotland	22/03/2023	Meeting	Notable level of recreational traffic in Hoy Sound, of which collision risk could be heightened by Project vessels.	Vessel management mitigations will be in place to avoid disruptions to other activities from the Project vessels (see Section 17).
RYA Scotland	22/03/2023	Meeting	Landfall areas do not raise any concerns as there is not much recreational activity close to shore by landfalls and locations are away from Thurso Bay.	Considered in Section 18.
NLB	12/05/2023	Meeting	Helicopter transit time during maintenance of the Sule Skerry lighthouse	Agreed discussion will be closed during the DSLP process post-consent.
UK Chamber of Shipping	29/06/2023	Email	Response to draft NRA comments.	Clarifying that the UKCoS will be consulted on the DSLP (see section 17).

4.3 Hazard Workshop

A key element of the consultation undertaken was the Hazard Workshop, a meeting of local and national marine stakeholders to identify and discuss potential shipping and navigation hazards. Using the information gathered from the Hazard Workshop, a hazard log was produced to be used as input into the risk assessment undertaken in Offshore EIA Report, chapter 15: Shipping and navigation and Section 18 of the NRA. This ensured that expert opinion and local knowledge was incorporated into the hazard identification process and that the hazard log was site-specific.

4.3.1 Hazard Workshop Attendance

The Hazard Workshop was held via teleconferencing on 27 October 2022 and was attended by the organisations listed in Section 4.1.

4.3.2 Hazard Workshop Process and Hazard Log

During the Hazard Workshop, key maritime hazards associated with the construction, operation and maintenance and decommissioning of the offshore 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.

Following the Hazard Workshop, the risks associated with the identified hazards were ranked in the hazard log based upon the discussions held during the workshop. Where appropriate, mitigation measures were 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.

The hazard log has been used to inform the risk assessment undertaken in Offshore EIA Report, chapter 15: Shipping and navigation and Section 18 of the NRA, and is presented in full in Appendix B.

5 Data Sources

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

5.1 Summary of Data Sources

The main data sources used in assessing the shipping and navigation baseline relative to the offshore 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	AIS, Radar, and visual observation summer survey data for the offshore study area (14 days, August 2022).	Characterising vessel traffic movements within and in proximity to the OAA.
	AIS, radar, and visual observation winter survey data for the offshore study area (14 days, November 2022).	
	AIS summer survey data for the offshore ECC study area (14 days, August 2022).	Characterising vessel traffic movements within and in proximity to the offshore ECC.
	AIS winter survey data for the offshore ECC study area (14 days, November 2022).	
	AIS data for the offshore study area (12 months, 2021).	Validation of survey data for the offshore study area.
	Anatec's ShipRoutes database (2022).	
	UK ports: ship arrivals (Department for Transport (DfT), 2022).	Characterising vessel traffic movements in relation to ports local to the offshore Project.
	UK Coastal Atlas of Recreational Boating (RYA, 2019 (a)).	Characterising recreational activity in proximity to the offshore Project.
Maritime incidents	MAIB marine accidents database (2000 to 2019).	Review of historical maritime incidents within and in proximity to the offshore Project.
	Royal National Lifeboat Institution (RNLI) incident data (2010 to 2019).	
	DfT UK civilian SAR helicopter taskings (April 2015 to March 2022).	
Other navigational features	Admiralty Chart 1954 (United Kingdom Hydrographic Office (UKHO), 2022).	Characterising other navigational features within and in proximity to the offshore Project.
	Admiralty Sailing Directions North Coast of Scotland Pilot NP52 (UKHO, 2022)	
	Marine Scotland military exercise and danger areas (2019).	
Weather	Wind direction data.	Characterising weather conditions in proximity to the offshore Project for use as input
	Significant wave height data..	

Data	Source(s)	Purpose
	Tidal data from Admiralty Charts 1954 and 2720 (UKHO, 2022).	to the collision and allision risk modelling.
	Visibility data from *Admiralty Sailing Directions North Coast of Scotland Pilot NP52* (UKHO, 2022).	

5.2 Vessel Traffic Surveys

The vessel traffic surveys were undertaken using methodology agreed with the MCA and NLB. Two 14-day AIS, Radar, and visual observation surveys undertaken in summer 2022 (17 to 31 August 2022) and winter 2022 (1 to 15 November 2022) have been considered within the baseline for a total of 28 full days, with a long-term dataset from 2021 used as validation (see Appendix E). It is noted that due to severe weather, the survey vessel left the offshore study area for approximately 12 hours on the 3 of November, with this period of time appended to the end of the survey period to allow for the full 28 days of data to be collected.

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 other non-routeing survey vessels. These have therefore been excluded from the analysis.

The dataset is assessed in full in Section 10.

5.3 Long-Term Vessel Traffic Data

Long-term vessel traffic data consisting of AIS covering 12 months in 2021 was collected from coastal receivers. Taking into account the distance offshore of the OAA, the long-term vessel traffic data is considered to be comprehensive for the offshore study area. The assessment of this dataset allowed seasonal variations to be captured.

The dataset is assessed in full in Appendix E.

5.4 Data Limitations

5.4.1 Automatic Identification System Data and Vessel Traffic Survey Data

For the purposes of the NRA, it has been assumed that vessels under an obligation to broadcast information via AIS have done so, both in the vessel traffic surveys and long-term vessel traffic data. It has also been assumed that the details broadcast via AIS (such as vessel type and dimensions) are accurate unless clear evidence to the contrary was identified during Anatec's thorough quality assurance of the data.

During the summer vessel traffic survey period, site investigation surveys were also ongoing in the OAA. It is therefore likely that fishing vessel activity in the OAA is underrepresented in the associated data set.

5.4.2 Vessel Traffic Data for ECC

The MCA and NLB were content with the methodology for vessel traffic data collection. This method used only the AIS dataset to characterise vessel movements within the offshore ECC study area. Consequently, this dataset has limitations associated with non-AIS targets.

5.4.3 Historical Incident Data

Although all UK commercial vessels are required to report accidents to the MAIB, this is not mandatory for non-UK vessels unless they are in a UK port, within 12 nm of territorial waters (noting that the OAA is located approximately two to three nm offshore at the closest point) or carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report accidents to the MAIB.

The RNLI incident data cannot be considered comprehensive of all incidents in the offshore 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.

5.4.4 United Kingdom Hydrographic Office Admiralty Charts

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. For aids to navigation, only those charted and considered key to establishing the shipping and navigation baseline are shown.

During consultation, input has been sought from relevant stakeholders regarding the navigational features baseline. Navigational features are based upon the most recently available UKHO Admiralty Charts and Sailing Directions at the time of writing.

6 Project Design Envelope Relevant to Shipping and Navigation

The NRA reflects the PDE, which is outlined in full in Offshore EIA Report, chapter 5: Project description. The following subsections outline the maximum extent of the offshore Project for which any shipping and navigation hazards are assessed.

6.1 Offshore Project Boundaries

6.1.1 OAA

The OAA is located approximately 15 nm west of Orkney, and 12 nm north of the northern coast of Scotland. The total area covered by the OAA is approximately 192 square nautical miles (nm^2) (657 square kilometres (km^2)), with water depths ranging between 45 and 99 metres (m) below CD.

All surface piercing structures (WTGs and Offshore Substation Platforms (OSP)) will be located entirely within the OAA, inclusive of blade overfly. The coordinates defining the boundary of the OAA are illustrated in Figure 6.1 and provided in Table 6.1. It is not intended that the OAA be designated as an Area to be Avoided (ATBA), with navigation only restricted where Safety Zones are active (see Section 17).

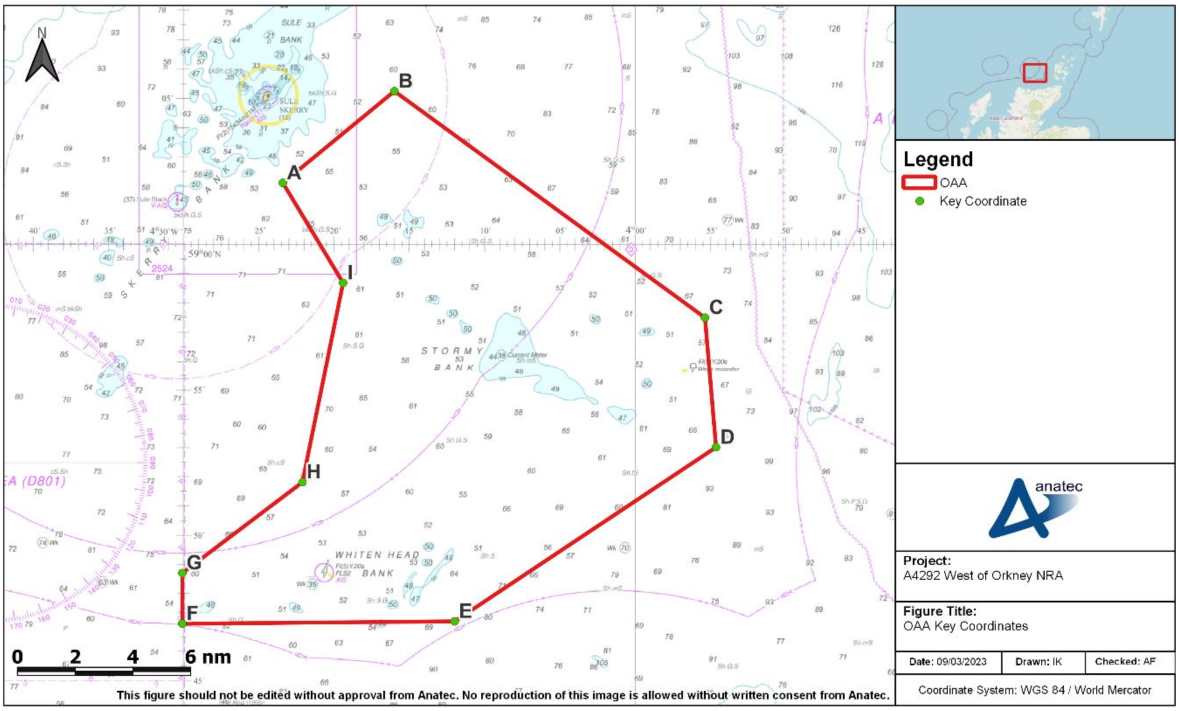

Figure 6.1 OAA Key Coordinates

Table 6.1 OAA Key Coordinates

Point	Latitude (World Geodetic System 1984 (WGS84))	Longitude (WGS84)
A	59° 02’ 06.25” N	004° 23’ 23.65” W
B	59° 05’ 14.67” N	004° 15’ 58.72” W
C	58° 57’ 28.98” N	003° 55’ 19.32” W
D	58° 53’ 01.75” N	003° 54’ 35.24” W
E	58° 47’ 01.79” N	004° 11’ 58.09” W
F	58° 46’ 56.92” N	004° 30’ 04.94” W
G	58° 48’ 41.75” N	004° 30’ 04.94” W
H	58° 51’ 49.61” N	004° 22’ 05.72” W
I	58° 58’ 40.64” N	004° 19’ 23.42” W

6.1.2 Offshore ECC

The offshore ECC runs between the southeastern boundary of the OAA and the landfall options at Crosskirk and Greeny Geo, is presented in Figure 6.2. The total area is approximately 37 nm^2 ($127km^2$) with water depths within offshore ECC ranging between shoreline and 114m below CD. The offshore export cables will be located fully within the offshore ECC.

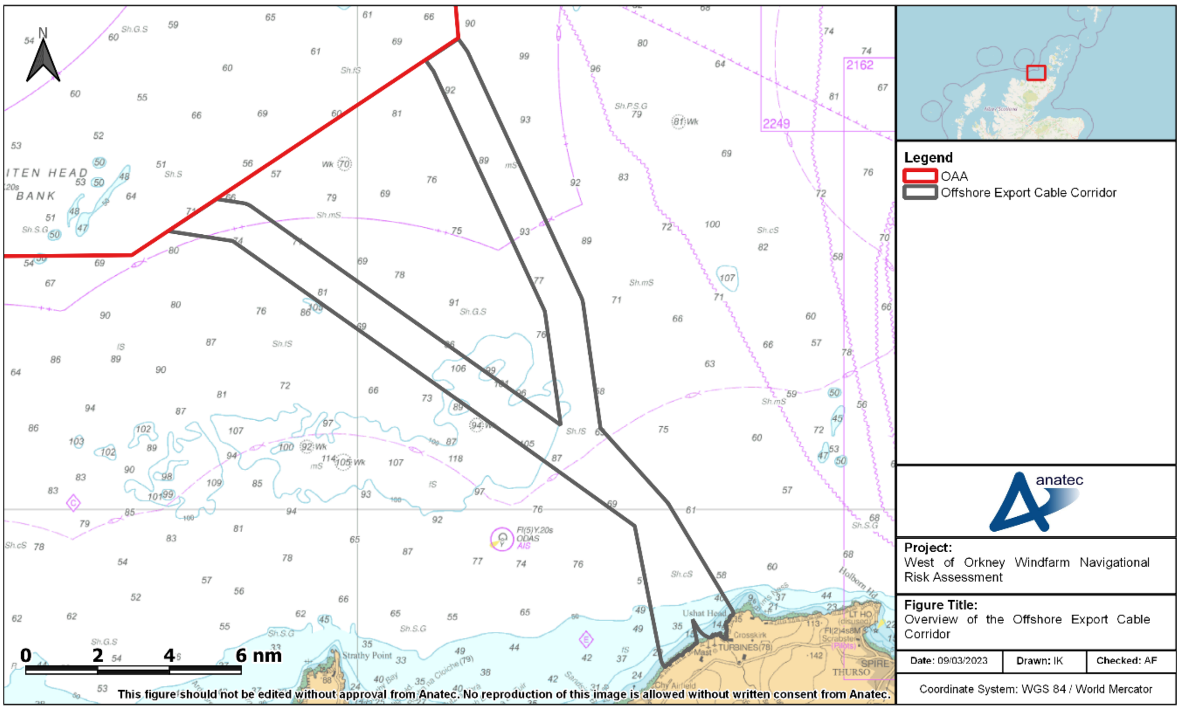

Figure 6.2 Overview of the Offshore ECC

6.2 Surface Infrastructure

6.2.1 Indicative Array Layout

Up to 130 surface structures will be installed within the OAA, consisting of up to 125 WTGs and five OSPs.

Although the final locations of infrastructure have not yet been defined, an indicative worst case array layout option has been considered in this NRA which represents the maximum spatial area and maximum number of WTGs. This layout is generally considered in the risk assessment in Section 18; however it is noted that where a minimum spacing has been considered as the worst case (as opposed to maximum spatial area) this has been flagged. The minimum centre-to-centre spacing between WTGs within the offshore PDE is 944 m.

The indicative worst case layout is presented in Figure 6.3.

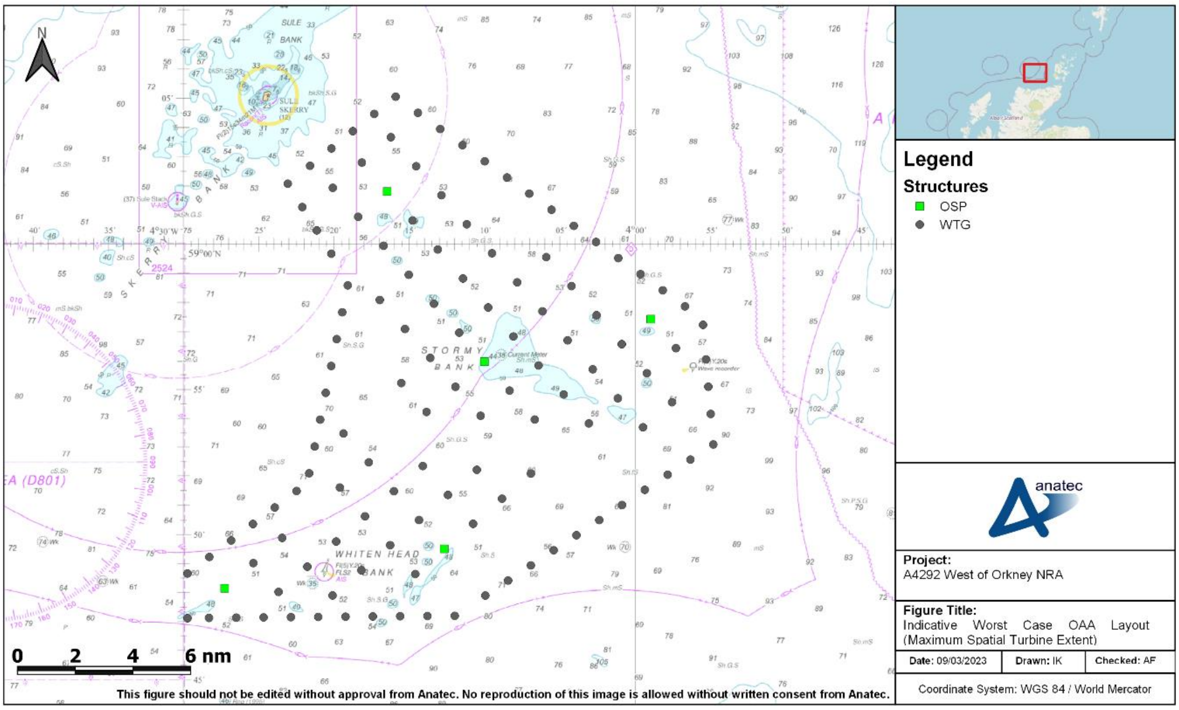

Figure 6.3 Indicative Worst Case OAA Layout (Maximum Spatial WTG Layout)

The indicative worst case array layout consists of a full build out of the OAA periphery to maximise the spatial extent of vessel deviations and the maximum possible number of surface structures to maximise exposure for passing (or adrift) vessels.

It is noted that temporary equipment (e.g., mooring buoys, in field FLIDAR measurement systems) will also be used during the construction stage. Such equipment will be within the OAA and therefore by extension the buoyed construction area.

6.2.2 WTGs

The WCS for the WTGs within the indicative array layout is for a maximum rotor diameter of 330 m and maximum blade tip height (above Lowest Astronomical Tide (LAT)) of up to 359.52 m. It is noted that these values reflect the worst-case values that could be used.

Piled jackets, and suction bucket foundations have been considered as the WCS for shipping and navigation[1] as these foundation types provide the maximum structure dimension at the sea surface, and therefore maximise exposure for passing (or adrift) vessels. The WCS for the WTGs, which assume use of a piled jacket or suction bucket foundation design, are provided in Table 6.2.

[1] Monopiles are also under consideration however are of smaller size at sea level and therefore are not in the shipping and navigation MDS.

Table 6.2 WTG WCS for Shipping and Navigation

Parameter	WCS for shipping and navigation
Foundation type	Jacket
Dimensions at sea surface	20×20 m
Minimum blade clearance above HAT	24.7 m
Maximum blade tip height above LAT	359.52 m
Maximum rotor diameter	330 m

6.2.3 Offshore Substation Platform

The OSPs will be installed on jacket foundations (either piled or suction buckets), utilising High Voltage Alternating Current (HVAC). The maximum topside dimensions are 66×45 m. Positions of substations are not yet known however they may be installed anywhere in the OAA.

6.3 Subsea Infrastructure

6.3.1 Inter-array Cables

The inter-array cables will be fully installed within the OAA to connect individual WTGs to each other and to the OSPs. Up to 270 nm (500 kilometres (km)) of inter-array cables will be required. Up to 10 crossings between the inter-array cables and other inter-array cables, the offshore export cables and the interconnector cables will be required. The final length and number of crossings will depend upon the final array layout. The maximum height of inter-array cable crossings will be 4 m.

6.3.2 Interconnector Cables

The interconnector cables will be fully installed within the OAA to provide interlink connections between the OSPs. Up to 81 nm (150 km) of interconnector cables will be required, although the final length will depend upon the final array layout. The number of crossings required across all cables is 10 as mentioned in section 6.3.1, the maximum height of interconnector cable crossings will be 4 m.

6.3.3 Offshore Export Cables

The offshore export cables will be installed within the offshore ECC to carry the electricity generated by the WTGs to the landfall location. Up to 173 nm (320 km) of offshore export cables will be required. The number of crossings required across all cables is 10 as mentioned in section 6.3.1, the maximum height of offshore export cable crossings will be 4 m.

6.3.4 Cable Burial and Protection

Where possible, 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 subsea cable routes and associated cable burial risk assessment. However, a target burial depth of 1-3 m for all subsea cables associated with the offshore Project is assumed as part of the WCS.

Where cable burial is not possible, alternative cable protection methods may be deployed which will be determined within the cable burial risk assessment. These methods may include a combination of concrete mattresses, rock placement, grout bags, cement bags, sandbags, articulated pipes, cast iron shells, bend restrictors, and filter units/gabion bags (rock bags). It is assumed that up to 20% inter-array cables (100 km), 70% of interconnector cables (99 km), and 30% of offshore export cables (93.5 km) may require cable protection as part of the WCS with a maximum cable protection height of 3 m and width of 20 m.

6.4 Construction Stage

The indicative offshore construction stage will last for four years, noting schedules will be subject to change (e.g., due to adverse weather, vessel availability).

Indicatively, 101 construction vessels may be utilised, with up to 30 vessels on site simultaneously throughout the construction stage. It is likely that construction will be seasonal with limited operations over winter months due to weather restrictions. Table 6.3 provides a breakdown of the installation activities and vessel types during the construction stage .

It is noted that autonomous surface or subsurface vessels may be used. Any use of such vessels would be discussed with the MCA.

Table 6.3 Breakdown of Construction Vessel Peak Numbers

Package	Operation	Vessel Type	Estimated Max Number of Vessels	Transits Per Year
UXO	UXO survey	Multipurpose Survey Vessel	2	48
	UXO Intervention Deep Water	Multipurpose vessel with ROV	1	8
	UXO Intervention Shallow Water	CTV or Multicat	1	28
Site Preparation	PLGR	Multicat or Tug	4	32
	Dredging and Boulder Removal	Dredging Vessel	4	
Pile Installation (Jacket Piles)	Pile Transport	Barge or Self Propelled Vessel	4	32
	Pile Transport (Tug Assistance)	Ocean Going Tug	6	64
	Noise Mitigation & Survey	Multipurpose Vessel	2	24
	Installation Vessel Supply & Stores	Multipurpose Vessel	1	24
	Pile Installation	Semisubmersible crane vessel (e.g. Balder)	1	1
	Scour Protection	Rock Dumper	1	20
Jacket Installation	Jacket Transport	Barge or Self Propelled Vessel	4	32
	Jacket Transport (Tug Assistance)	Ocean Going Tug	6	64
	Grouting	Multipurpose Vessel or Semisubmersible crane vessel (Balder)	1	24
	Jacket Installation	Semisubmersible crane vessel (e.g. Thialf/Sleipnir)	1	1
	Installation Vessel Supply & Stores	Multipurpose Vessel	1	24

Package	Operation	Vessel Type	Estimated Max Number of Vessels	Transits Per Year
	Pile cleaning & Survey	Multipurpose Vessel	2	24
	Personnel Transfer	SOV	1	12
WTG Installation	WTG Installation	Jack Up	4	60
	WTG Component Transport	Transport Vessel	10	131
	Personnel Transfer and Accommodation	SOV	4	48
Inter Array Cable Installation	Cable Lay	Cable Lay Vessel	2	8
	Cable Burial	Multipurpose Vessel	2	12
	Accommodation Vessel	Multipurpose Vessel	1	8
	Supply Vessel	Tug/multicat	2	32
	SOV	As per SOV WTG	As per SOV WTG	As per SOV WTG
Export Cable Installation	Cable Lay	Cable Lay Vessel	2	8
	Jointing Vessel	Cable Lay vessel or Multipurpose Vessel	1	2
	Cable Burial	Multipurpose Vessel	2	12
	Supply Vessel	Tug/multicat	2	32
	SOV	As per SOV WTG	As per SOV WTG	As per SOV WTG
Cable External Protection (Array and Export)	Rock placement	Rock Dumper	4	16
	Mattress Placement, Sand Bag Installation	Multipurpose Vessel	2	8
OSS Installation	Jacket Placement and Piling	Semisubmersible Crane Vessel	1	1

Package	Operation	Vessel Type	Estimated Max Number of Vessels	Transits Per Year
	Topside Installation	Semisubmersible Crane Vessel	0	0
	Jacket and Pile Transport	Barge or Self Propelled Vessel	4	4
	Topside Transport	Barge or Self Propelled Vessel	2	4
	Support Tugs	Oceangoing Tugs	4	16
	Accommodation Vessel for Commissioning	Accommodation Vessel or JUV	2	10
CTV Personnel Transfer	Construction Support CTV	CTV	6	840
As Built Survey ETC	As Built and Ad Hoc Survey	Survey Vessel	1	8
Total			**101**	**1722**

6.5 Operation and Maintenance Stage

The operation and maintenance stage will last at least 30 years. Throughout the operation and maintenance stage , an indicative number of 19 operation and maintenance vessels may be located on-site simultaneously with a maximum of 468 annual round trips to port. Table 6.4 provides a breakdown of the installation activities and vessel types during the operation and maintenance stage .

Table 6.4 Maximum Vessel Numbers per Vessel Type for Operation and Maintenance Stage

Vessel Type	Maximum Number of Vessels
Construction Support Vessel/Cable Install Vessel	1
Remotely Operated Vehicle (ROV)/ Autonomous Surface Vehicle (ASV) Survey Vessel	4
Pre-Lay Grapnel Run Vessel	1
Rock Placement Vessel	1
Guard Vessel	1
CTV/Walk-to-Work (WTW) Vessel	7
Semi-submersible Crane Vessel	1
Barge	3
Jack-up	1
Total	19

Helicopters and drones may form part of the operations and maintenance strategy, with an estimated 195 round trips required annually split between helicopters and CTVs for OSP inspection purposes. In this case, helicopter(s) launching from a nearby heliport are anticipated for frequent use.

6.6 Decommissioning Stage

The decommissioning stage will generally be the reverse of the construction stage in terms of duration, vessel types and vessel numbers. It is anticipated that all sea surface structures will be completely removed above the seabed and all subsea cables will be left in situ (although best practice will be followed at the time of decommissioning).

6.7 Worst Case Scenario

The WCS 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 WCS for Shipping and Navigation by Hazard

Potential Hazard	Stage (s)	WCS for Shipping and Navigation	Justification
Vessel displacement and increased vessel to vessel collision risk between third-party vessels	Construction (including pre-construction) / decommissioning	▪ Construction of up to four years (with an additional one year pre construction activities e.g., UXO); ▪ Full build out of the OAA; ▪ Buoyed construction / decommissioning area encompassing the maximum extent of the OAA; ▪ Presence of 500 m construction safety zones; ▪ Up to five offshore export cables of combined 173 nm length; ▪ Indicative separation of 170 m between offshore export cables; and ▪ Up to 30 construction / decommissioning vessels on-site simultaneously.	Largest possible extent of infrastructure, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on vessel displacement and subsequent vessel to vessel collision risk.
	Operation and maintenance	▪ Maximum operational life of 30 years; ▪ Full build out of the OAA; ▪ Presence of 500 m safety zones during major maintenance; and ▪ Up to 19 operation and maintenance vessels on-site simultaneously and up to 468 annual round trips to port (including helicopters).	

Potential Hazard	Stage (s)	WCS for Shipping and Navigation	Justification
Increased vessel to vessel collision risk between a third-party vessel and a project vessel	Construction (including pre-construction) / decommissioning	▪ Construction of up to four years (with an additional one year pre construction activities e.g., UXO); ▪ Full build out of the OAA; ▪ Buoyed construction / decommissioning area encompassing the maximum extent of the OAA; ▪ Presence of 500 m construction safety zones and 50 m pre commissioning safety zones; ▪ Up to five offshore export cables of combined 173 nm length; ▪ Indicative separation of 170 m between offshore export cables; and ▪ Up to 30 construction / decommissioning vessels on-site simultaneously.	Largest possible extent of infrastructure, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on vessel to vessel collision risk involving a third-party vessel and a Project vessel.
	Operation and maintenance	▪ Maximum operational life of 30 years; ▪ Full build out of the OAA; ▪ Presence of 500 m safety zones during major maintenance; and ▪ Up to 19 operation and maintenance vessels on-site simultaneously and up to 468 annual round trips to port (including helicopters).	
Vessel to structure allision risk	Operation and maintenance	▪ Maximum operational life of 30 years; ▪ Full build out of the OAA; ▪ Presence of 500 m safety zones during major maintenance; and ▪ Up to 19 operation and maintenance vessels on-site simultaneously and up to 468 annual round trips to port (including helicopters). ▪ Minimum spacing of 944 m between WTGs; ▪ Up to 125 WTGs on four-legged piled jackets with sea surface dimensions of 20×20 m; ▪ Up to five OSPs with topside dimensions of 66×45 m;	Largest possible extent of surface infrastructure, greatest number of surface structures and greatest duration resulting in the maximum spatial and temporal effect on vessel to structure allision risk.

Potential Hazard	Stage (s)	WCS for Shipping and Navigation	Justification
Reduction of under keel clearance due to cable protection	Operation and maintenance	▪ Maximum operational life of 30 years; ▪ Up to 270 nm of inter-array cables; ▪ Up to six interconnector cables with combined 81 nm length; ▪ Up to five offshore export cables of combined 173 nm length; ▪ Indicative separation of 170 m between offshore export cables; ▪ Indicative maximum proportion of inter-array cable protection requirement of 20%; ▪ Indicative maximum proportion of interconnector cable protection requirement of 70%; ▪ Indicative maximum proportion of export cable protection requirement of 30%; ▪ Up to ten crossings in total for the inter-array cables, the interconnector cables and the offshore export cables; ▪ Indicative height of protection for inter-array cables (including crossings) of 4.0 m; ▪ Indicative height of protection for interconnector cables (including crossings) of 4.0 m; and ▪ Indicative height of protection for offshore export cables (including crossings) of 4.0 m.	Largest possible extent of sub-sea infrastructure and greatest duration resulting in the maximum spatial and temporal effect on under keel clearance.

Potential Hazard	Stage (s)	WCS for Shipping and Navigation	Justification
Anchor interaction with sub-sea cables	Operation and maintenance	▪ Maximum operational life of 30 years; ▪ Up to 270 nm of inter-array cables; ▪ Up to six interconnector cables with combined 81 nm length; ▪ Up to five offshore export cables of combined 173 nm length; ▪ Indicative separation of 170 m between offshore export cables; ▪ Indicative maximum proportion of inter-array cable protection requirement of 20%; ▪ Indicative maximum proportion of interconnector cable protection requirement of 70%; ▪ Indicative maximum proportion of export cable protection requirement of 30%; ▪ Up to ten crossings in total for the inter-array cables, the interconnector cables and the offshore export cables; ▪ Indicative height of protection for inter-array cables (including crossings) of 4.0 m; ▪ Indicative height of protection for interconnector cables (including crossings) of 4.0 m; and ▪ Indicative height of protection for offshore export cables (including crossings) of 4.0 m.	Largest possible extent of sub-sea infrastructure and greatest duration resulting in the maximum spatial and temporal effect on anchor interaction with sub-sea cables.

Potential Hazard	Stage (s)	WCS for Shipping and Navigation	Justification
Reduction of emergency response capability (including SAR access)	Operation and maintenance	▪ Maximum operational life of 30 years; ▪ Full build out of the OAA; ▪ Presence of 500 m safety zones during major maintenance; and ▪ Up to 19 operation and maintenance vessels on-site simultaneously and up to 468 annual round trips to port (including helicopters). ▪ Minimum spacing of 944 m between WTGs; ▪ Up to 125 WTGs on four-legged piled jackets with sea surface dimensions of 20×20 m; ▪ Up to five OSPs with topside dimensions of 66×45 m.	Largest possible extent, greatest number of surface structures, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on emergency response capability.

7 Navigational Features

The navigational features within, and in proximity to, the OAA and offshore ECC are presented in Figure 7.1. It is noted that planned developments (e.g., PFOWF) are not considered baseline but have been considered on a cumulative basis in Section 14.

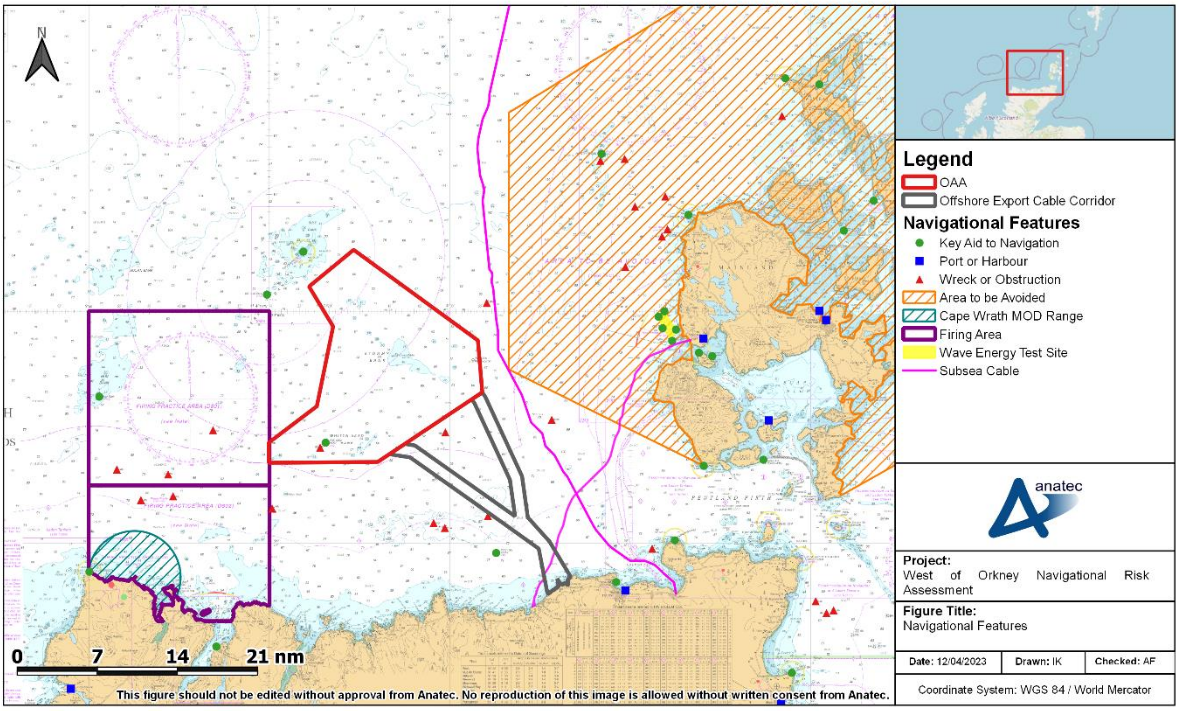

Figure 7.1 Navigational Features in Proximity to West of Orkney

7.1 Shallow Waters and Rocks

Shallow water and surface rock features in proximity to the OAA are presented in Figure 7.2.

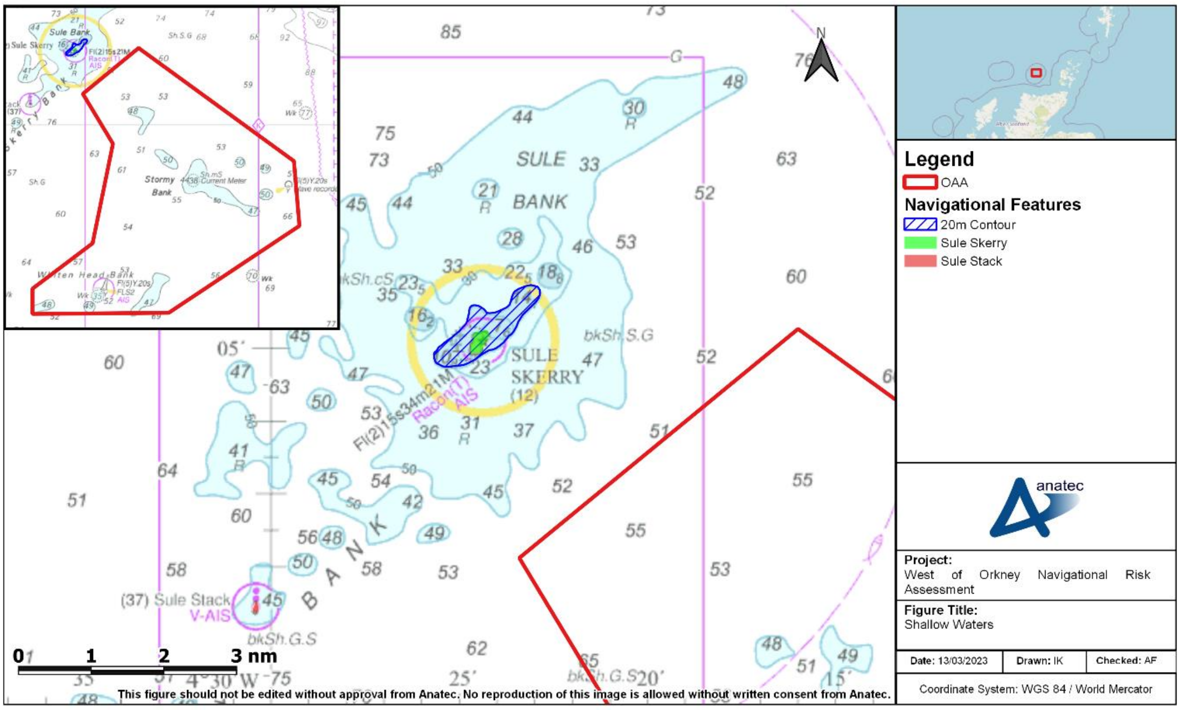

Figure 7.2 Shallow Waters

Sule Skerry is located approximately 2.5 nm northwest of the OAA and is described by the Admiralty Sailing Directions (UKHO, 2022) as being “a grassy islet, 12 m in height”, which is marked with “a light fitted with AIS and a racon.” The area in immediate proximity to Sule Skerry is also referenced – “Rocky patches, with depths of less than 20 m, lie on a bank extending more than 1 mile NE from the islet; in W gales the sea breaks over this bank. On the W side of the islet a more dangerous reef, over which the sea breaks in a moderate swell, extends 3 cables (0.3nm) W”.

Sule Stack is located approximately 3.6 nm west of the OAA. Marked by virtual AIS, according to the Admiralty Sailing Directions (UKHO, 2022), the Stack is “37 m high, rises from Skerry Bank and is steep-to. Viewed from S the stack resembles a vessel under sail; from W it appears as a double rock.”

7.2 Ports and Related Services

A plot of nearby ports and harbours is presented in Figure 7.3.

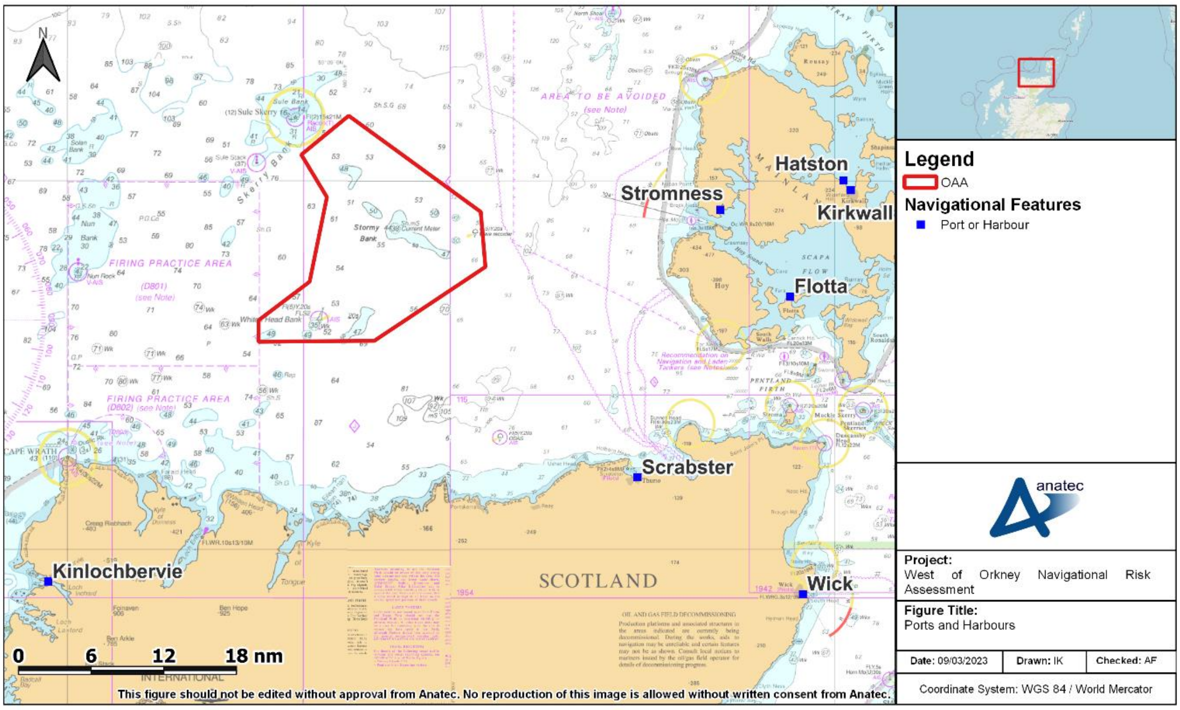

Figure 7.3 Ports and Harbours

The closest port or harbour to the OAA is Stromness Harbour, located approximately 20 nm to the east, on the mainland Orkney coast. The Admiralty Sailing Directions describe Stromness as "a fishing and ferry terminal port, important to the local economy" (UKHO, 2022).

Scrabster Harbour is located approximately 22 nm to the southeast on the northern mainland Scotland coast and is described by the Admiralty Sailing Directions as "an important fishing port at which catches from both UK and foreign registered vessels are landed". It is also "frequently used by cruise ships and is a support base for supply and survey vessels" as well as "a busy Roll-on/Roll-off cargo (RoRo) terminal for ferries to the Orkney Islands".

DfT port arrivals data was available for Scrabster Harbour (DfT, 2022). Vessel traffic arrival numbers have steadily increased from 2017 to 2021 at the Harbour, with a high of 934 vessel arrivals in 2021.

Flotta Oil Terminal is located approximately 25 nm to the east on the island of Flotta. As described by the Admiralty Sailing Directions, it "receives crude oil by pipeline from the North Sea and discharges it into tankers for onward shipment; liquid gases are also shipped by tanker from the terminal".

Kirkwall Harbour is located approximately 30 nm to the east on the northern mainland Scotland coast and is described by the Admiralty Sailing Directions as "an important local commercial centre and port" used by "Ferries, RoRo and container vessels, bulk carriers and cruise ships".

7.3 Area to be Avoided

The ATBA relative to the OAA is presented in Figure 7.4.

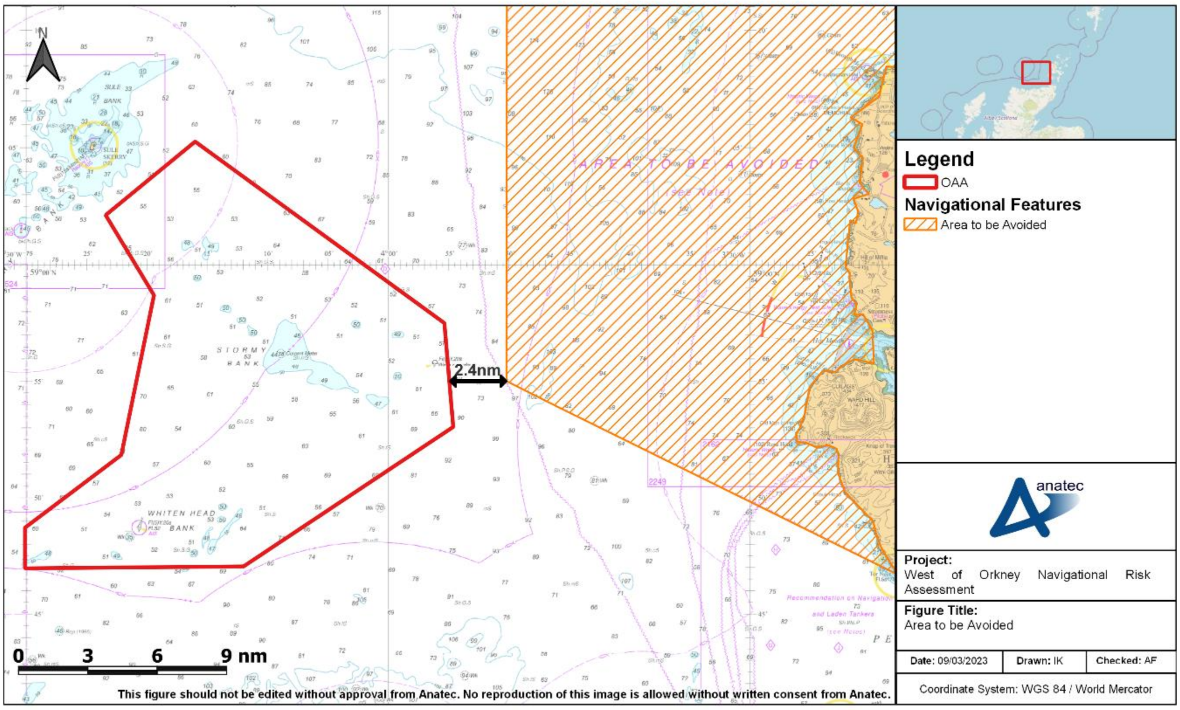

Figure 7.4 Area to be Avoided

The closest distance of the ATBA to the OAA is 2.4 nm. According to the Admiralty Sailing Directions (UKHO, 2022) and a note on charts, "Ships of more than 5000 gross tonnes (GT) carrying oil or hazardous cargoes in bulk should avoid this area."

7.4 Key Aids to Navigation

The Sule Skerry lighthouse is located approximately 2.5 nm northwest of the OAA, with the virtual aid to navigation at Sule Stack located approximately 3.5 nm to the west. A cluster of aids to navigation denoting the EMEC test site are located approximately 16 nm east of the OAA. There were no key aids to navigation located within either the OAA or offshore ECC.

7.5 Charted Wrecks and Obstructions

Charted wrecks and obstructions are shown in Figure 7.1, noting this includes one within the OAA. Offshore EIA Report, Chapter 16: Marine archaeology and cultural heritage provides further details of wrecks including non-charted wrecks, and known losses that have no known location, but could be within the general area.

7.6 Military Exercise Areas

Two military firing areas are located immediately west of the OAA. The Cape Wrath Ministry of Defence (MOD) range is located within the southern of these. The Cape Wrath Training Area provides opportunities for a wide range of field fire and dry training exercises and is the only range in Europe where land, air, and sea training activities can be conducted simultaneously and heavy ordnance, including live 1000lb bombs, can be used.

According to the Admiralty Sailing Directions, "firing takes place from time to time involving use of live ammunition by ships and aircraft." During these practices "vessels may only pass through the area in the ordinary course of navigation, but for their own safety are advised to keep well clear; pleasure craft should not cruise in the area; anchoring and fishing are prohibited when the range is in use."

7.7 Preferred Anchorages

There are, according to the Admiralty Sailing Directions (UKHO, 2022), a number of preferred anchorages located to the south of the array, on the north coast of the Scottish mainland. These include anchorages at Cape Wrath, Sango Bay, Achininiver Bay, Skerray Bay, Torrisdale Bay, Farr Bay, Kirtomy Bay, and Armadale Bay. The closest of these to the ECC is Armadale Bay, approximately 11 nm to the southwest.

The Orkney Islands Council Supplementary Guidance for Aquaculture (Orkney Islands Council, 2017) shows recreational anchorages in Scapa Flow. None are in proximity to the study areas considered in the NRA.

7.8 Subsea Cables

There is one operational subsea telecommunications cable within the offshore study area as shown in Figure 7.1, namely the FARICE-1 cable which connects Scotland, the Faroe Islands and Iceland. It passes 1.9nm east of the OAA and 2.8nm east of the offshore ECC.

There are three existing subsea power cables in the area. These are located in excess of 10nm from the OAA and as such are not captured within the offshore study area. Further details are provided in chapter 20: Other sea users.

The Scottish Hydro Electric Transmission Ltd (SHET-L) Caithness to Orkney HVAC Link crosses the offshore ECC as shown in Figure 7.1. The consented 70 km 220 kilovolt (kV) subsea electricity transmission connection runs from the existing connection site at Dounreay, Caithness to Warebeth on the west coast of Orkney mainland. The Marine Licence for the project expired in 2021 and has since been extended to cover a period between 2022 and 2027.

8 Meteorological Ocean Data

This section presents meteorological and oceanographic (metocean) statistics local to the offshore Project. The data presented in this section has been used as input to the collision and allision risk modelling (see Section 16).

8.1 Wind

Based on wind direction data the proportion of the wind direction within each 30-degree interval is presented in Figure 8.1 in the form of a wind rose. It can be seen that wind is predominately from the west to the southeast.

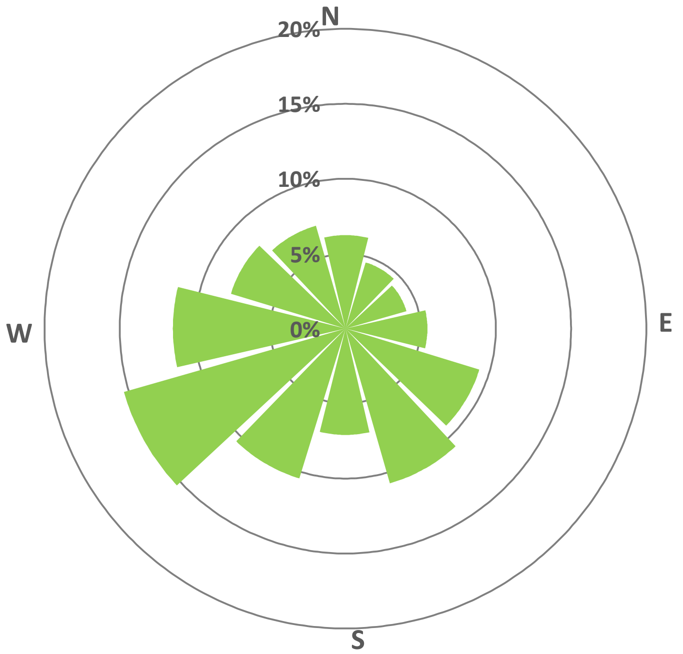

Figure 8.1 Wind Direction Distribution

8.2 Wave

Based on significant wave height data the proportion of the sea state within each of the three defined ranges, where the sea state is based upon significant wave height, is presented in Table 8.1.

Table 8.1 Sea State Distribution

Sea State	Proportion (%)
Calm (<1 m)	5
Moderate (1 to 5 m)	88
Severe (≥5 m)	7

8.3 Visibility

Based on information provided by the Admiralty Sailing Directions (UKHO, 2022), the proportion of poor visibility (defined as the proportion of a year where the visibility can be expected to be less than 1 km) is 4%.

8.4 Tide

From UKHO Admiralty Charts 1954 and 2720, currents within and in proximity to the OAA are set in a generally northwest to southwest on the flood tide and the same on the ebb tide. The greatest flood peak tidal rate is 1.8 knots (kt) and the greatest peak ebb tidal rate is 1.0 kt. The peak speed and corresponding direction data for the flood and ebb tides for the relevant tidal diamonds on the UKHO Admiralty Charts 1952 and 2720 are presented in Table 8.2.

Table 8.2 Peak Flood and Ebb Tidal Data

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (kt)	Direction (°)	Speed (kt)
1954	A	64	1.8	253	0.7
	B	263	0.9	79	0.4
	C	266	1.4	255	0.5
	D	114	0.8	297	0.4
	E	63	0.6	222	0.2
	F	245	1.8	245	1.0
	G	115	1.6	115	0.9
	H	326	1.3	326	0.7
	K	57	0.8	57	0.4
2720	G	65	1.0	73	0.4
	H	247	0.9	247	0.5

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 wind farm 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

This section summarises the existing SAR resources in the region, and issues being considered in relation to the offshore Project.

9.1 Search and Rescue Helicopters

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

The SAR helicopter service is currently operated out of ten base locations around the UK, with the closest to the OAA located approximately 67 nm south-west at Stornoway. This base operates two Sikorsky S92 helicopters.

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 2022.

The locations of SAR helicopter taskings within the OAA and offshore ECC study areas are presented in Figure 9.1, colour-coded by tasking type.

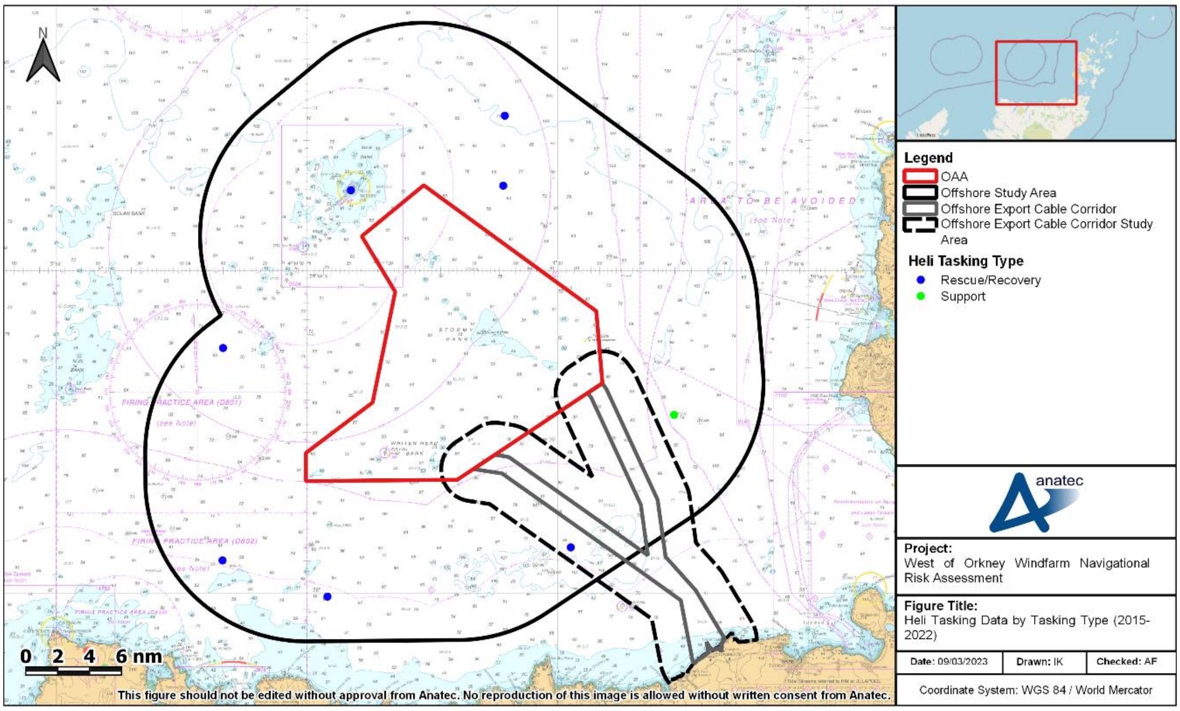

Figure 9.1 Heli Tasking Data by Tasking Type (2015-2022)

There were eight SAR taskings within the offshore study area between April 2015 and March 2022, corresponding to an average of one SAR tasking per year. Seven were rescue/recovery, with the other being a support tasking. Five taskings originated from the Stornoway base, with two from the Inverness base and the other from the Sumburgh base.

There was one SAR tasking within the offshore ECC study area between April 2015 and March 2022. This was a rescue/recovery tasking originating from the Stornoway base.

9.2 Royal National Lifeboat Institution

The RNLI is organised into six regions, with the relevant region for the Project being 'Scotland'. 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).

Figure 9.2 presents the RNLI stations in proximity to the OAA as well as the incidents documented by the RNLI that occurred within the offshore and offshore ECC study areas, colour-coded by incident type. Figure 9.3 presents the same data, colour-coded by casualty type. It is noted that incidents which were deemed hoaxes or false alarms have been excluded from the analysis.

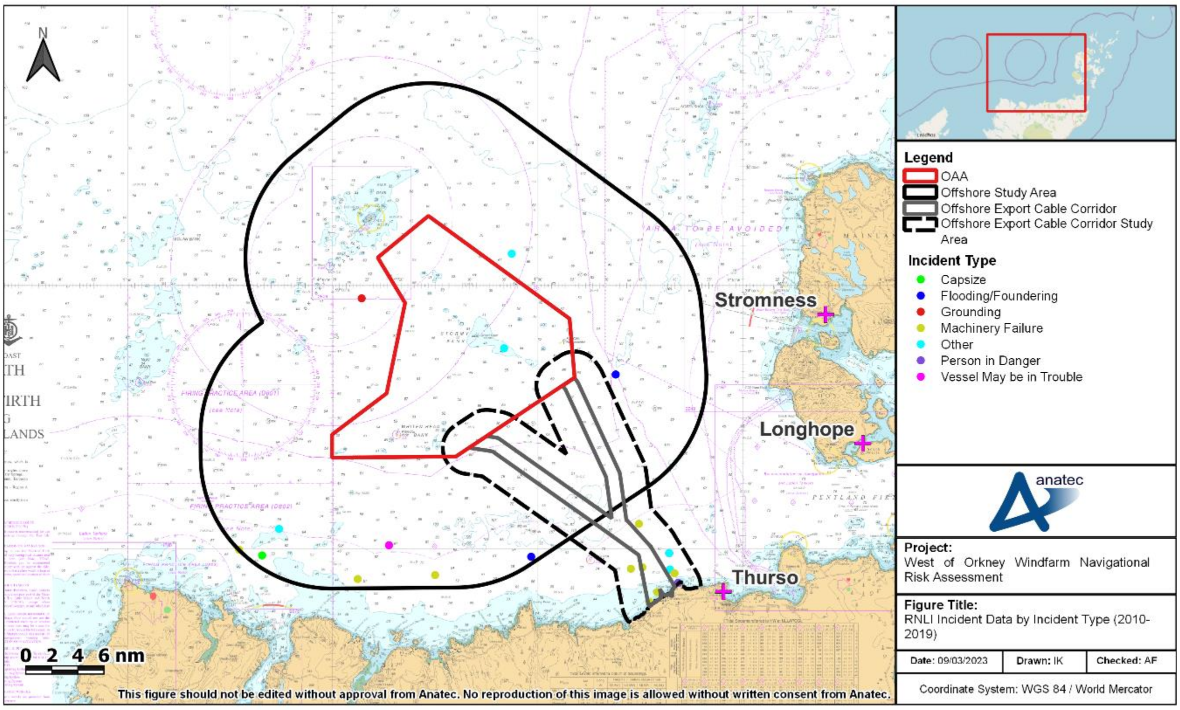

Figure 9.2 RNLI Incident Data by Incident Type (2010-2019)

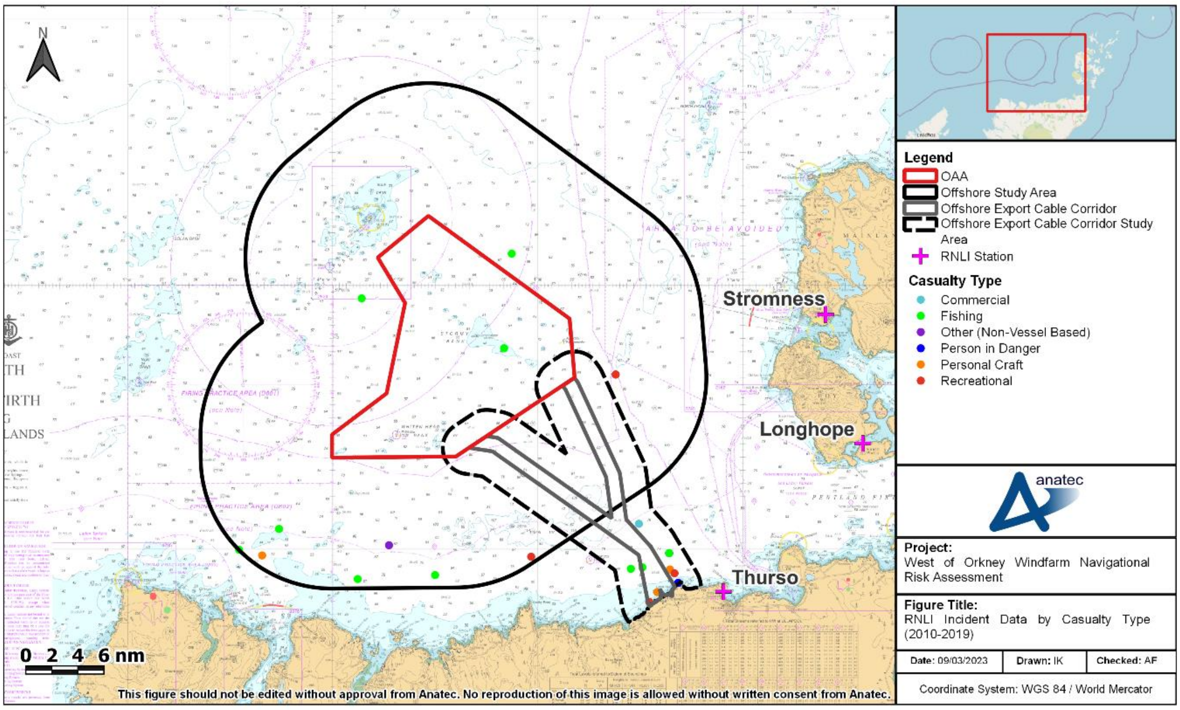

Figure 9.3 RNLI Incident Data by Casualty Type (2010-2019)

The closest RNLI station to the OAA is at Stromness (approximately 19 nm east), where an ALB is available. Thurso, located approximately 20 nm south-east, also has a RNLI station, where an ALB is available; this station is also the closest to the offshore ECC, located approximately 1.8 nm north. Other RNLI stations in proximity include Longhope, Wick, and Lochinver.

A total of 11 incidents were responded to by the RNLI within the offshore study area between 2010 and 2019. This corresponds to an average of approximately one incident per year. The most frequent station for incident response was Stromness (50%), with Thurso (42%) and Longhope (8%) also used. The most common incident types recorded were "*machinery failure*" (27%) and "*person in danger*" (18%), with incident types of "*other*" comprising 27% of incidents. The most common vessel types recorded were fishing vessels (64%) followed by recreational vessels (18%). One incident was responded to by the RNLI within the OAA itself – a fishing vessel with a fouled propellor.

A total of nine incidents were responded to by the RNLI within the offshore ECC study area between 2010 and 2019. This corresponds to an average of one incident per year, with the majority of incidents occurring close to shore. All incidents were responded to by the Thurso station. The most common incident types recorded were "*machinery failure*" (67%) and "*person in danger*" (22%), with incident types of "*other*" comprising the remaining 11% of incidents. The most common vessel types recorded were fishing vessels (33%) followed by personal craft (22%) and person in danger (22%). Three incidents were responded to by the RNLI within the offshore ECC itself.

9.3 Maritime Rescue Coordination Centres and Joint Rescue Coordination Centres

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).

HMCG coordinates SAR operations through a network of 11 Maritime Rescue Coordination Centres (MRCC), including a Joint Rescue Coordination Centre (JRCC) based in Hampshire.

All of the MCA's operations, including SAR, are divided into 18 geographical regions. The 'Area 2 – North of Scotland' region covers the OAA and offshore ECC. The Stornoway MRCC is located approximately 67 nm south-west of the OAA, as illustrated in Figure 9.4, and coordinates the SAR response for maritime and coastal emergencies within the district boundary.

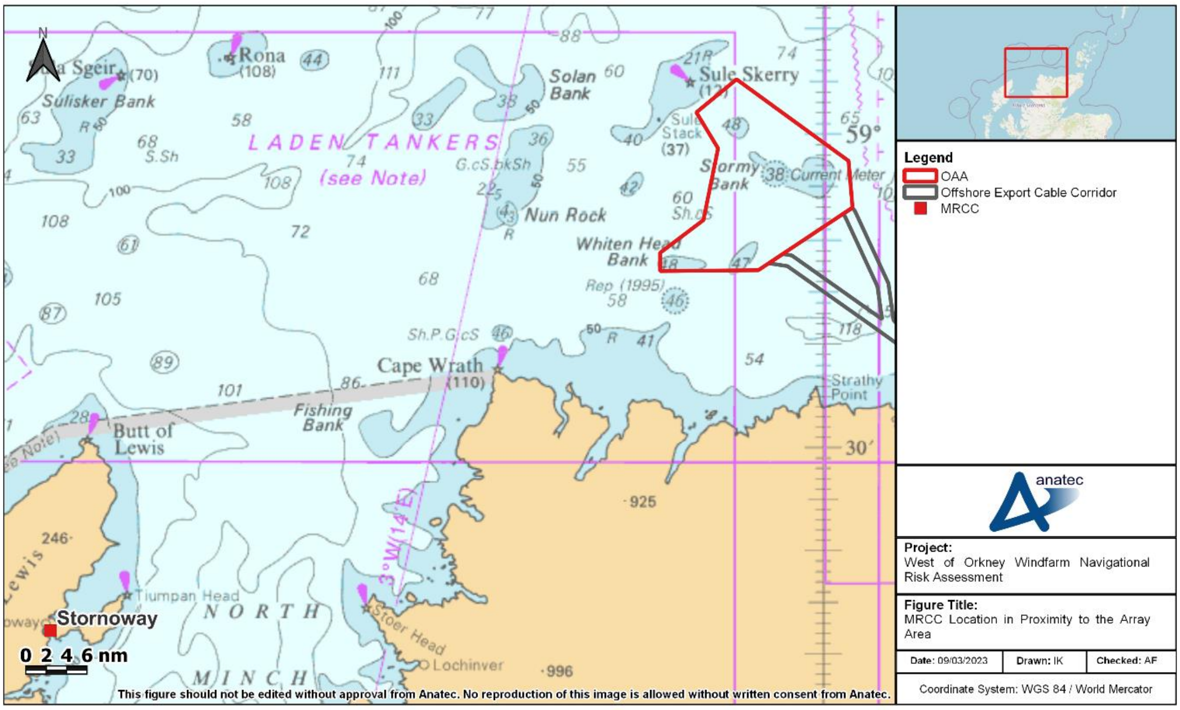

Figure 9.4 MRCC Location in Proximity to the OAA

9.4 Global Maritime Distress and Safety System

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.

There are four GMDSS sea areas, with the areas applicable in proximity to the UK shown in Figure 9.5. Vessels in proximity to the OAA would be located within sea area A1.

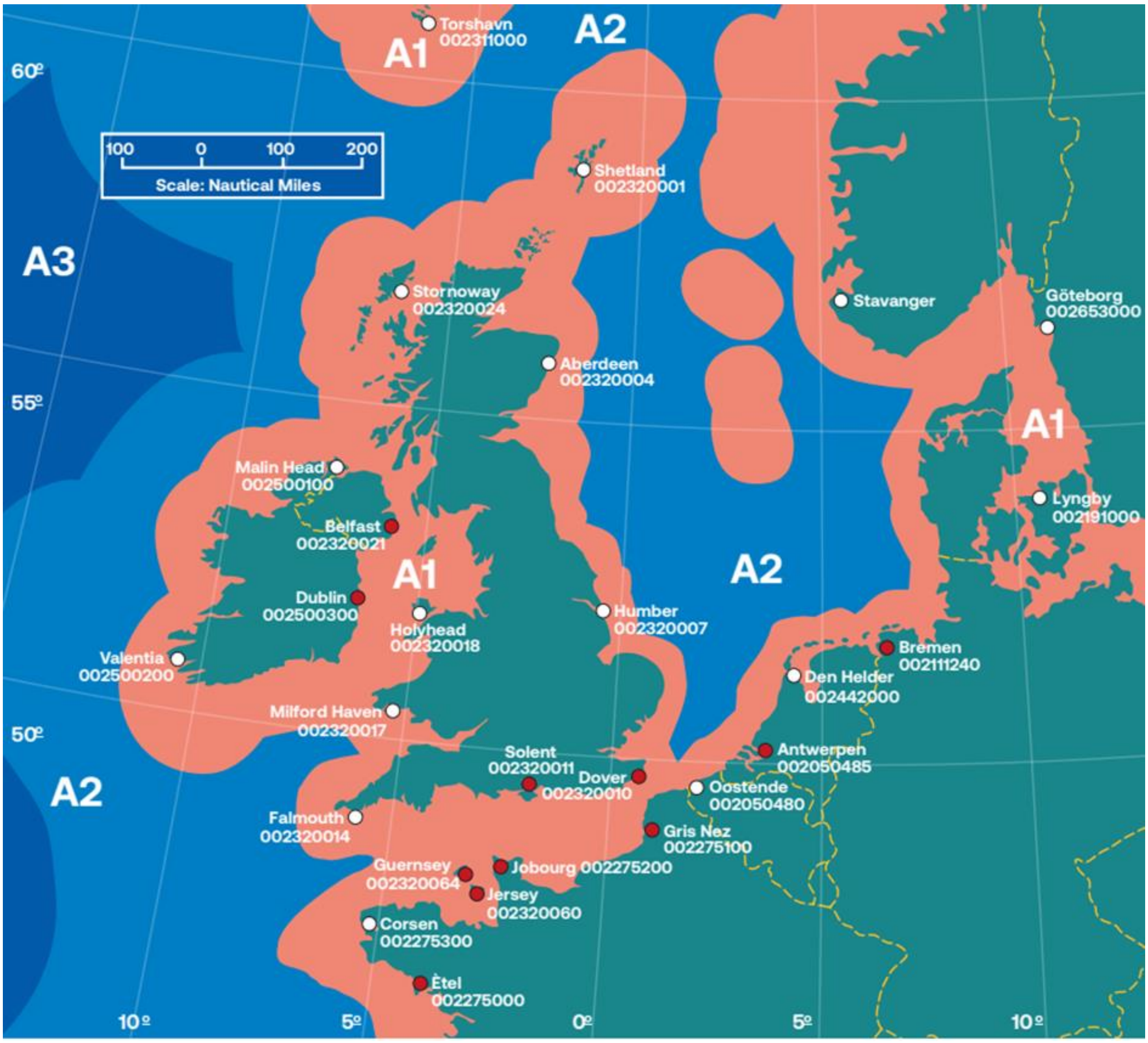

Figure 9.5 GMDSS Sea Areas (MCA, 2021)

In the event of an emergency involving a vessel located further offshore within sea area A1 or A2, vessels are able to contact coastal stations using High Frequency (HF) or Medium Frequency (MF) radio or otherwise contact other offshore resources.

9.5 Marine Accident Investigation Branch

All UK flagged vessels and non-UK flagged vessels in UK territorial waters (12 nm), a UK port or carrying passengers to a UK port are required to report incidents to the MAIB. Data arising from these reports are assessed within this section, primarily covering the ten-year period between 2010 and 2019.

The incidents recorded within the MAIB data between 2010 and 2019 occurring within the offshore study area and offshore ECC study area are presented in Figure 9.6, colour-coded by incident type. Following this, Figure 9.7 shows the same data colour-coded by the type of vessel(s) involved in each incident.

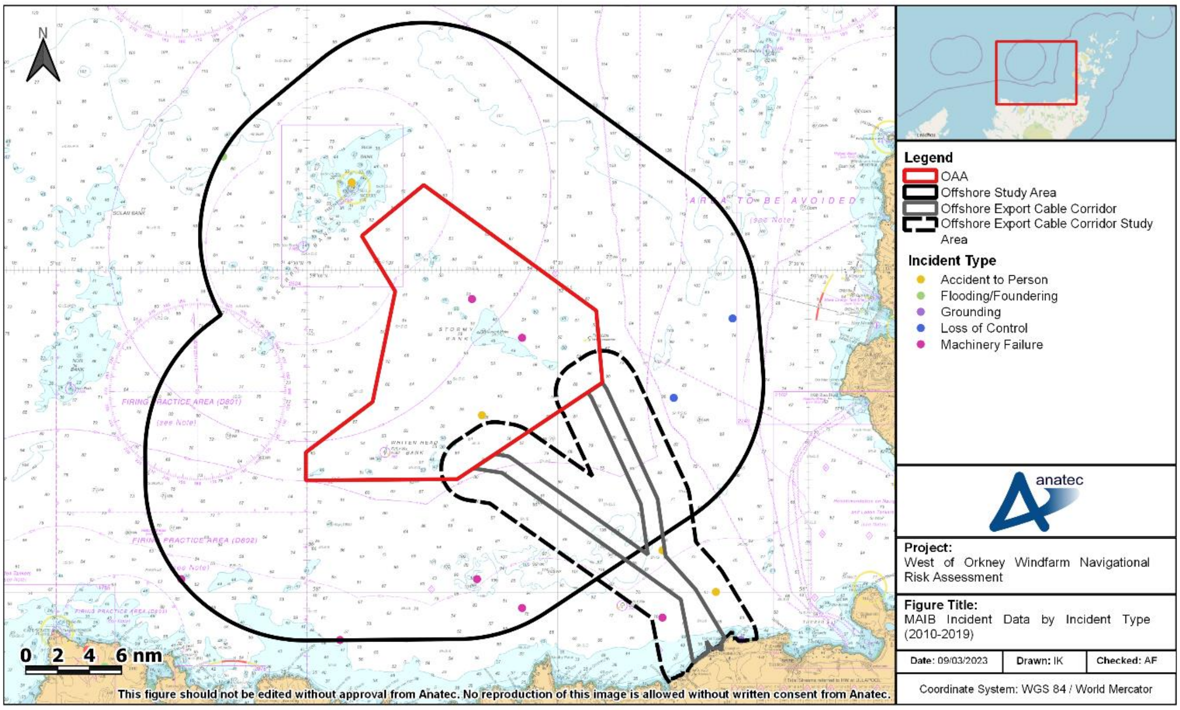

Figure 9.6 MAIB Incident Data by Incident Type (2010-2019)

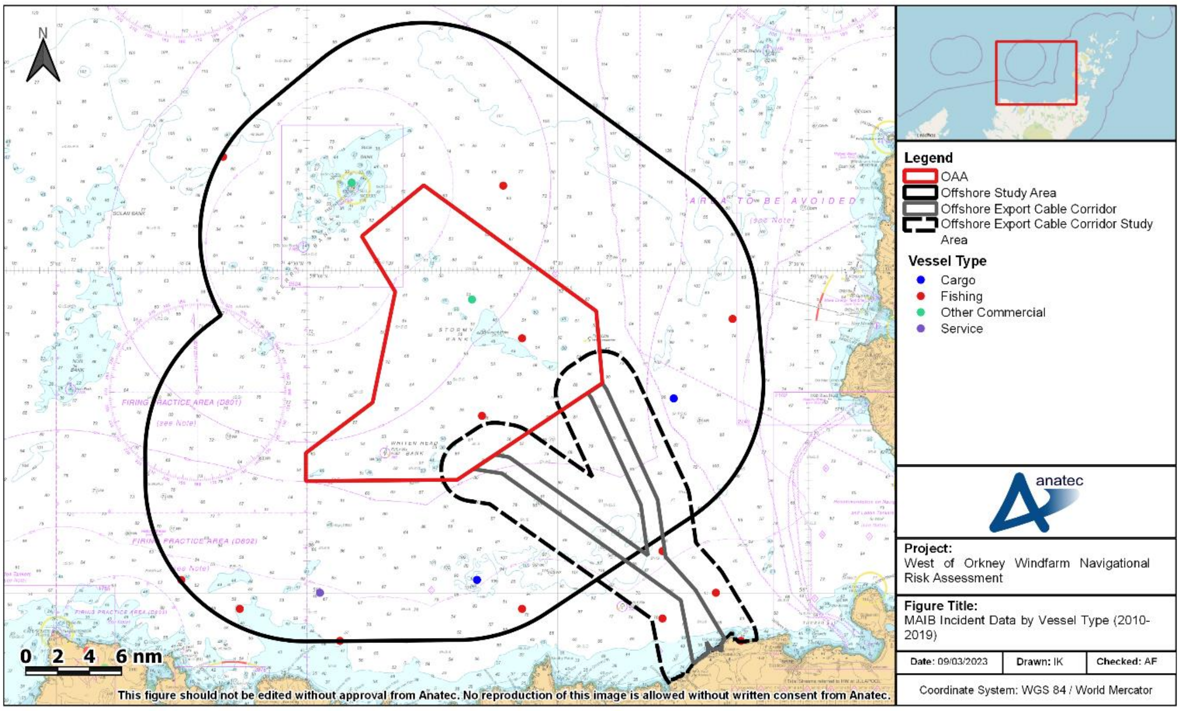

Figure 9.7 MAIB Incident Data by Vessel Type (2010-2019)

A total of 15 unique incidents were recorded by the MAIB within the offshore study area between 2010 and 2019, which corresponds to an average of one to two incidents per year. The most common incident types recorded were "*machinery failure*" (40%), "*accident to* person" (13%), and "*loss of control*" (13%), with incident types of "*other"* comprising 27% of incidents. The most common vessel types recorded were fishing vessels (67%) followed by cargo vessels (13%) and other commercial vessels (13%). Three incidents were recorded by the MAIB within the OAA itself – two instances of machinery failure, and one accident to person.

A total of Four incidents were recorded by the MAIB within the offshore ECC study area between 2010 and 2019, which corresponds to an average of one incident every two to three years. These comprised two accidents to person, one instance of grounding, and one of machinery failure. All four incidents involved fishing vessels. There was one incident within the offshore ECC itself – an accident to person involving a fishing vessel.

A review of older MAIB incident data within the offshore study area between 2000 and 2009 indicates that the number of incidents has generally decreased in proximity to the OAA, with a total of 21 incidents within the offshore study area, and six incidents within the offshore ECC study area recorded. Two incidents occurred within the OAA, and one within the offshore ECC.

9.6 Historical Offshore Wind Farm Incidents

9.6.1 Incidents Involving UK Offshore Wind Farm Developments

As of February 2023, there are 42 operational offshore wind farms in the UK, ranging from the North Hoyle offshore wind farm (fully commissioned in 2003) to Hornsea Project Two (fully commissioned in 2022). Between them these developments encompass approximately 19,611 fully operational WTG years[2].

MAIB incident data has been used to collate a list of reported historical collision and allision incidents involving UK offshore wind farm developments[3], 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 Maritime, International Marine Contractors Association (IMCA) and basic web searches.

Table 9.1 Summary of Historical Collision and Allision Incidents Involving UK Offshore Wind Farm 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	Minor damage to gangway	None	MAIB

[2] Calculation based on estimated commissioning dates and number of WTGs per operational project.
[3] Includes only incidents 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.

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
			on the vessel, the WTG tower and a WTG blade.	on the vessel		
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	CTV allision with flotel. Nine persons safely evacuated and transferred to nearby vessel before being brought back into port.	Moderate	None	UK CHIRP
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

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
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 following human error (autopilot). Lifeboat attended the incident.	Moderate	Injury	Web search (RNLI, 2016)
Project	Allision	14 February 2019	Survey vessel contacted with WTG jacket whilst autopilot was engaged.	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)
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.

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

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

As of February 2023, there have been 13 reported cases of an allision between a vessel and a WTG (under construction, operational or disused) in the UK, with all but one 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 1,509 WTG years per allision incident in the UK, noting that this is a conservative calculation given that only operational WTG hours have been included (whereas allision incidents counted include non-operational WTGs).

9.6.2 Incidents Involving Non-UK Offshore Wind Farms

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

One high profile non-UK incident which is noted 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 offshore wind farm where it allided with a WTG foundation and a platform foundation before being taken under tow.

9.6.3 Incidents Responded to by Vessels Associated with UK Offshore Wind Farms

From news reports, basic web searches and experience at working with existing offshore wind farm developments, a list has been collated of historical incidents responded to by vessels associated with UK offshore wind farm developments, which is summarised in Table 9.2.

Table 9.2 comprises known incidents that were responded to by a wind farm vessel. Additional incidents associated with the construction or operation of offshore wind farms 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 Offshore Wind Farm Developments

Incident Type	Date	Related Development	Description of Incident	Source
Capsize	21 June 2018	Walney	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	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	Yacht in difficulty 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	Web search (The Isle of Thanet News, 2019)

Incident Type	Date	Related Development	Description of Incident	Source
			to return to port and seek medical assistance for the casualty vessel's occupant.	
Drifting	7 July 2019	Gwynt y Môr	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	Fishing vessel suffered mechanical failure and launched flares. Guard vessel and 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	Passing vessel got into difficulty and guard vessel for Race Bank was requested to assist. The Coastguard later requested that the guard vessel tow the casualty vessel into port.	Internal daily progress report received by Anatec
Search	21 May 2020	Walney	Coastguard contacted guard vessel for Walney reporting red flare sighting at the wind farm. 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	Fishing vessel experienced explosions on board with crew injured. SOV for Dudgeon deployed its Fast Rescue Boat (FRB) and evacuated the crew from the vessel.	Web search (Offshore WIND, 2020)
Vessel in distress	3 July 2021	Robin Rigg	Wind farm 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	Small dinghy with two children aboard drifted offshore due to strong winds. A guard vessel associated with Neart na Gaoithe 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

This section presents an analysis of vessel traffic movements in relation to the OAA and offshore ECC. The methodology for vessel traffic data collection including details of the on-site vessel traffic surveys is provided is Section 5.2.

10.1 OAA

A number of vessel tracks recorded during the OAA survey periods were classified as temporary (non-routine), such as tracks of the survey vessel and vessels undergoing other surveys within the offshore study area during the data periods. These vessels have therefore been excluded from the analysis.

A plot of the vessel tracks recorded during the 14-day summer survey period in August 2022, colour-coded by vessel type and excluding any temporary traffic, is presented in Figure 10.1. Following this, a plot of the vessel tracks recorded during the further 14-day winter survey period in November 2022, colour-coded by vessel type and excluding any temporary traffic, is presented in Figure 10.2.

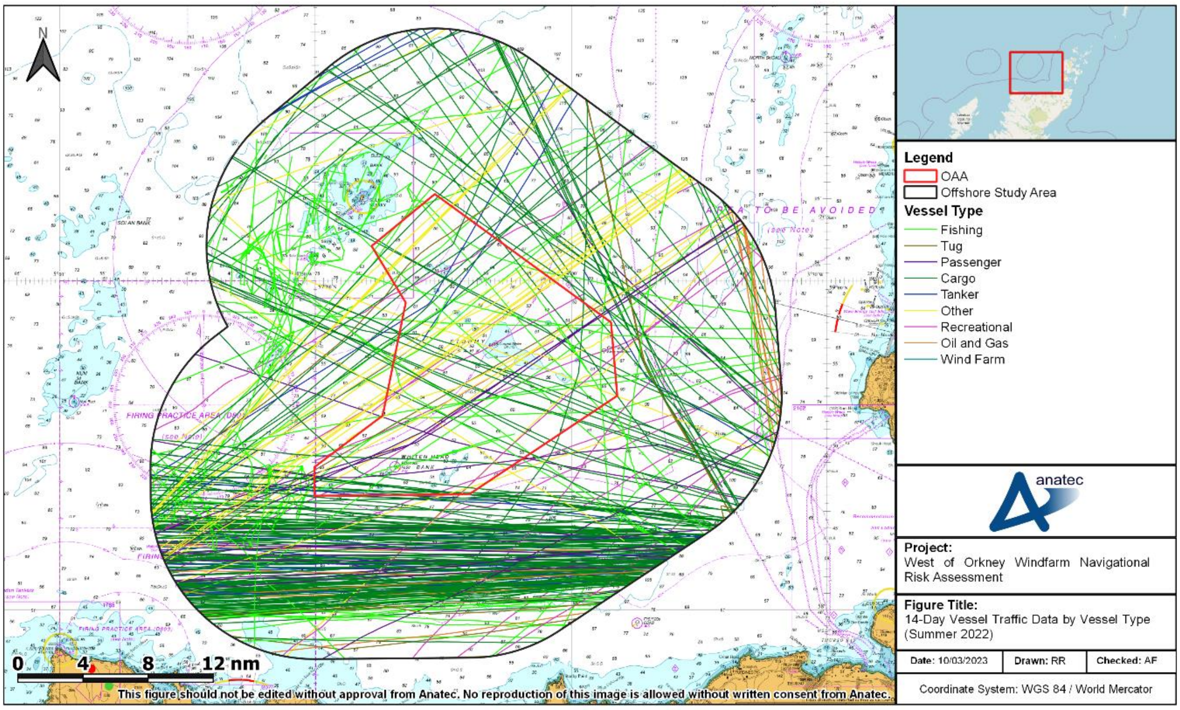

Figure 10.1 Vessel Traffic Survey Data within the OAA and Offshore Study Area by Vessel Type (14-Days Summer 2022)

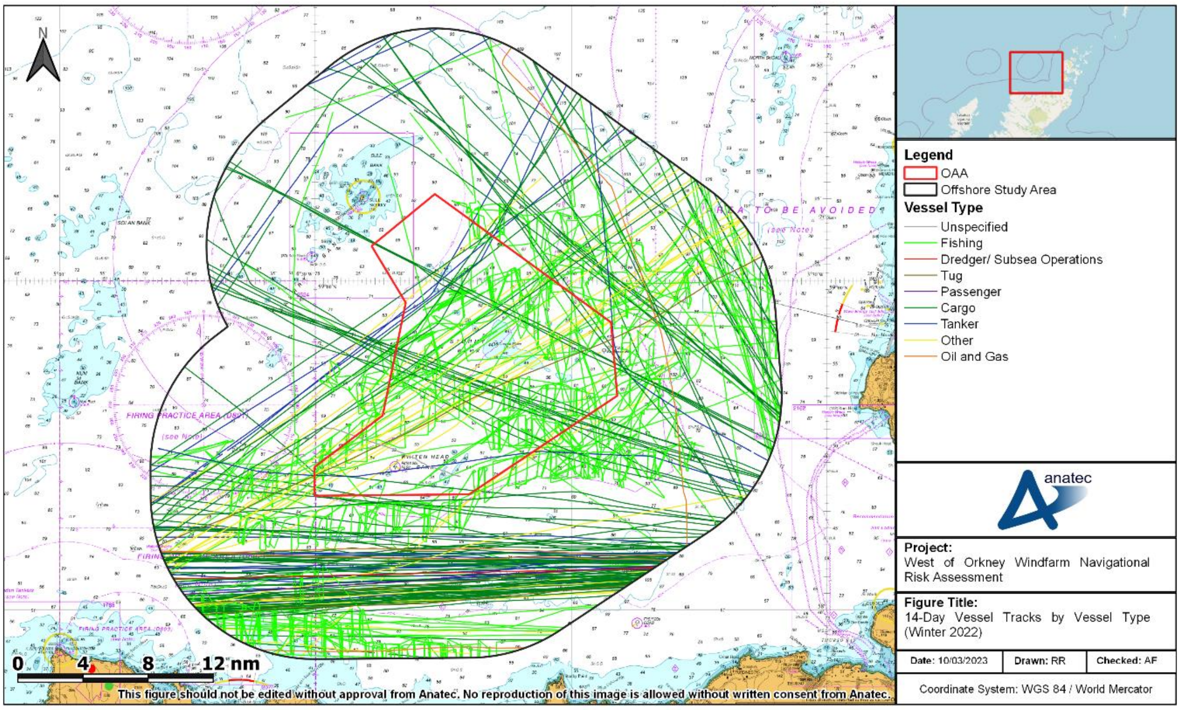

Figure 10.2 Vessel Traffic Survey Data within the OAA and Offshore Study Area by Vessel Type (14-Days Winter 2022)

The 'other' vessel tracks intersecting the OAA were observed to be primarily composed of fish carrier vessels operated by the various aquaculture operators in the area (see Section 4).

Plots of the vessel tracks for the summer and winter survey periods converted to a density heat map are presented in Figure 10.3 and Figure 10.4, respectively. It is noted that the same density brackets were used for both survey periods to allow for direct comparison in vessel density.

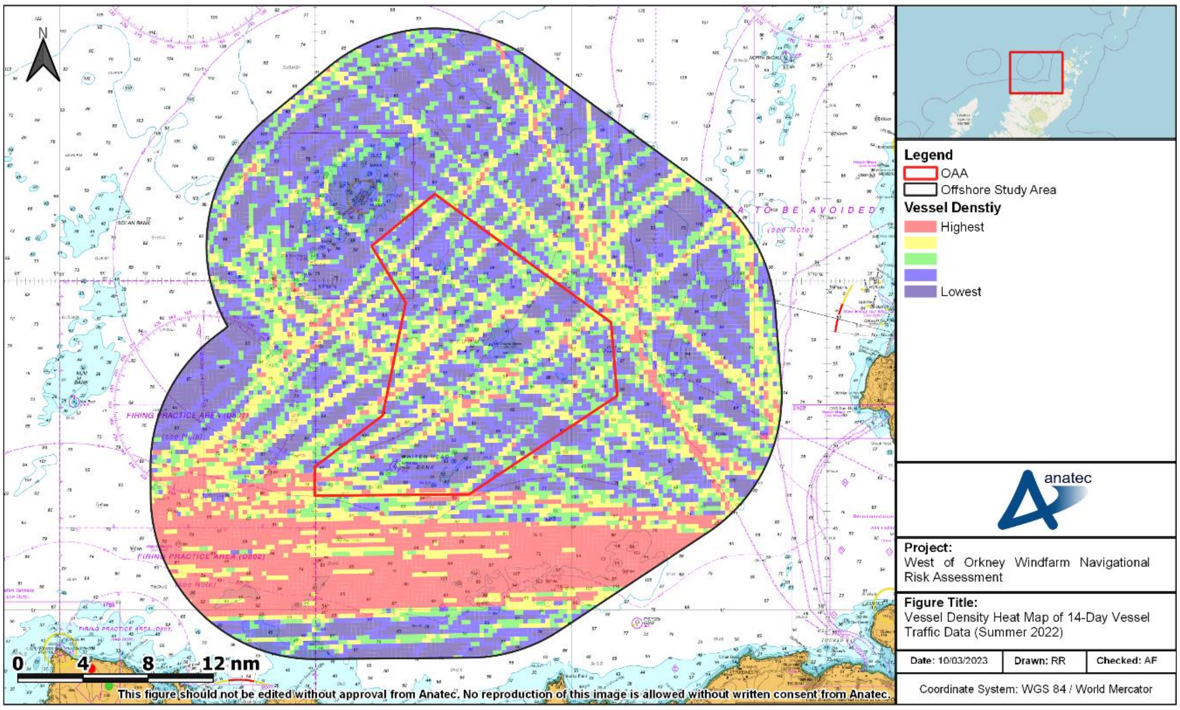

Figure 10.3 Vessel Density Heat Map within the OAA and Offshore Study Area (14-Days Summer 2022)

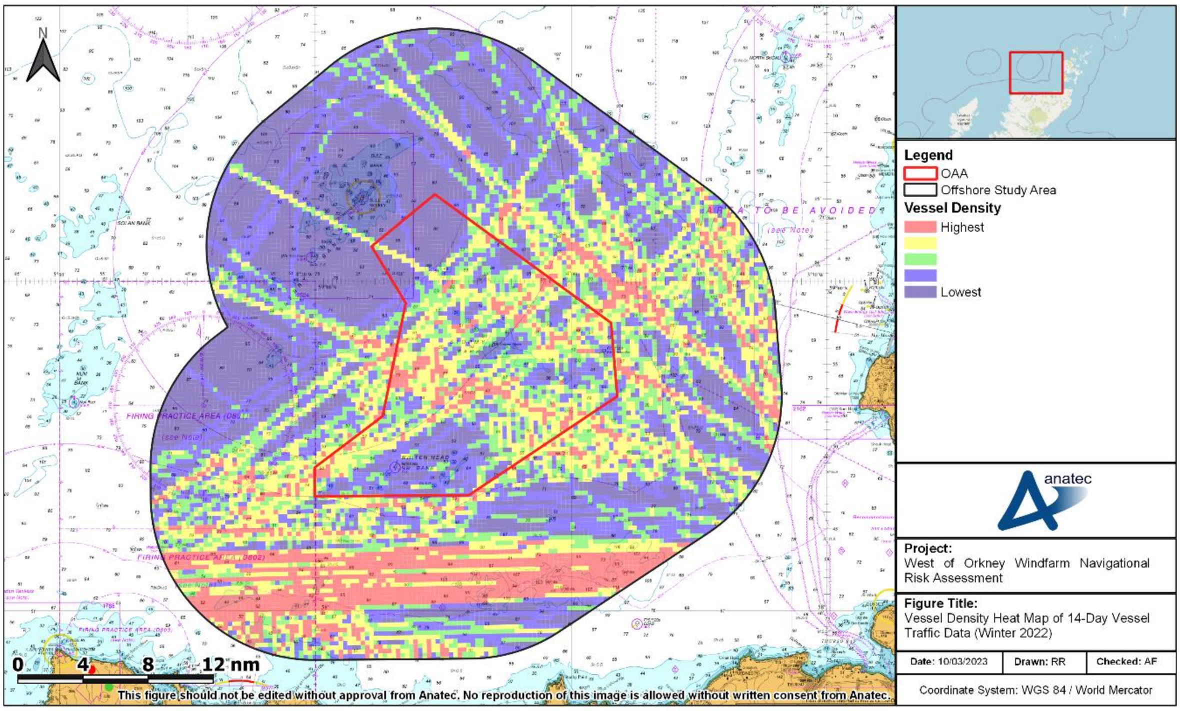

Figure 10.4 Vessel Density Heat Map within the OAA and Offshore Study Area (14-Days Winter 2022)

10.1.1 Vessel Counts

For the 14-days analysed during the summer survey period, there was an average of 23 unique vessels recorded per day within the offshore study area. In terms of vessels intersecting the OAA itself, there was an average of six to seven unique vessels per day during the survey period. It is noted that the first and last day of the summer survey were partial survey days (as described in Section 5.2) and so the analysis was only carried out for full days.

The daily number of unique vessels recorded within the offshore study area and the OAA itself during the summer survey period are presented in Figure 10.5. It is noted that fishing vessel activity, and so vessel numbers overall, may be lower than anticipated due to the presence of geophysical surveying vessels on site during the summer period (see Section 5.4).

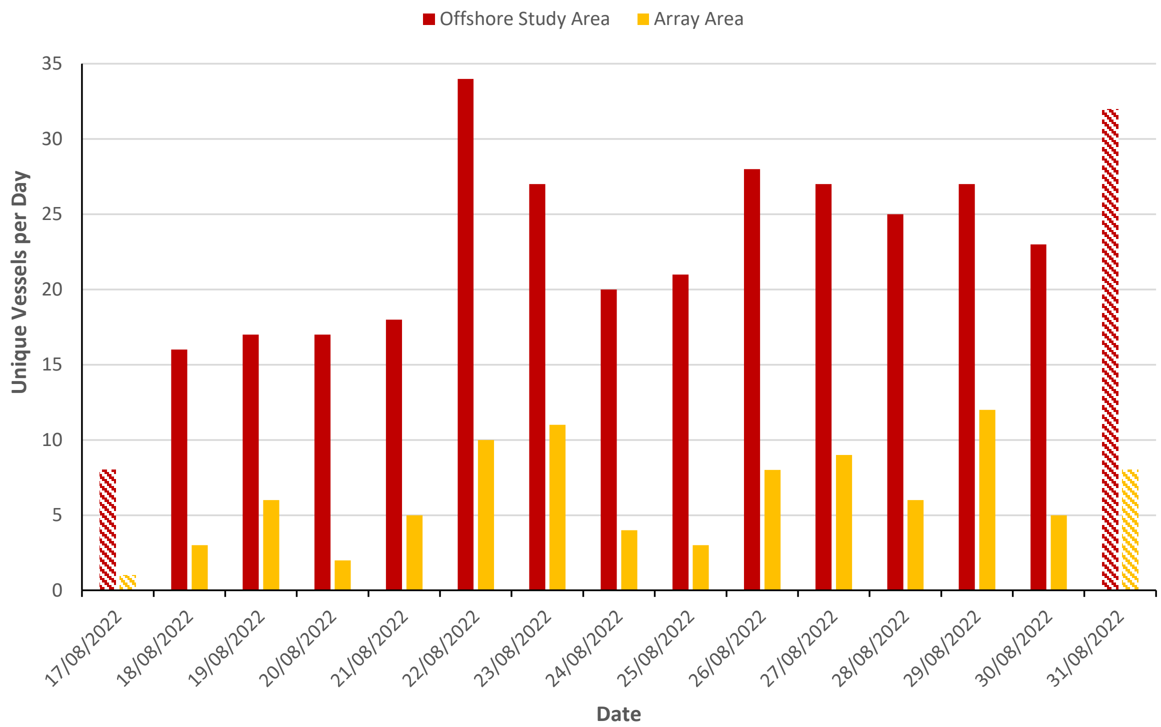

Figure 10.5 Unique Vessels per Day within the OAA and Offshore Study Area (14-Days Summer 2022)

Throughout the summer survey period, approximately 25% of unique vessel tracks recorded within the offshore study area intersected the OAA.

The busiest full day recorded within the offshore study area throughout the summer survey period was 22 August 2022, during which 34 unique vessels were recorded. The busiest full day recorded within the OAA during the summer survey period was 29 August 2022, during which 12 unique vessels were recorded.

The quietest full day recorded within the offshore study area throughout the summer survey period was 18 August 2022, during which 16 unique vessels were recorded. The quietest full day recorded within the OAA during the summer survey period was 20 August 2022, during which two unique vessels were recorded.

For the 14-days analysed during the winter survey period, there was an average of 18 unique vessels recorded per day within the offshore study area. In terms of vessels intersecting the OAA itself, there was an average of five to six unique vessels per day during the survey period. It is noted that the first and last day of the winter survey, as well as 3 November due to adverse weather, were partial survey days (as described in Section 5.2) and so the analysis was only carried out for full days.

The daily number of unique vessels recorded within the offshore study area and the OAA itself during the winter survey period are presented in Figure 10.6.

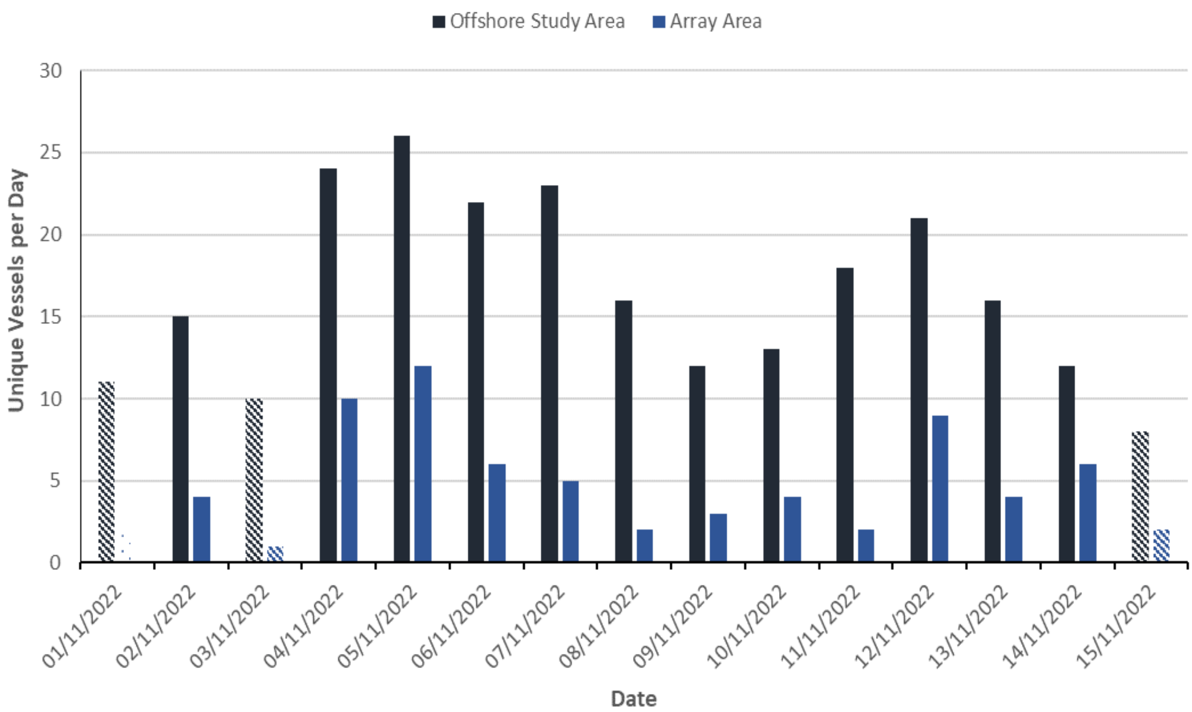

Figure 10.6 Unique Vessels per Day within the OAA and Offshore Study Area (14-Days Winter 2022)

Throughout the winter survey period, approximately 29% of unique vessel tracks recorded within the offshore study area intersected the OAA.

The busiest full day recorded within the offshore study area throughout the winter survey period was 5 November 2022, during which 26 unique vessels were recorded. The busiest full day recorded within the OAA during the winter survey period was also 5 November 2022, during which 12 unique vessels were recorded.

The quietest full day recorded within the offshore study area throughout the winter survey period was 9 and 14 November 2022, during which 12 unique vessels were recorded. The quietest full days recorded within the OAA during the winter survey period were 8 and 11 November 2022, during which two unique vessels were recorded.

10.1.2 Vessel Types

The percentage distribution of the main vessel types recorded within the offshore study area and the OAA is presented in Figure 10.7.

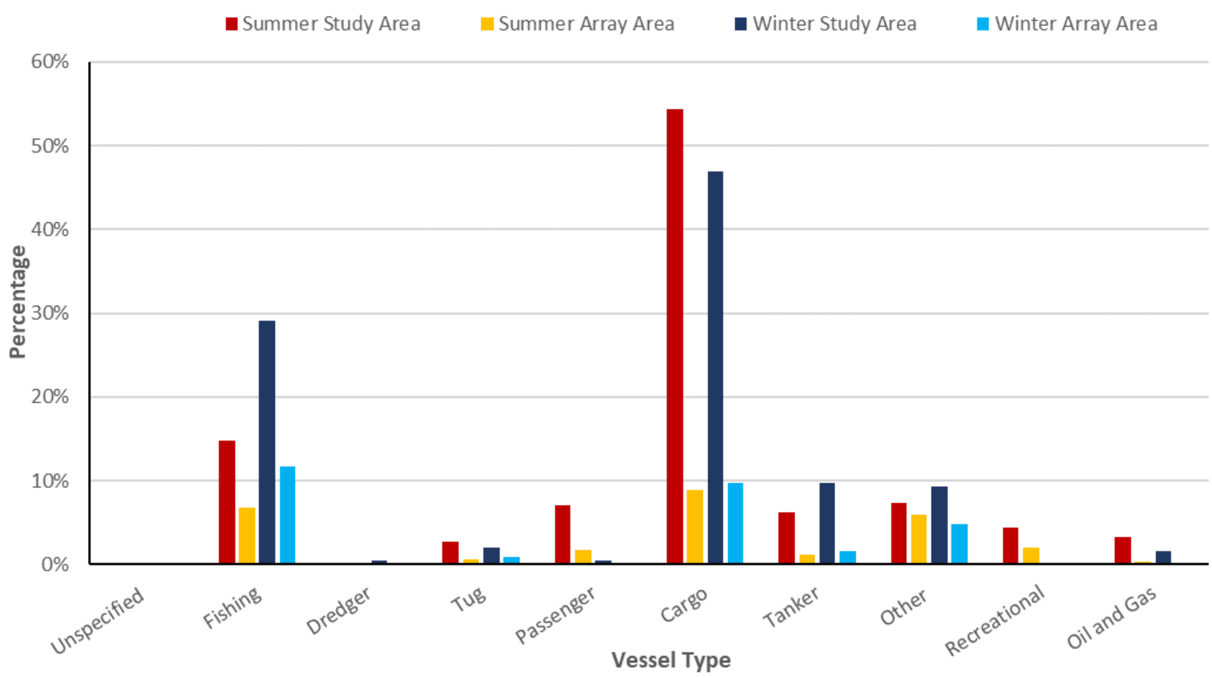

Figure 10.7 Vessel Type Distribution within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Throughout the summer survey period, the most common vessel types within the offshore study area were cargo vessels (54%) and fishing vessels (15%). Throughout the winter survey period, the most common vessel types within the offshore study area were also cargo vessels (47%) and fishing vessels (29%). Both vessel types were also the most common types to intersect the OAA during both the winter and summer survey periods.

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

10.1.2.1 Cargo Vessels

The tracks of cargo vessels within the offshore study area throughout the summer and winter survey periods combined are presented in Figure 10.8.

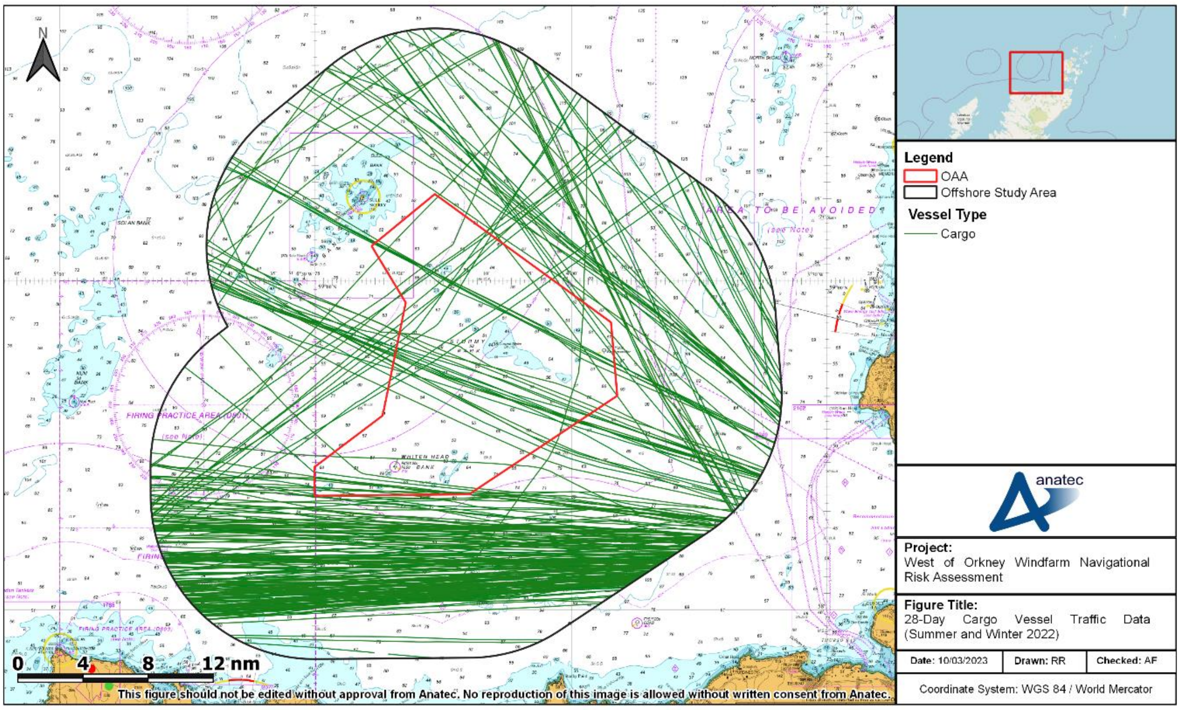

Figure 10.8 Cargo Vessel Traffic within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Throughout both survey periods, vessels were noted to transit heavily in an east-west bearing to the south of the OAA with several vessels on routes through the OAA itself. Vessels transiting through the array were on routes to/from the Pentland Firth on a southeast-northwest bearing as well as routes southwest-northeast passing through Cape Wrath.

During the summer survey period, an average of 13 unique cargo vessels per day were recorded within the offshore study area with an average of two unique cargo vessels per day intersecting the OAA. The most common cargo sub types within the offshore study area were general cargo (42%), bulk carriers (30%), and container vessels (16%).

During the winter survey period, an average of between eight or nine unique cargo vessels per day were recorded within the offshore study area with an average of between one and two unique cargo vessels per day intersecting the OAA. The most common cargo sub types within the offshore study area were the same as the summer period with general cargo (49%), bulk carriers (19%), and container vessels (10%) being the most frequently recorded.

Regular routeing involving RoRo vessels was recorded by one vessel operated by Smyril Line. This vessel transited between Rotterdam and Þorlákshöfn (Iceland) and passed through the offshore study area approximately twice per week in both the winter and summer survey periods. Although this route was not recorded within the long-term dataset (see Appendix E), an additional Smyril Line-operated route between Scrabster and Tórshavn with approximately one transit per week was noted. In addition, a RoRo vessel operated by Royal

Wagneborg was recorded on one occasion destined for Uddevalla (Sweden). The tracks of both vessels are presented in Figure 10.9.

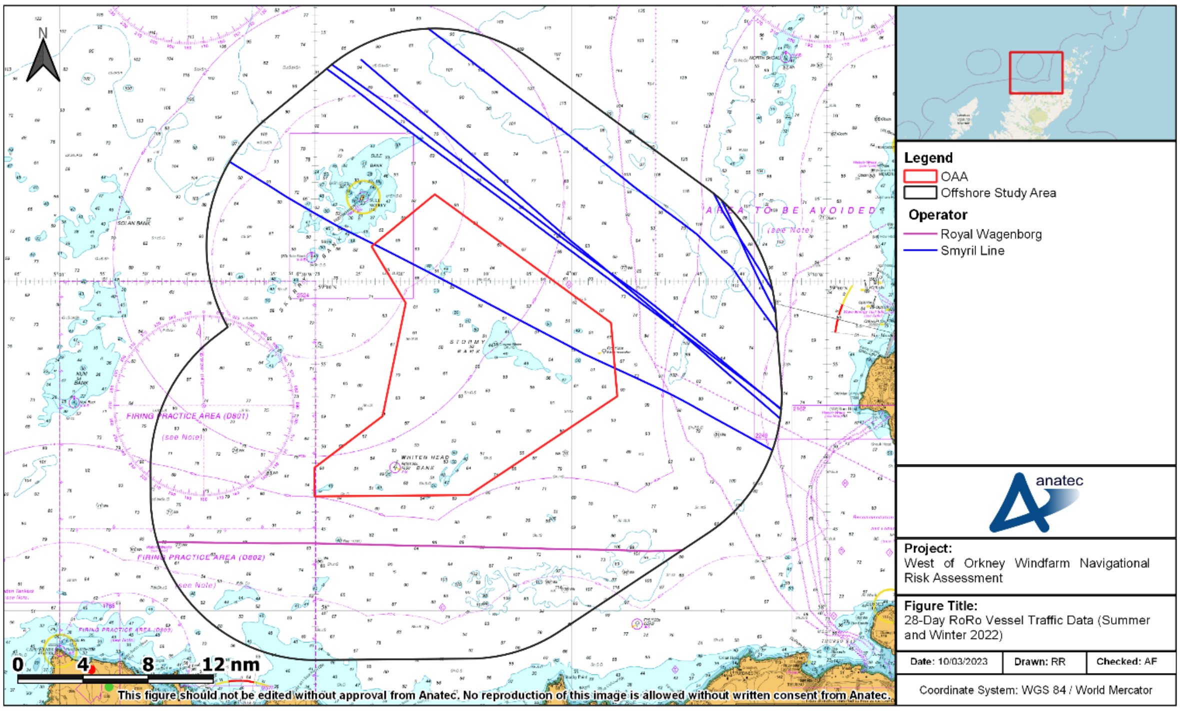

Figure 10.9 Ro-Ro Vessel Traffic Data within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Though not recorded within the winter or summer survey periods, a route operated by DFDS Seaways between Belfast (UK) and Skogn (Norway) was captured within the long-term dataset (see Appendix E) and raised in consultation. Vessels on this route transited through the study area approximately two to three times per month.

10.1.2.2 Commercial Fishing Vessels

10.1.2.2.1 Vessel Traffic Data

Commercial fishing vessel data was extracted from the vessel tracks recorded during the vessel traffic surveys. It is noted that the term 'fishing vessel' as used throughout this NRA refers to commercial fishing vessels, and any non-commercial fishing activity (such as rod and line angling) is categorised under recreational vessel activity. On this basis the tracks of commercial fishing vessels recorded within the offshore study area throughout both survey periods are presented in Figure 10.10.

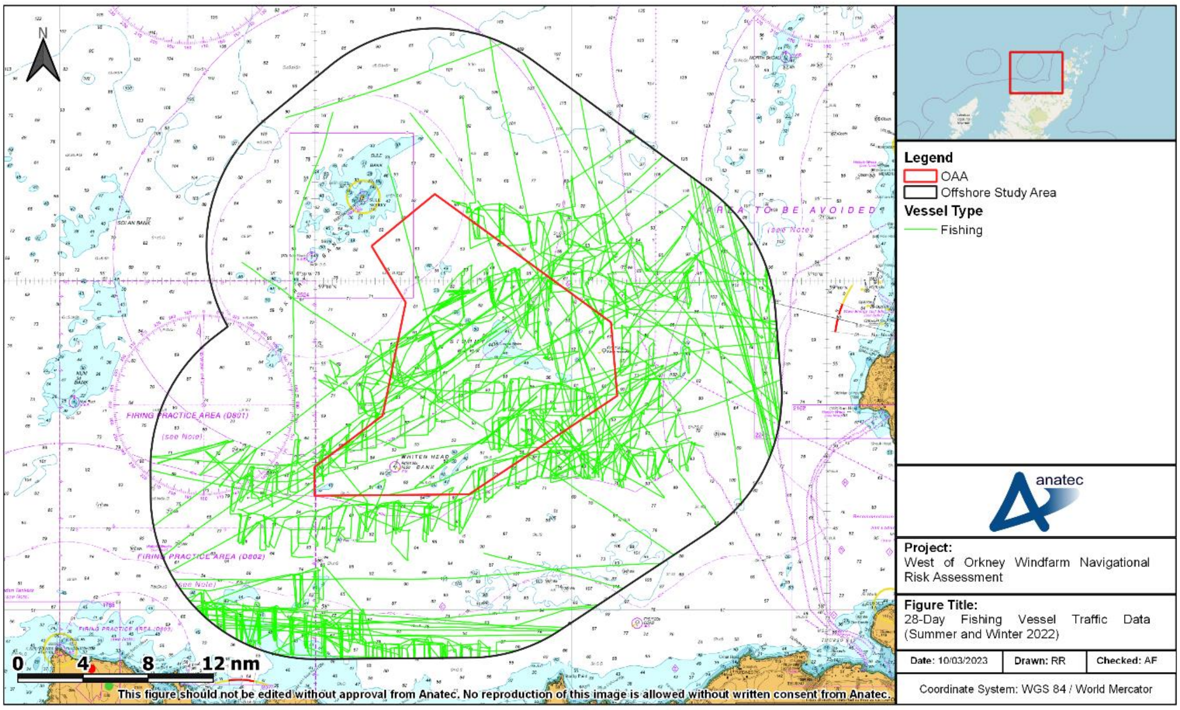

Figure 10.10 Fishing Vessel Traffic within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

During the summer survey period, an average of three unique fishing vessels per day were recorded within the offshore study area with an average of one to two unique fishing vessels per day intersecting the OAA. The majority of fishing vessels were in transit with only vessels engaged in likely activity to the west of the OAA, both vessels engaged in likely activity were potter/whelkers. All vessels intersecting the OAA during the summer survey period were in transit. As mentioned in Section 5.4, fishing vessel numbers within the study area during the summer survey period may be lower due to the presence of ongoing geophysical work within the site.

Fishing vessels were more common during the winter survey period, with an average of five unique fishing vessels per day were recorded within the offshore study area with an average of between one and two unique fishing vessels per day intersecting the OAA. Fishing vessels were seen in transit and engaged in likely fishing activity with higher levels of activity across the OAA and to the south of the offshore study area. Of those vessels engaged in likely activity, most were primarily either potter/whelkers (61%) or demersal trawlers (27%). Vessels in transit were recorded mainly to the south and east of the offshore study area.

10.1.2.2.2 VMS Data

In addition to the vessel traffic survey data, VMS data recorded throughout 2022 has also been analysed within the offshore study area. A density grid, using the VMS data during this period as input, is presented in Figure 10.11.

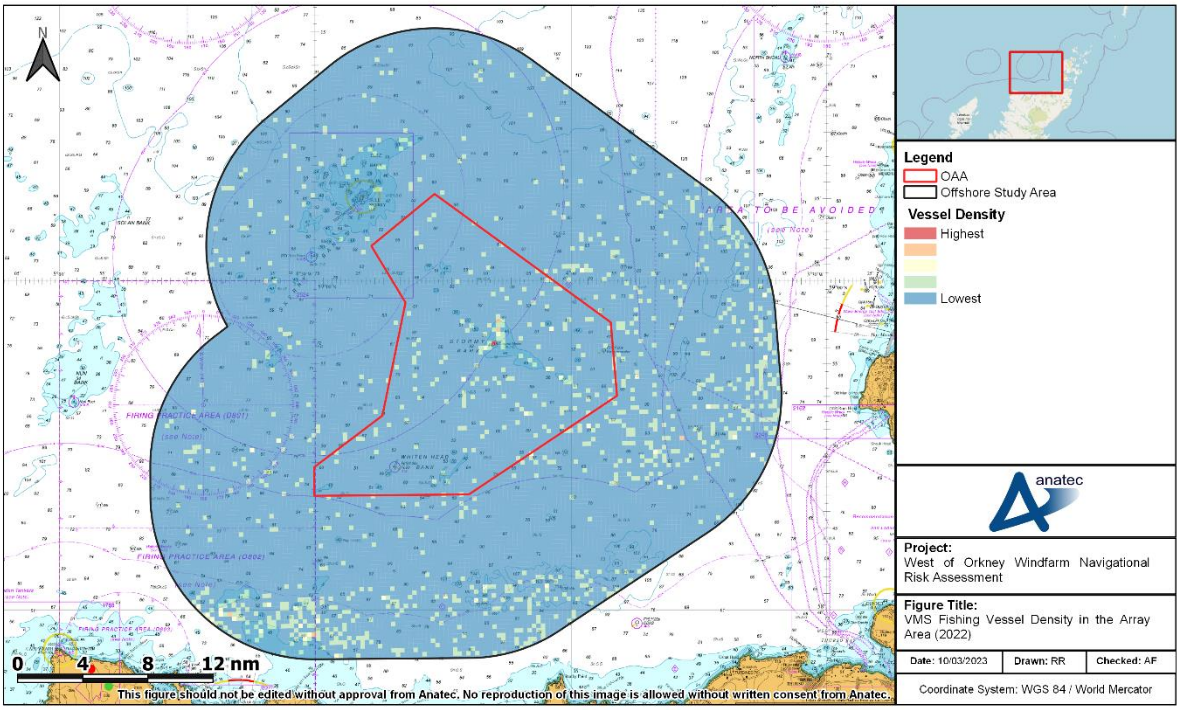

Figure 10.11 VMS Fishing Vessel Density in the OAA (2022)

The highest density areas were to the east and to the south of the OAA, and within the OAA itself in particular around Stormy Bank. This correlates well with the long-term AIS data for fishing vessels during 2021 presented in Appendix E.

10.1.2.3 Tankers

The tracks of tankers within the offshore study area throughout the summer and winter survey periods combined are presented in Figure 10.12.

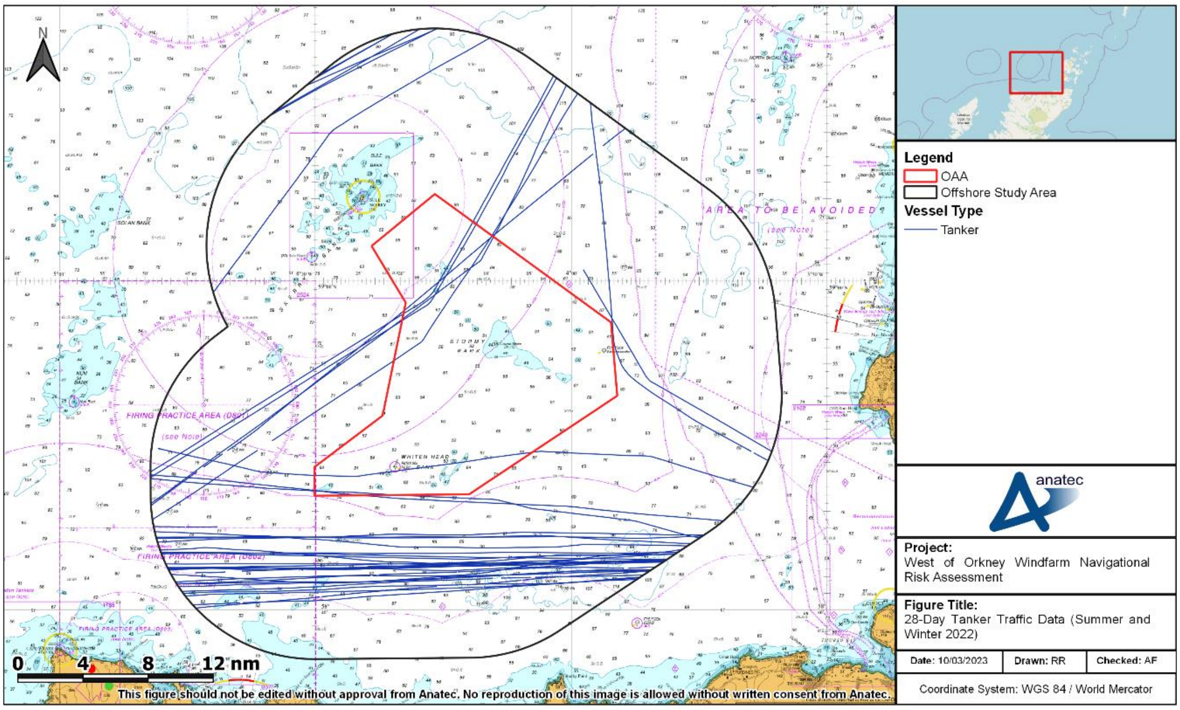

Figure 10.12 Tanker Traffic within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Throughout both survey periods, tankers were noted to transit heavily in an east-west bearing to the south of the OAA with several vessels on a southwest-northeast route through the OAA itself to/from Cape Wrath. An average of between one and two unique tankers per day were recorded within the offshore study area during both survey periods with an average of less than one unique tanker per day intersecting the OAA. An average of one unique tanker intersected the array are every three to four days during the summer survey period, and one unique tanker every four to five days during the winter.

Two tankers were noted to likely be avoiding the ATBA surrounding the Orkney Islands, with more instances noted within the long-term data annex (see Appendix E).

The most common tanker sub types recorded during both survey periods were combined oil/chemical tankers and crude oil tankers. Both equating to a combined total of approximately 50% of all tankers recorded within each survey period.

10.1.2.4 Passenger Vessels

The tracks of passenger vessels within the offshore study area throughout the summer and winter survey periods combined are presented in Figure 10.13.

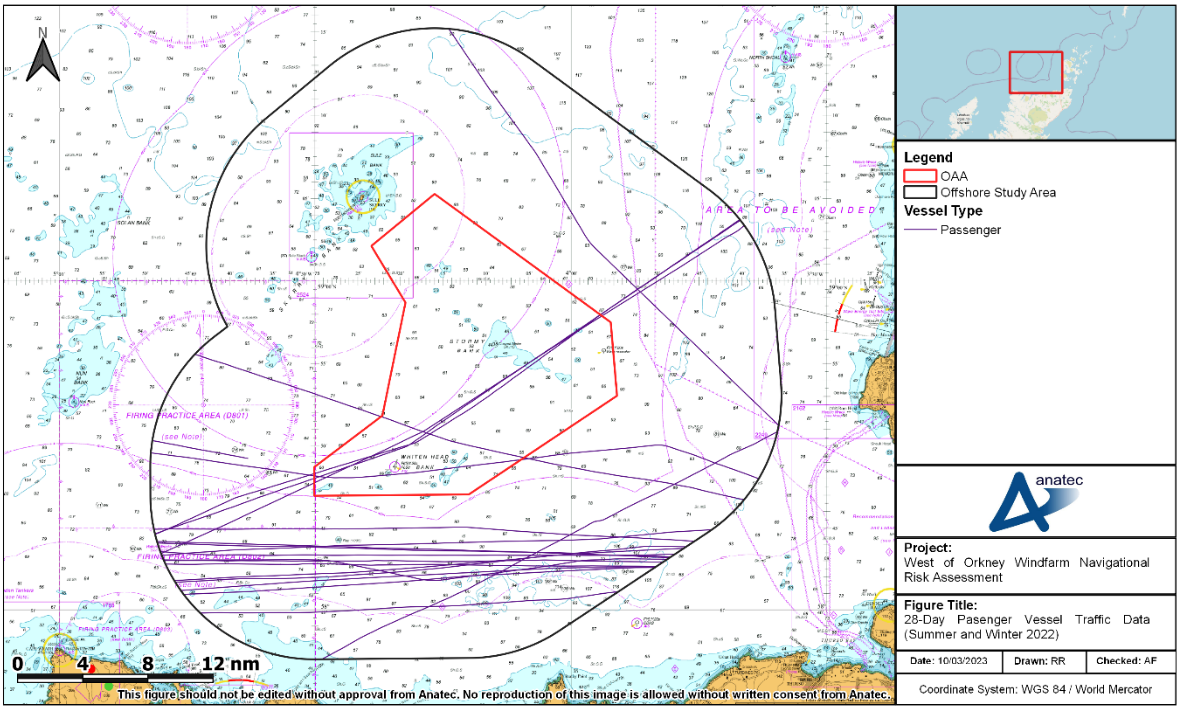

Figure 10.13 Passenger Vessel Traffic within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Passenger vessels were recorded mostly in the summer survey period with one unique vessel recorded during the winter survey. The single vessel recorded during the winter survey was a Roll-on/Roll-off passenger (RoPax) vessel, although this was likely transiting through the offshore study area on passage to its charter, rather than regularly operating in the region.

During the summer survey period, an average of between one and two unique passenger vessels per day were recorded within the offshore study area with an average of one unique vessel every two days intersecting the OAA. Apart from the RoPax vessel, all passenger vessels were cruise liners (96%).

10.1.2.5 Recreational Vessels

10.1.2.5.1 Vessel Traffic Survey Data

The tracks of recreational vessels within the offshore study area throughout the summer survey period is presented in Figure 10.14.

It is noted that there were no recorded recreational vessels within the winter survey period.

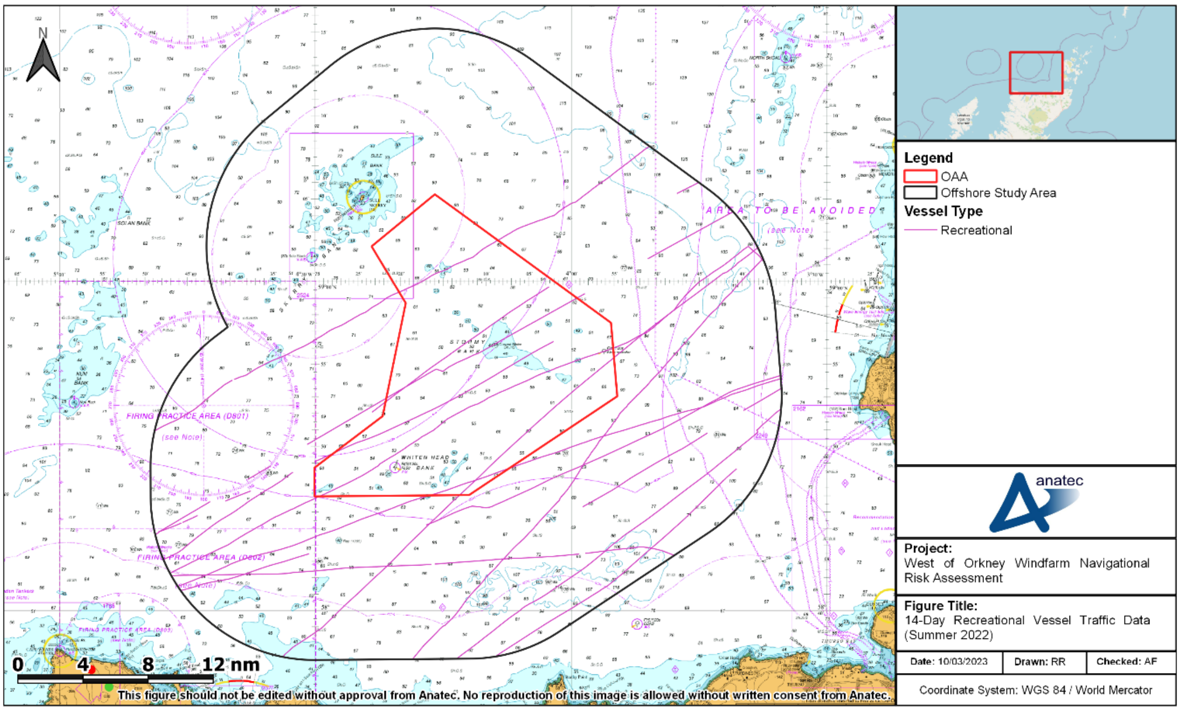

Figure 10.14 Recreational Vessel Traffic within the OAA and Offshore Study Area (14-Days Summer 2022)

All recreational vessels during the summer survey period were on a northeast-southwest transit across the center and southeast of the offshore study area. An average of one unique recreational vessel per day was recorded within the offshore study area and an average of one unique vessel every two days intersected the OAA.

10.1.2.5.2 RYA Coastal Atlas of Recreational Boating

In addition to the vessel traffic survey data, the *RYA Coastal Atlas of Recreational Boating* (RYA, 2019 (a)) 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.

Figure 10.15 presents a plot of the RYA Coastal Atlas heat map relative to the OAA. Following this, Figure 10.16 presents a plot of features relevant to recreational boating.

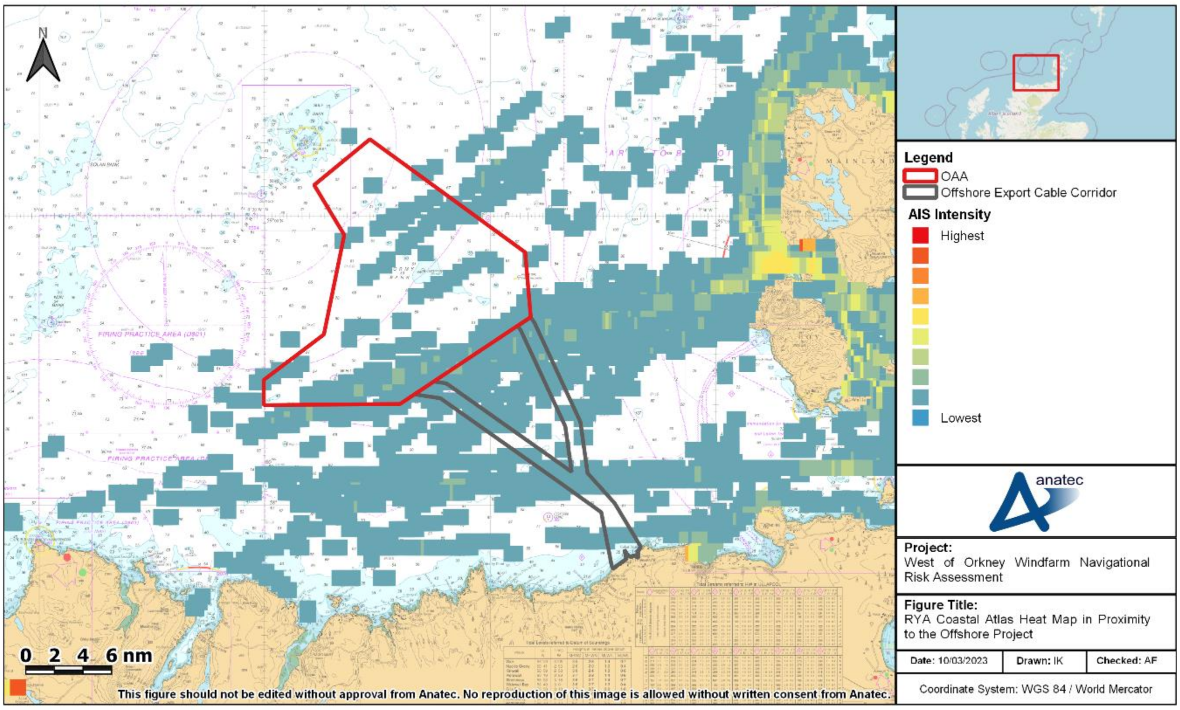

Figure 10.15 RYA Coastal Atlas Heat Map in Proximity to the Offshore Project

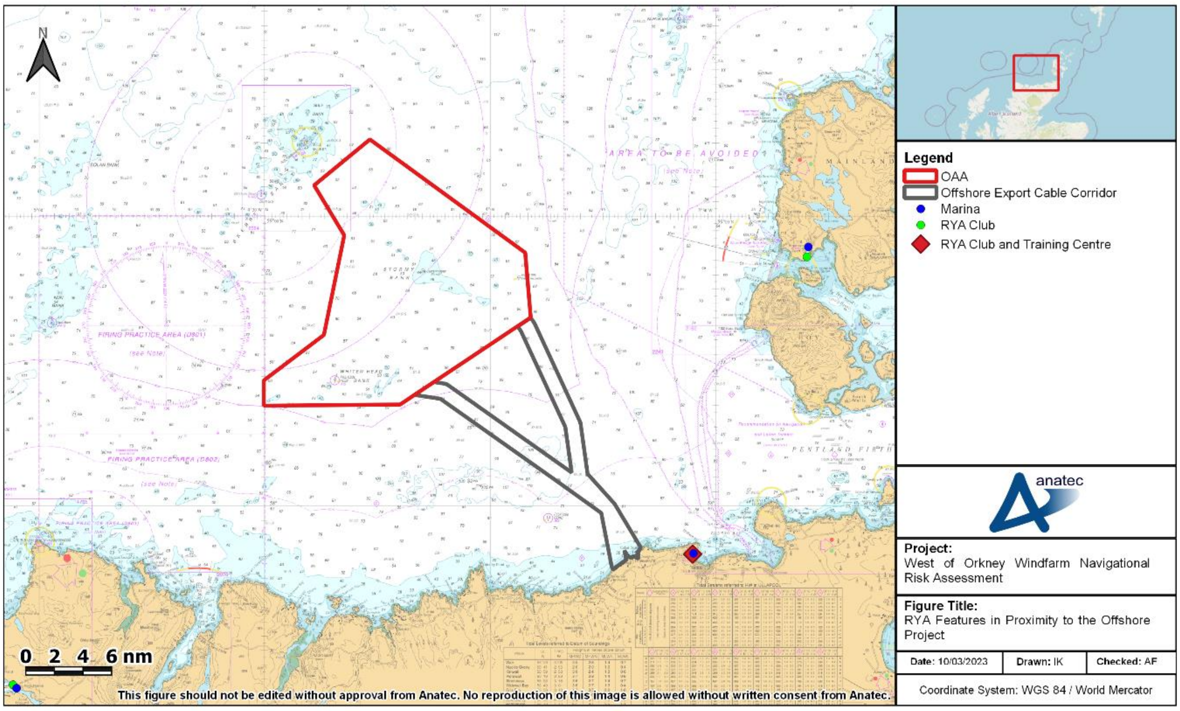

Figure 10.16 RYA Features in Proximity to the Offshore Project

Higher density recreational traffic is observed towards the Pentland Firth and Orkney, with a decrease culminating in sparse activity within the OAA. There are a number of RYA facilities along the coast in the vicinity, with the nearest club and training centre located approximately

20 nm to the south of the OAA, in Thurso, where there is also a marine. In addition, there is an RYA club and marina approximately 19 nm east of the OAA in Stromness, and an RYA club, training centre, and marine approximately 30 nm east of the OAA in Kirkwall.

10.1.2.6 Oil and Gas Support Vessels

The tracks of oil and gas support vessels within the offshore study area throughout the summer and winter survey periods combined are presented in Figure 10.13.

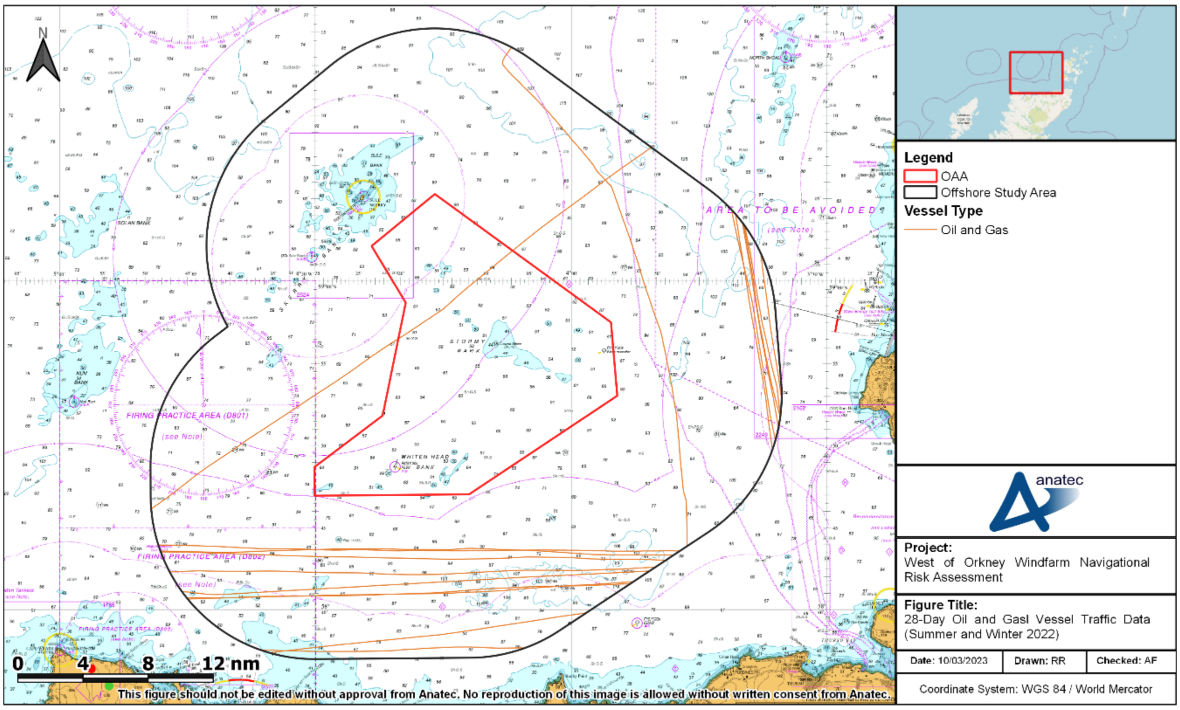

Figure 10.17 Oil and Gas Vessel Traffic within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Oil and gas support vessels were more frequent during the summer survey period with an average of one unique vessel per day recorded within the offshore study area. Only one of these vessels intersected the OAA during the survey period. Compared with the winter survey period, an average of less than one, or one unique vessel every three to four days, was recorded within the offshore study area. No vessels intersected the OAA during the winter survey period.

Oil and gas vessels were predominantly transiting east-west at the south of the offshore study area as well as north-south to the eastern extent of the offshore study area.

10.1.3 Vessel Size

10.1.3.1 Vessel Length

Vessel length information was available for 99% of all vessels recorded throughout the combined summer and winter survey periods. A plot of all vessel tracks (excluding temporary traffic) recorded within the offshore study area throughout the survey periods, colour-coded by length overall (LOA), is presented in Figure 10.18. Following this, the distribution of these LOA classes, by survey period, is presented in Figure 10.19.

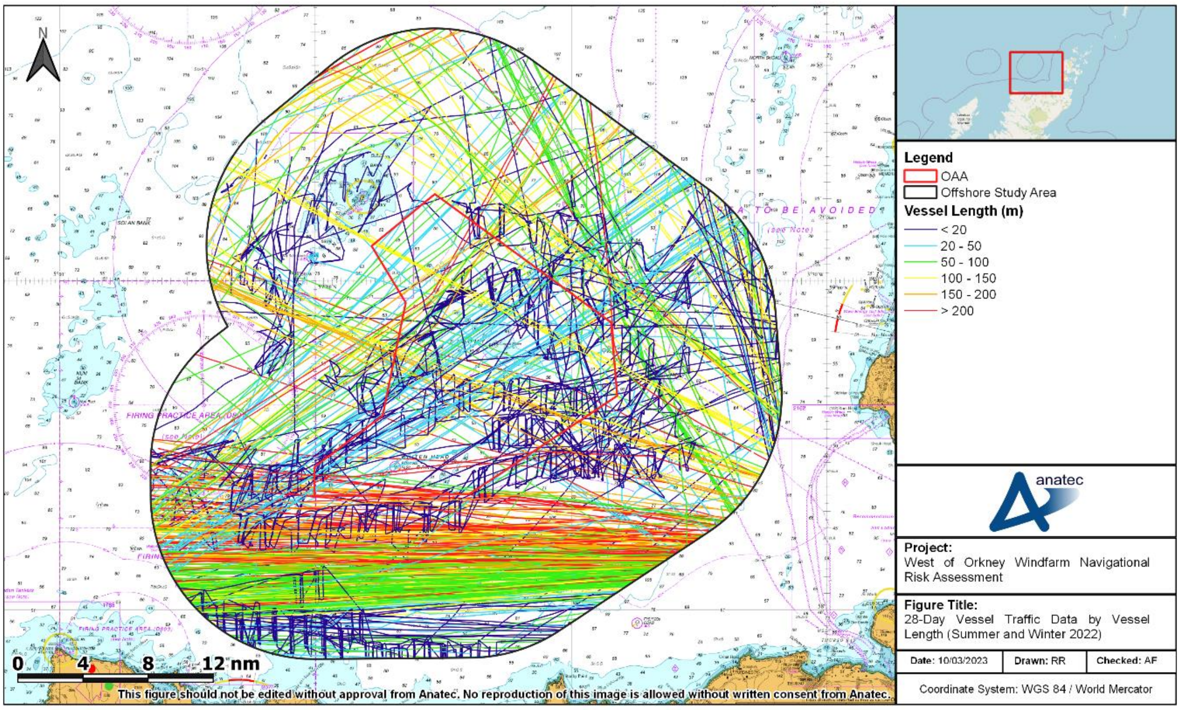

Figure 10.18 Vessel Traffic Data within the OAA and Offshore Study Area by Vessel LOA (28-Days Summer and Winter 2022)

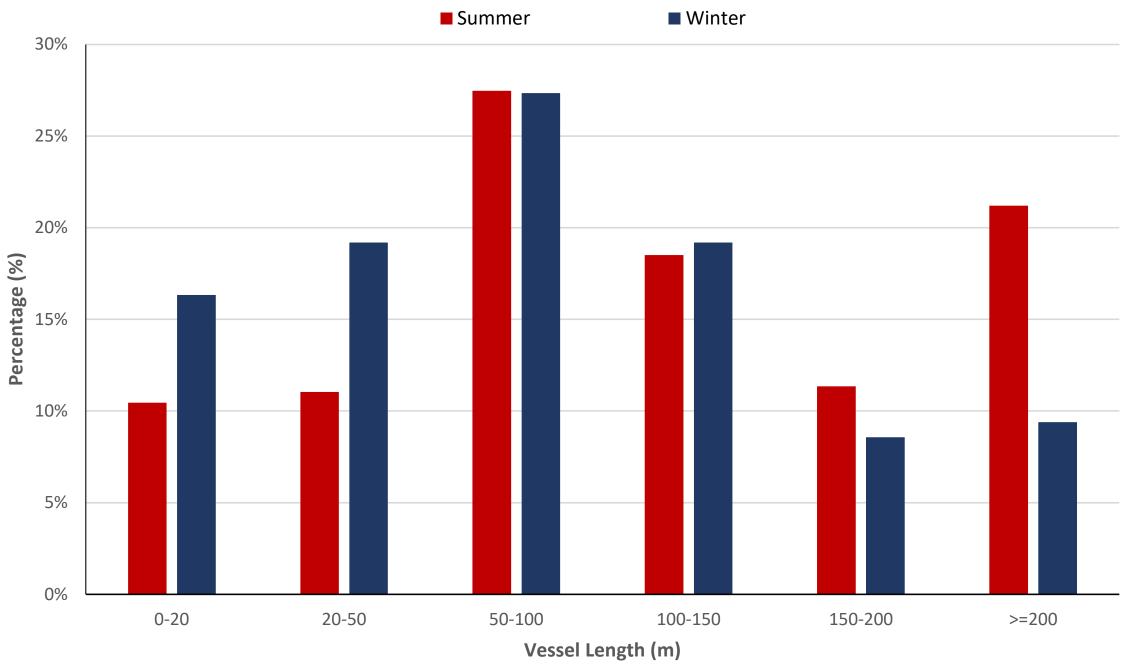

Figure 10.19 Vessel LOA Distribution within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Excluding the proportion of vessels for which LOA was not available, the average LOA of vessels within the offshore study area was 121 m and 93 m for the summer and winter surveys, respectively. Over the survey periods, LOA ranged between 10 m recreational vessels and a 332 m container cargo vessel.

Those vessels of greater lengths were primarily cargo and passenger vessels with the smaller lengths being fishing and recreational vessels.

10.1.3.2 Vessel Draught

Vessel draught information was available for 93% of all vessels recorded throughout the combined summer and winter survey periods. A plot of all vessel tracks (excluding temporary traffic) recorded within the offshore study area throughout the survey periods, colour-coded by vessel draught, is presented in Figure 10.20. Following this, the distribution of these draught classes, by survey period, is presented in Figure 10.21.

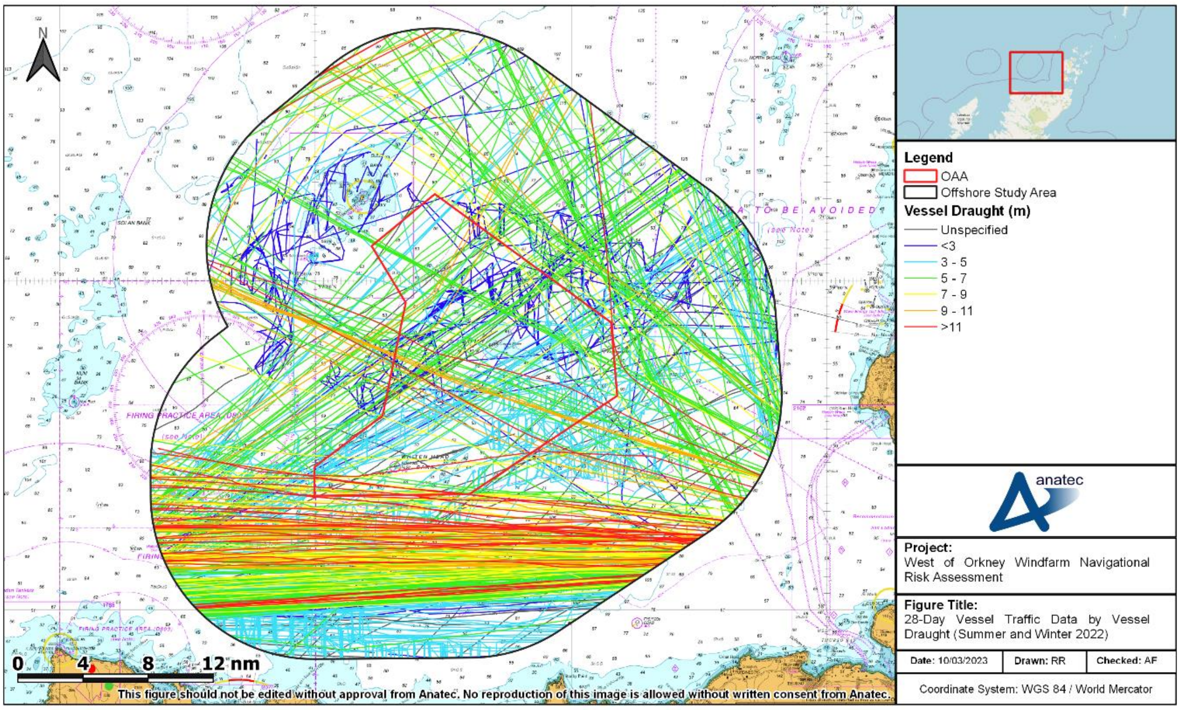

Figure 10.20 Vessel Traffic Data within the OAA and Offshore Study Area by Vessel Draught (28-Days Summer and Winter 2022)

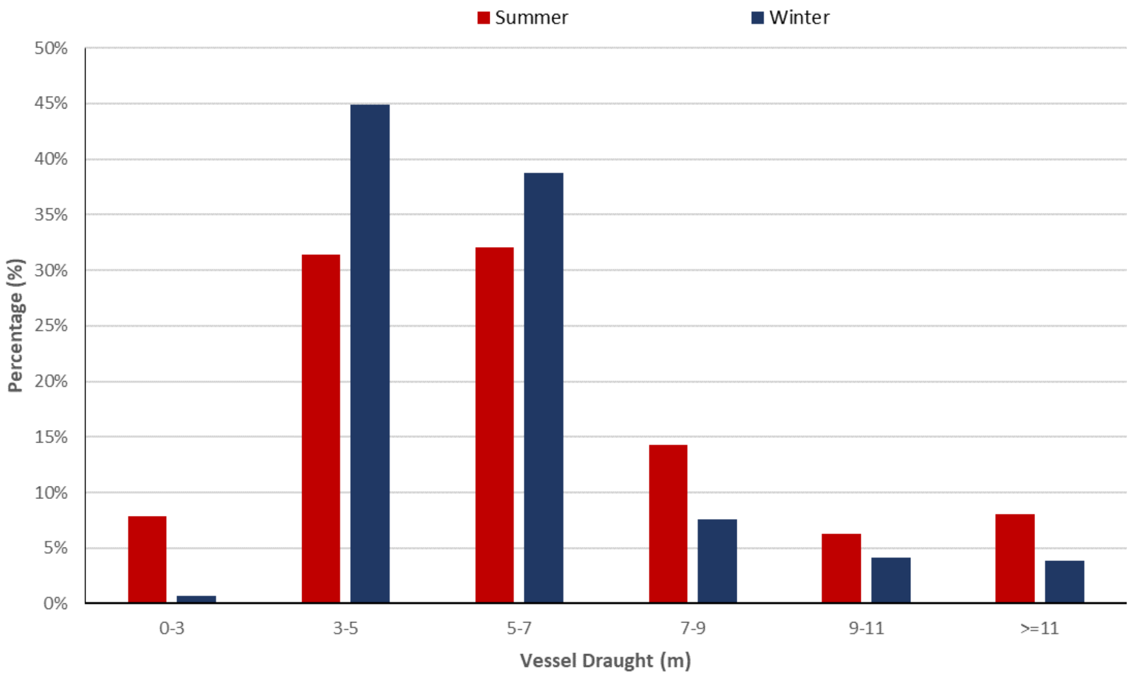

Figure 10.21 Vessel Draught Distribution within the OAA and Offshore Study Area (28-Days Summer and Winter 2022)

Excluding the proportion of vessels for which vessel draught was not available, the average draught of vessels within the offshore study area was 6.2 m and 5.7 m for the summer and winter surveys, respectively. Over the survey periods, transmitted draughts ranged between 2.4 m for a tug and 15.2 m for a bulk carrier.

Those vessels of greater draughts were primarily cargo vessels and tankers with the smaller draughts being fishing and recreational vessels.

10.1.4 Vessel Bearing

A plot of all vessel tracks recorded within the study area during the survey period is presented in Figure 10.22, colour-coded by average vessel bearing for each transit.

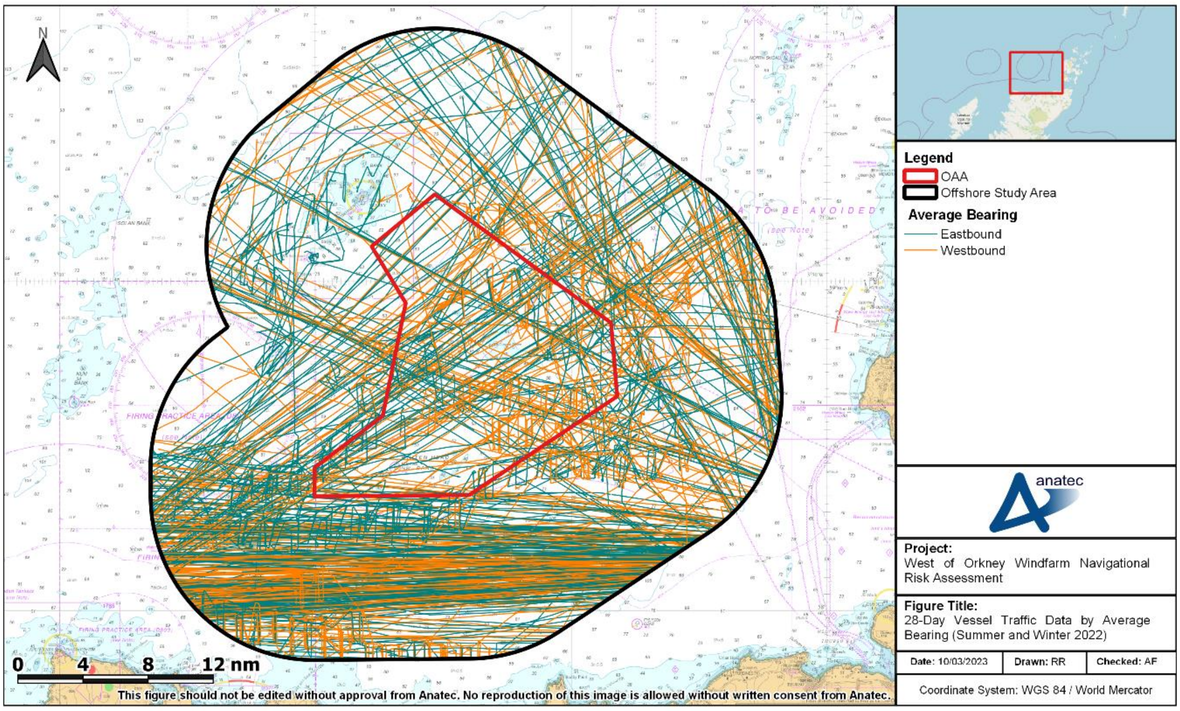

Figure 10.22 28-Day Vessel Traffic Data by Average Bearing (Summer and Winter 2022)

Throughout the 28-day survey period, approximately equal numbers of vessel transits were recorded in a broad eastbound and westbound bearings within the offshore study area.

10.1.5 Anchoring Activity

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.

For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, no vessels were deemed to be at anchor within the offshore study area.

10.2 Offshore ECC

This section presents an overview of vessel traffic movements within the offshore ECC study area based on AIS data alone. A number of trackers recorded during the data periods were classified as temporary (non-routine), such as the tracks of vessels engaged in benthic and geophysical survey work within the offshore ECC for West of Orkney Windfarm. These vessels have been excluded from the analysis in line with the approach taken for the assessment of the OAA (Section 10.1). It is noted that no temporary traffic was identified within the offshore ECC study area for the winter survey period.

A plot of vessel tracks recorded during the 14-day data period in August 2022 (summer), colour-coded by vessel type and excluding any temporary traffic, is presented in Figure 10.23. A plot of vessel tracks recorded during the 14-day date period in December 2022 (winter), colour-coded by vessel type, is presented in Figure 10.24.

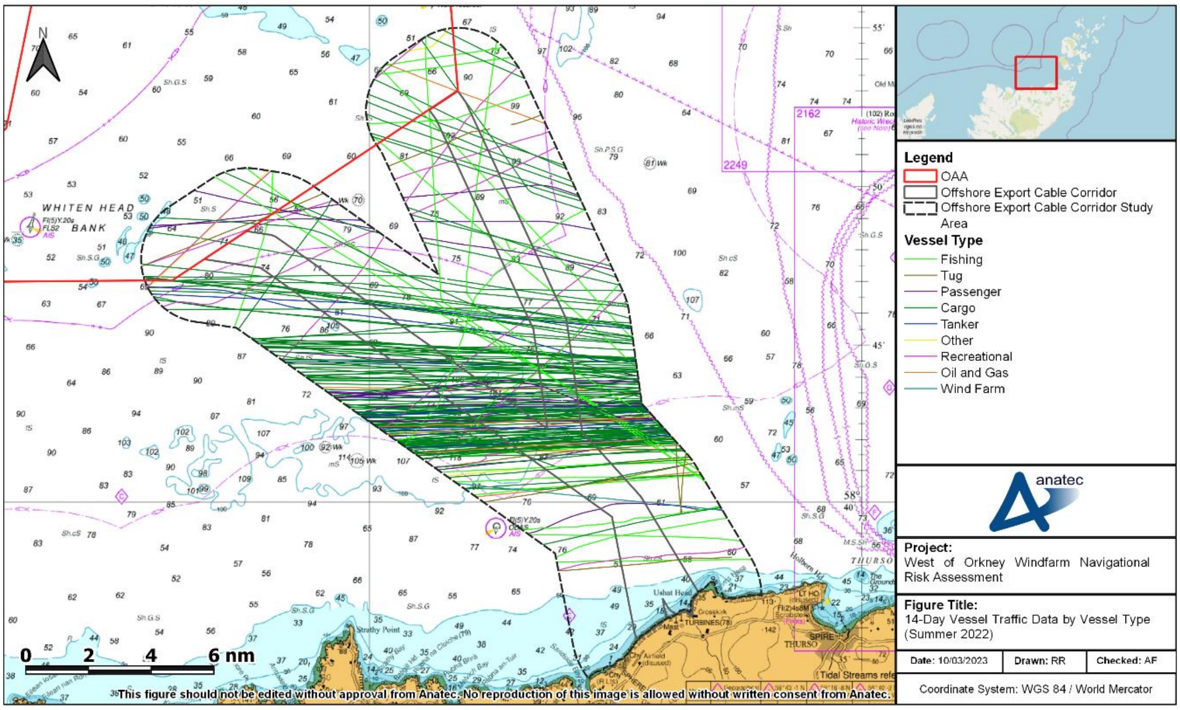

Figure 10.23 Vessel Traffic Data within the Offshore ECC and Study Area by Vessel Type (14-Days Summer 2022)

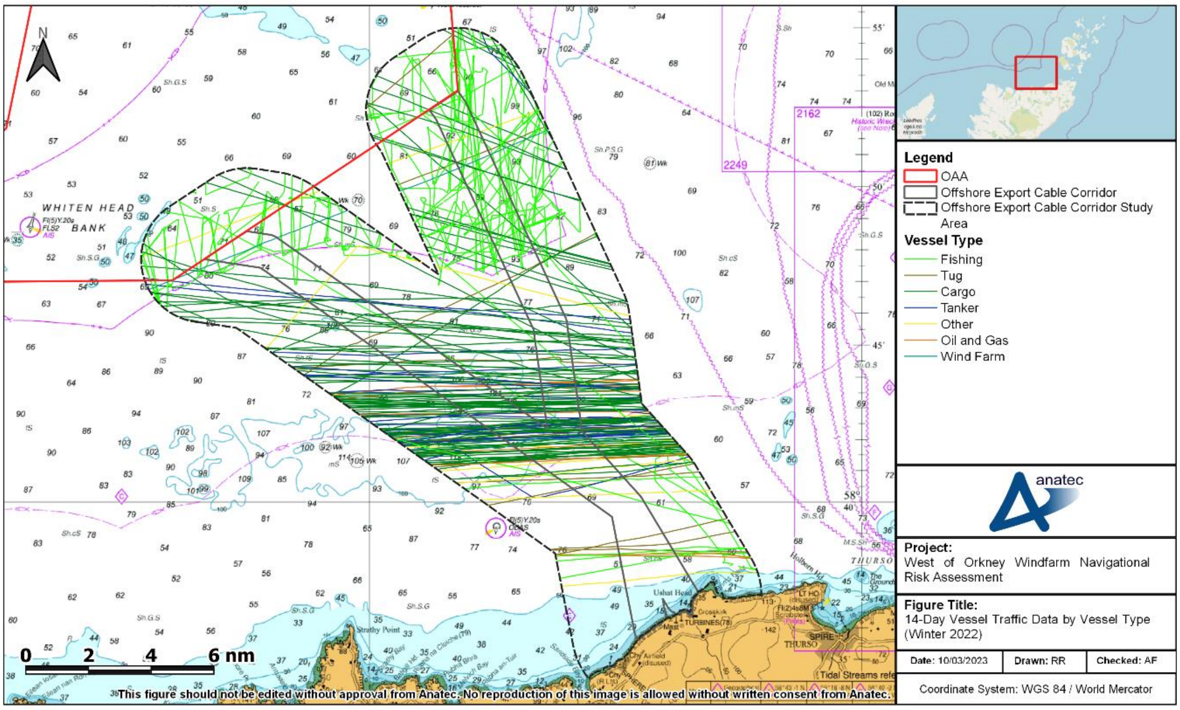

Figure 10.24 Vessel Traffic Data within the Offshore ECC and Study Area by Vessel Type (14-Days Winter 2022)

Plots of the vessel tracks for the summer and winter data periods converted to a density heat map are presented in Figure 10.25 and Figure 10.26, respectively. It is noted that the same density brackets were used for both data periods to allow for direct comparison in vessel density.

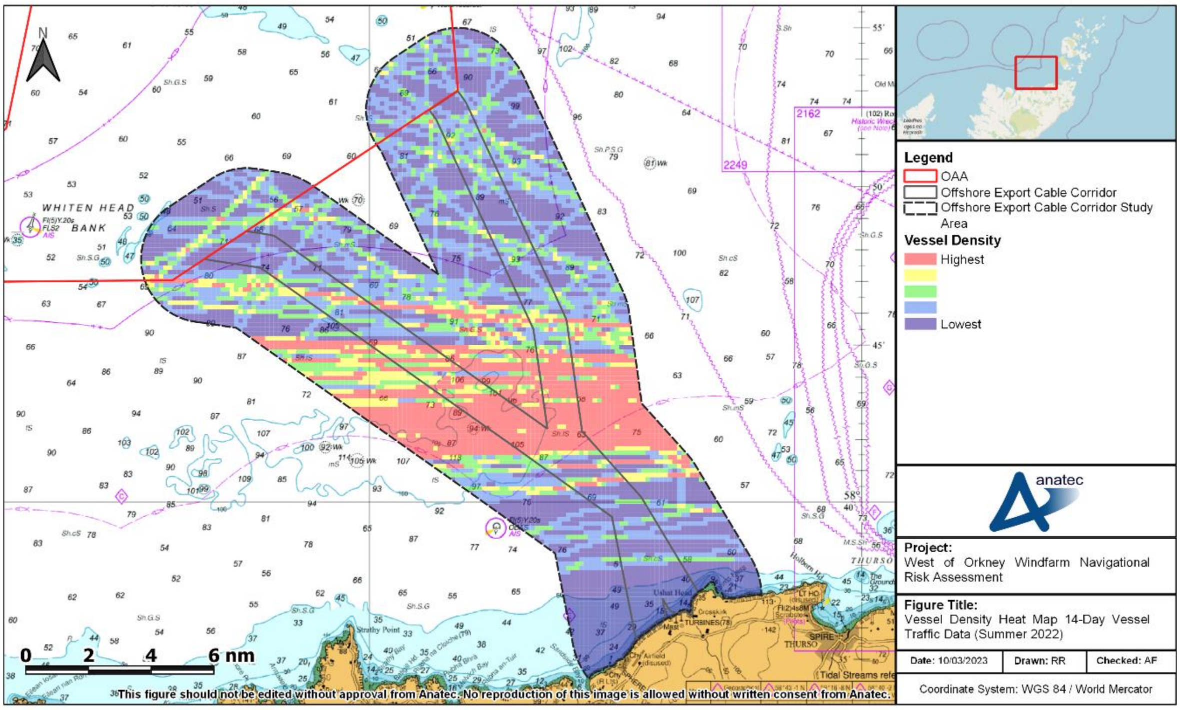

Figure 10.25 Vessel Density Heat Map within the Offshore ECC and Study Area (14-Days Summer 2022)

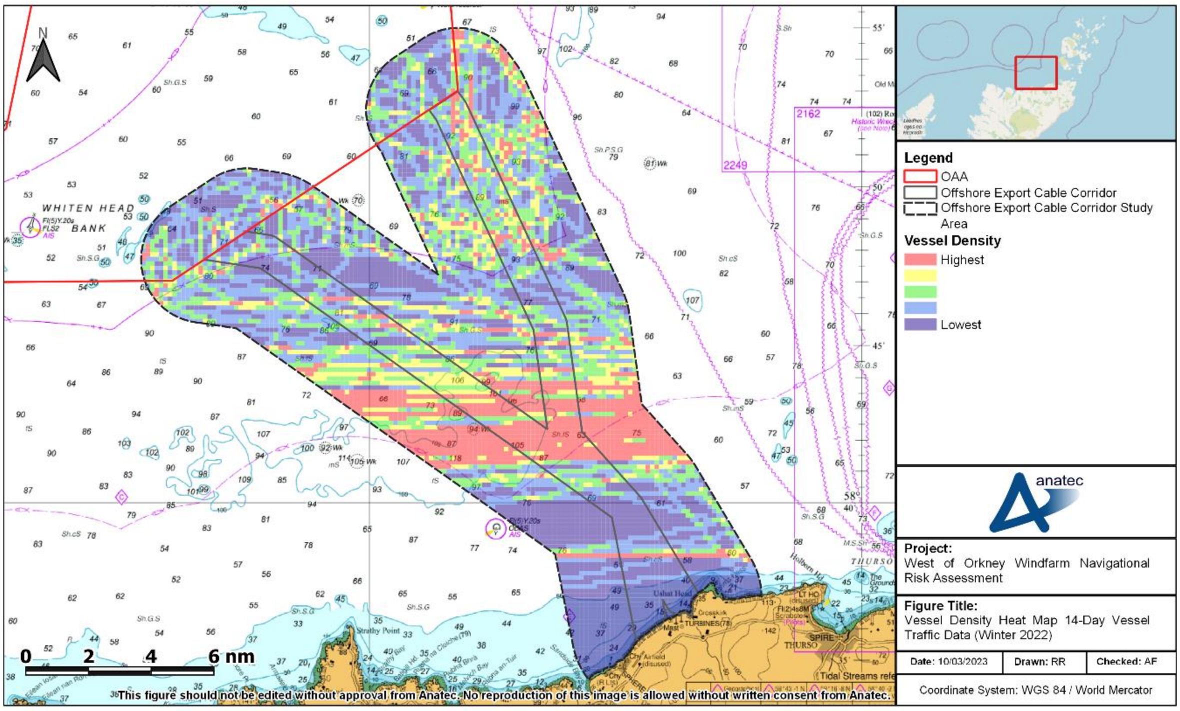

Figure 10.26 Vessel Density Heat Map within the Offshore ECC and Study Area (14-Days Winter 2022)

10.2.1 Vessel Counts

For the 14-days analysed during the summer data period, there was an average of 15 unique vessels recorded per day within the offshore ECC study area. In terms of vessels intersecting the offshore ECC itself, there was an average of 14 to 15 unique vessels per day within the offshore ECC during the data period.

The daily number of unique vessels recorded within the offshore ECC study area and the offshore ECC itself during the summer data period are presented in Figure 10.27.

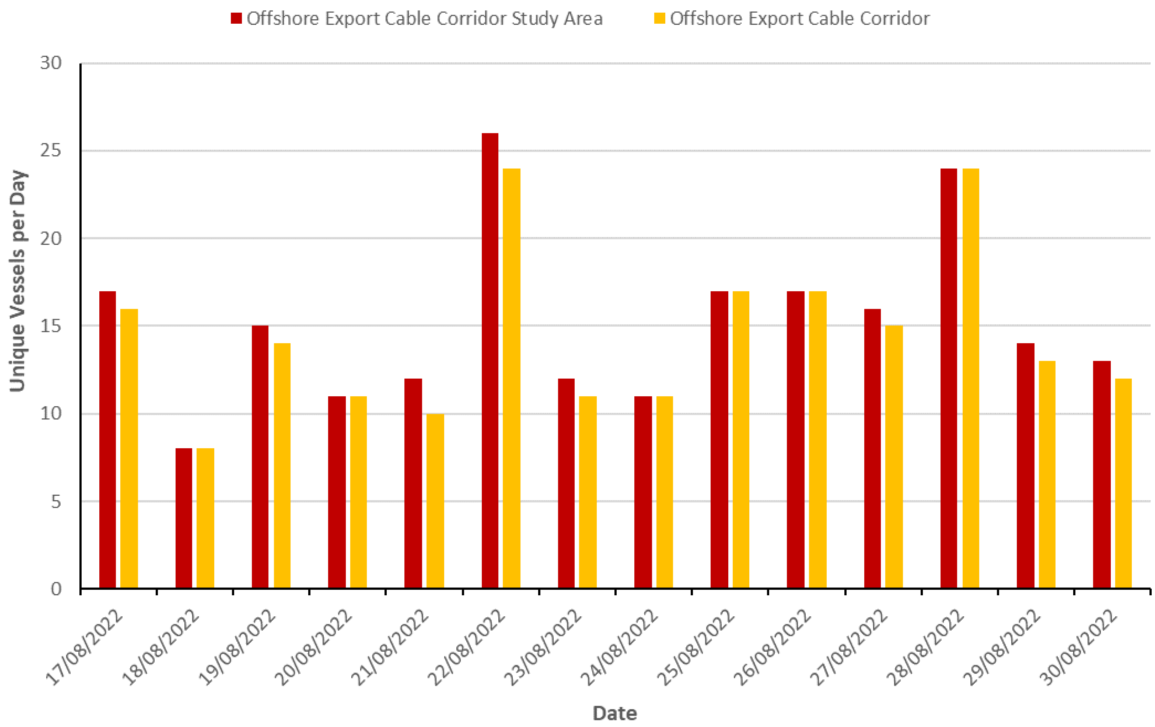

Figure 10.27 Unique Vessels per Day within the Offshore ECC and Study Area (14-Days Summer 2022)

Throughout the summer data period, approximately 95% of unique vessel tracks recorded within the offshore ECC study area intersected the offshore ECC.

The busiest day recorded within the offshore ECC study area throughout the summer data period was 22 August 2022, during which 26 unique vessels were recorded. The busiest full day recorded within the offshore ECC during the summer data period was also 22 August 2022, during which 24 unique vessels were recorded.

The quietest day recorded within the offshore ECC study area throughout the summer data period was 18 August 2022, during which 8 unique vessels were recorded. The quietest full day recorded within the offshore ECC during the summer data period was also 18 August 2022, during which 8 unique vessels were recorded.

For the 14-days analysed during the winter data period, there was an average of 13 unique vessels recorded per day within the offshore ECC study area. In terms of vessels intersecting the offshore ECC itself, there was an average of 12 to 13 unique vessels per day within the offshore ECC during the data period.

The daily number of unique vessels recorded within the offshore ECC study area and the offshore ECC itself during the winter data period are presented in Figure 10.28.

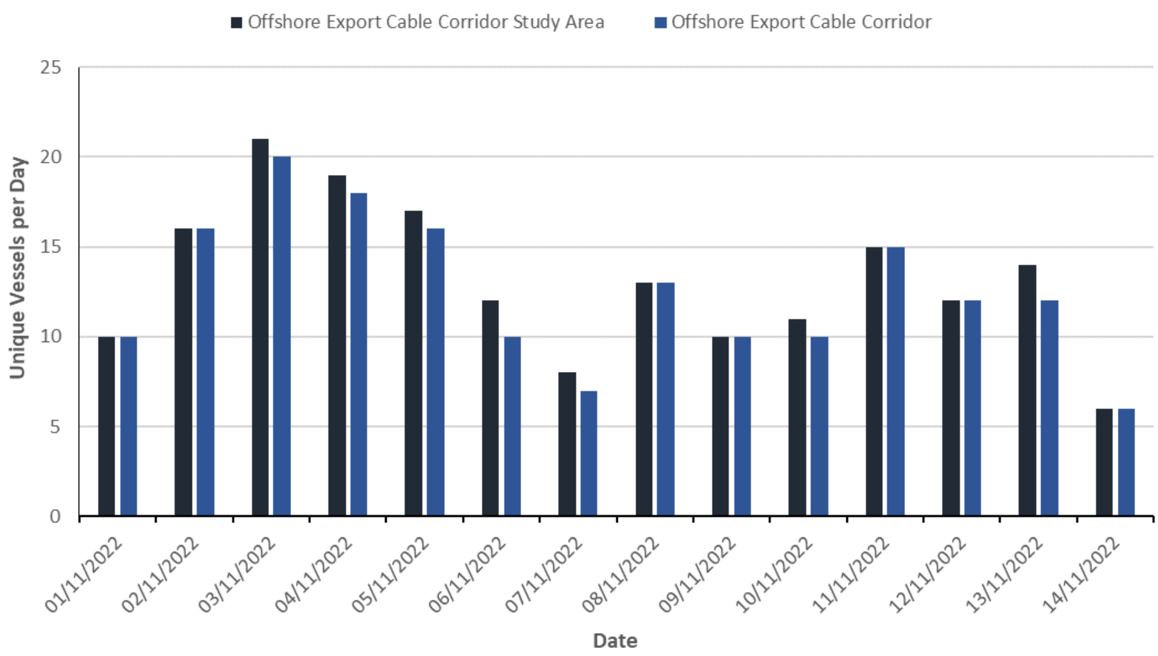

Figure 10.28 Unique Vessels per Day within the Offshore ECC and Study Area (14-Days Winter 2022)

Throughout the winter data period, approximately 95% of unique vessel tracks recorded within the offshore ECC study area intersected the offshore ECC.

The busiest day recorded within the offshore ECC study area throughout the winter data period was 3 December 2022, during which 21 unique vessels were recorded. The busiest full day recorded within the offshore ECC during the winter data period was also 3 December 2022, during which 20 unique vessels were recorded.

The quietest day recorded within the offshore ECC study area throughout the winter data period was 14 December 2022, during which 6 unique vessels were recorded. The quietest full day recorded within the offshore ECC during the winter data period was also 14 December 2022, during which 6 unique vessels were recorded.

10.2.2 Vessel Types

The percentage distribution of the main vessel types recorded within the offshore ECC study area and the offshore ECC is presented in Figure 10.29.

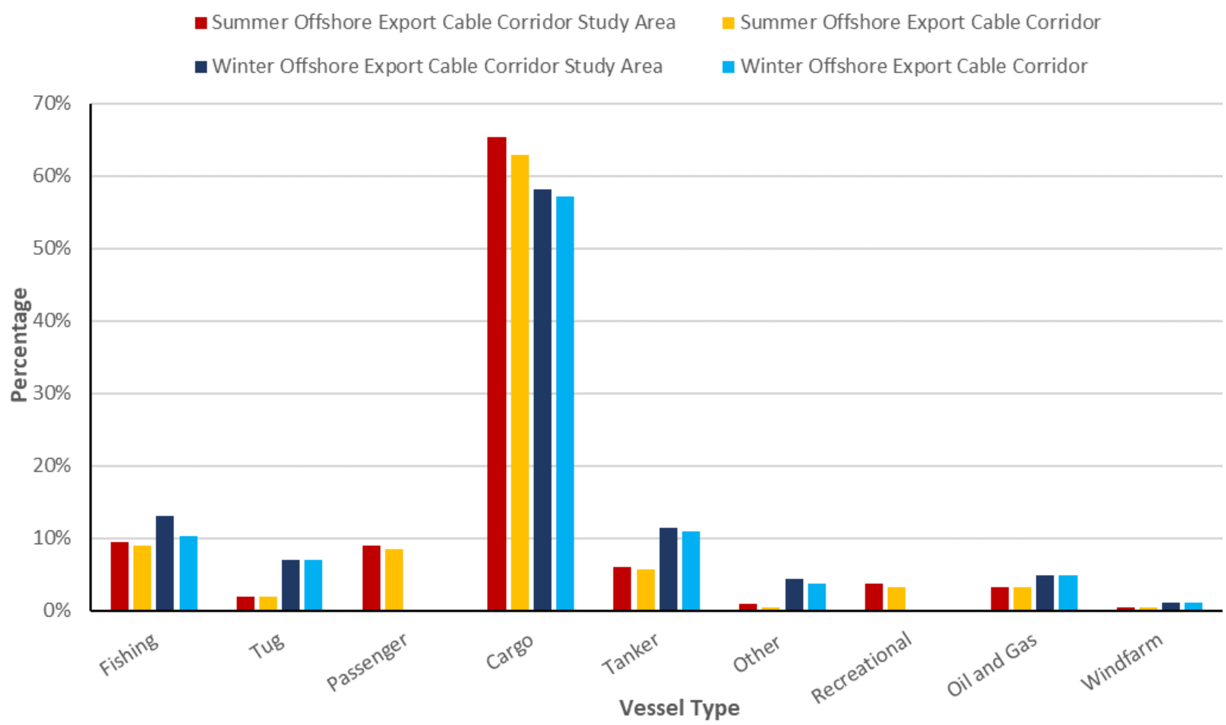

Figure 10.29 Vessel Type Distribution within Offshore ECC and Study Area (28-Days Summer and Winter 2022)

Throughout the summer data period, the most common vessel types within the offshore ECC study area were cargo vessels (65%), fishing vessels (9%), and passenger vessels (9%). Throughout the winter data period, the most common vessel types within the offshore ECC study area were cargo vessels (58%), fishing vessels (13%), and tankers (11%). Within the offshore ECC, the most common vessel types followed the same trends as the offshore cable corridor study area for each data period.

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

10.2.2.1 Cargo Vessels

The tracks of cargo vessels within the offshore ECC study area throughout the summer and winter data periods combined are presented in Figure 10.30.

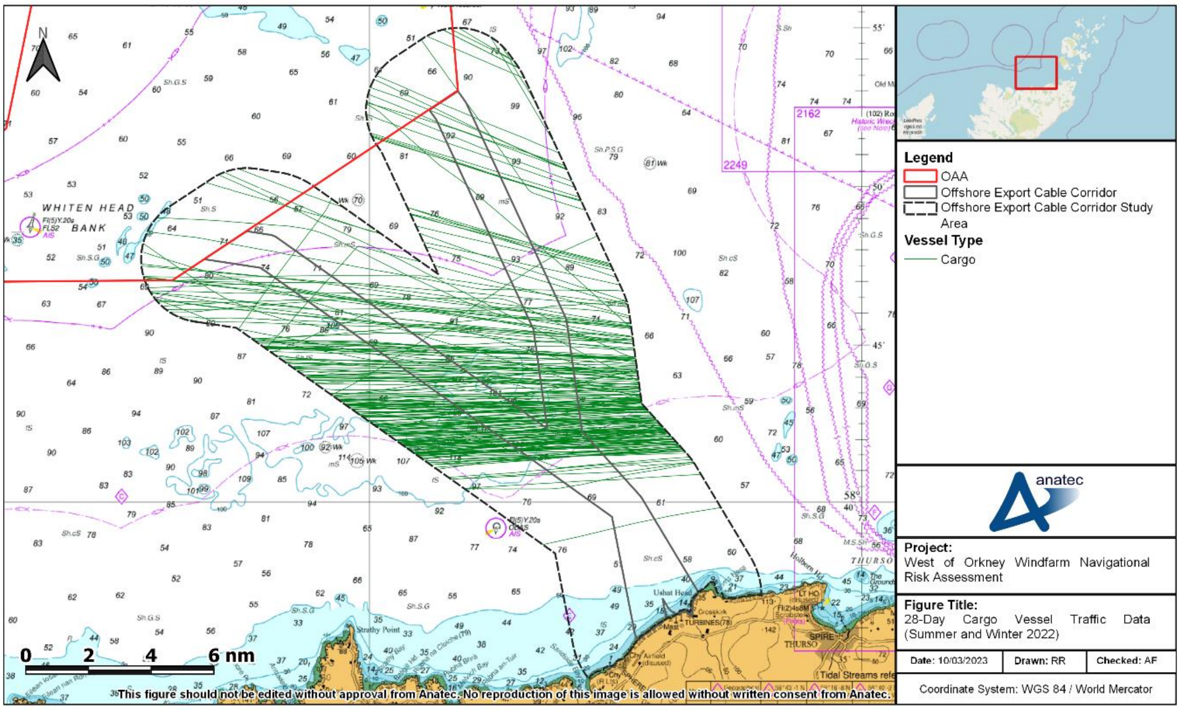

Figure 10.30 Cargo Vessel Traffic within the Offshore ECC and Study Area (28-Days Summer and Winter 2022)

Throughout both data periods, vessels were noted to transit heavily in an east-west bearing through the center of the offshore ECC study area. Vessels are also seen transiting in the northern extent of the offshore ECC on northeast-southwest bearings.

During the summer data period, an average of ten unique cargo vessels per day were recorded within the offshore ECC study area. The most common cargo sub-types within the offshore ECC study area were general cargo (42%), bulk carriers (34%), and container vessels (15%).

During the winter data period, an average of seven to eight unique cargo vessels per day were recorded within the offshore ECC study area. The most common cargo sub-types within the offshore ECC study area were general cargo (46%), bulk carriers (27%), and container vessels (12%).

10.2.2.2 Commercial Fishing Vessels

10.2.2.2.1 Vessel Traffic Data

Commercial fishing vessel tracks within the offshore ECC study area throughout the summer and winter data periods combined are presented in Figure 10.31.

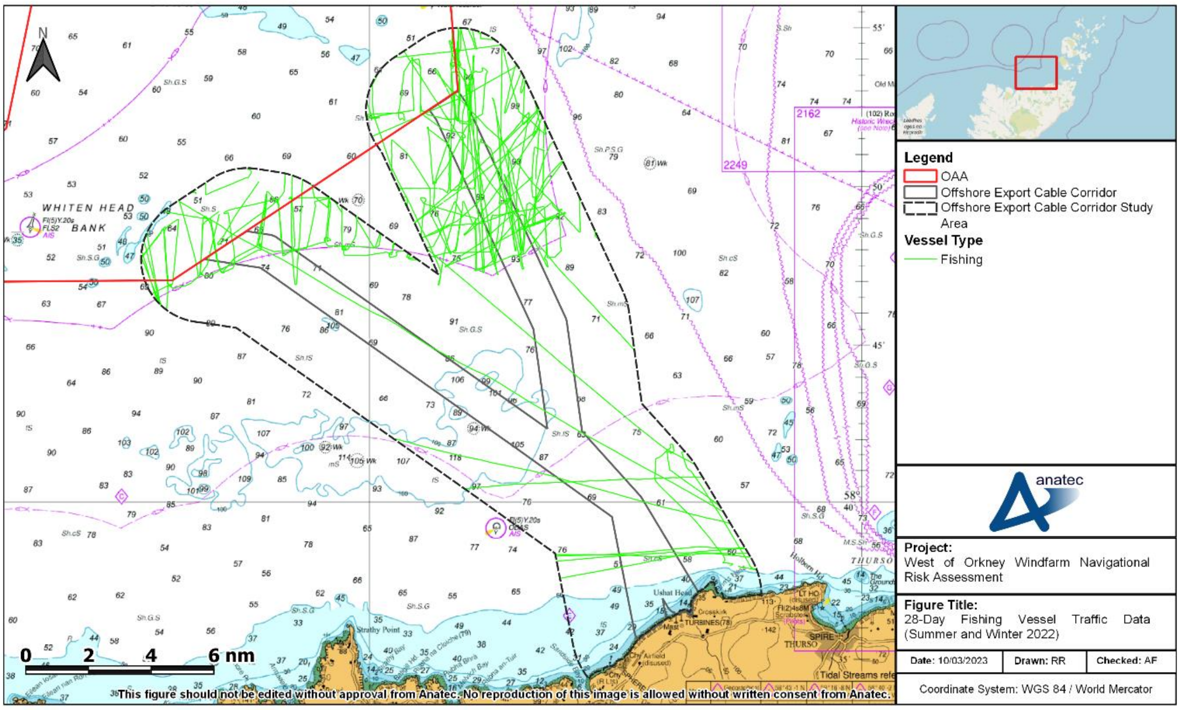

Figure 10.31 Fishing Vessel Traffic within the Offshore ECC and Study Area (28-Days Summer and Winter 2022)

During the summer and winter data periods, an average of one to two unique fishing vessels per day were recorded within the offshore ECC study area. All fishing vessels were in transit during the summer data period with vessels engaged in likely fishing activity only present during the winter data period. Those vessels engaged in fishing activity were noted to the north of the offshore ECC study area, and the offshore ECC itself, with those in transit recorded more southernly. Of those vessels engaged in likely fishing activity, all were potter/whelkers. As mentioned in Section 5.4, fishing vessel numbers within the study area during the summer survey period may be lower due to the presence of ongoing geophysical work within the site.

10.2.2.2.2 VMS Data

In addition to the vessel traffic survey data, VMS data recorded throughout 2022 has also been analysed within the offshore ECC study area. A density grid, using the VMS data during this period as input, is presented in Figure 10.32.

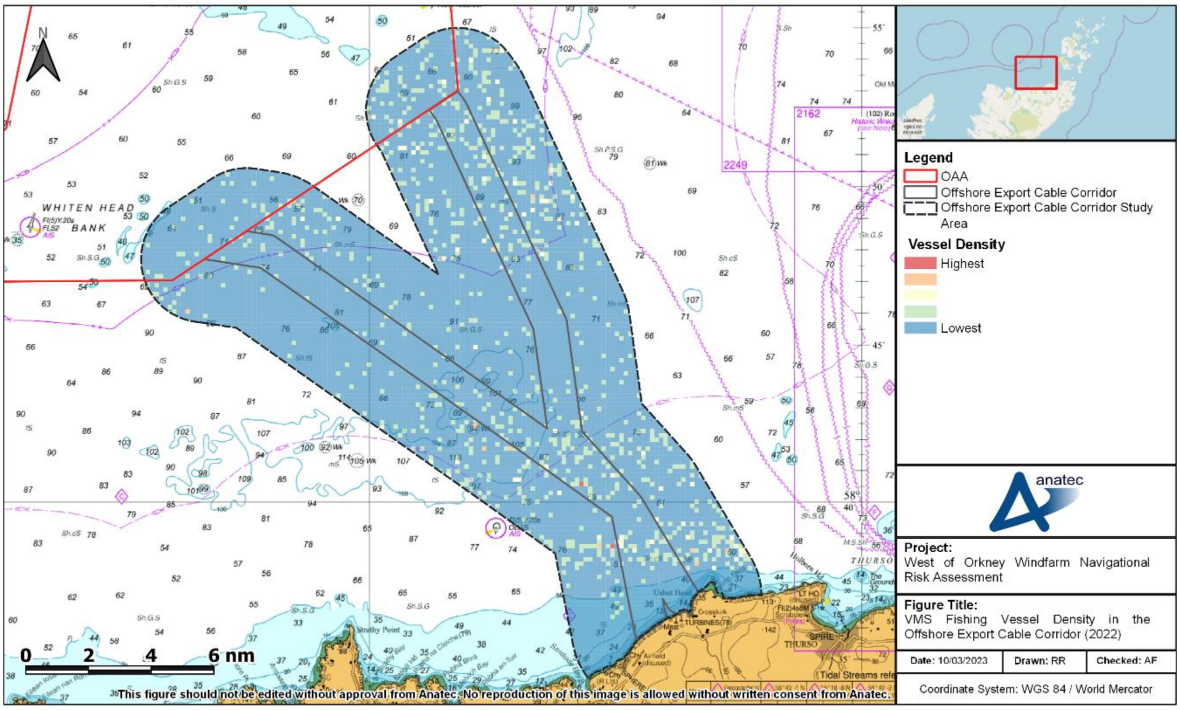

Figure 10.32 VMS Fishing Density in the Offshore ECC (2022)

The nearshore areas recorded the highest density of VMS fishing activity, with moderate density recorded on the northern segment of the offshore ECC study area.

10.2.2.3 Tankers

The tracks of tankers within the offshore ECC study area throughout the summer and winter data periods combined are presented in Figure 10.33.

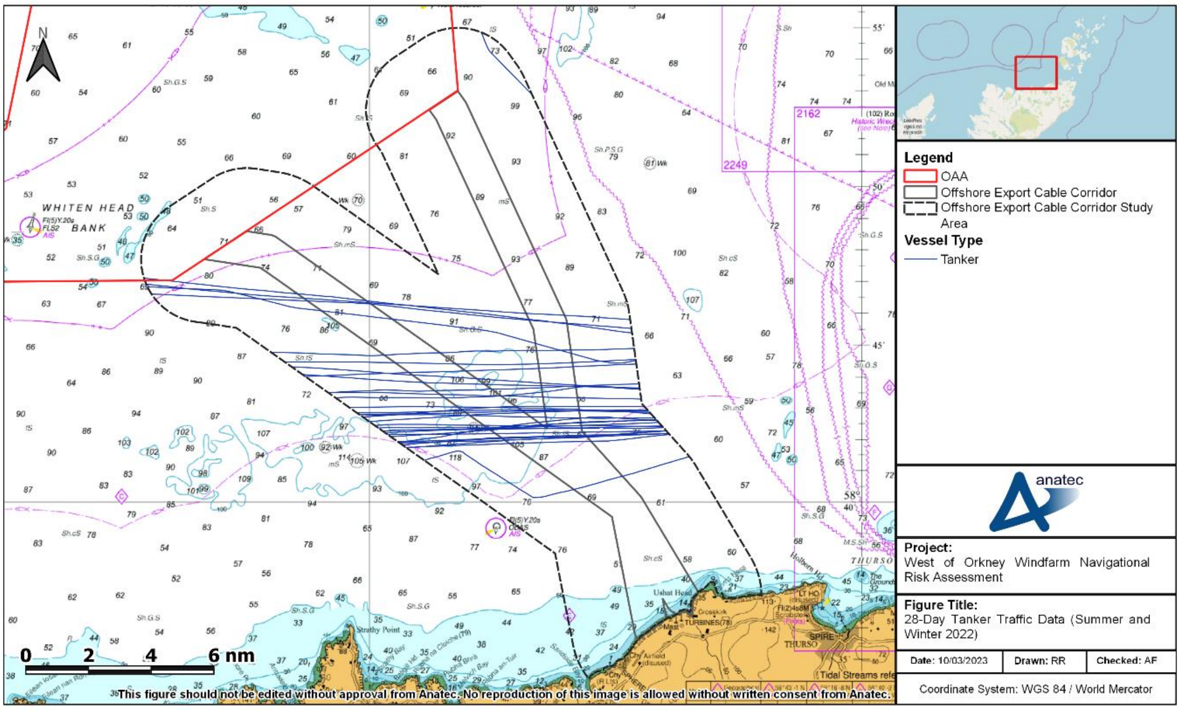

Figure 10.33 Tanker Traffic within the Offshore ECC and Study Area (28-Days Summer and Winter 2022)

Throughout both survey periods, tankers were noted to transit heavily in an east-west bearing through the center of the offshore ECC study area with few vessels transiting at the outer extremities of the offshore study area. An average of one unique tanker was recorded per day during the summer data period within the offshore ECC study area, with an average of between one and two unique vessels per day recorded during the winter data period.

The most common tanker sub types recorded during both survey periods were combined oil/chemical tankers and crude oil tankers with equated to 38% of all tankers recorded within each of the data periods. Following this, for the summer data period, Liquid Petroleum Gas (LPG) tankers (23%) and crude oil tankers (23%) were commonly reported and for the winter data period, LPG tankers (24%) and chemical tankers (14%) were reported.

10.2.2.4 Oil and Gas Support Vessels

The tracks of oil and gas support vessels within the offshore ECC study area throughout the summer and winter data periods combined are presented in Figure 10.34.

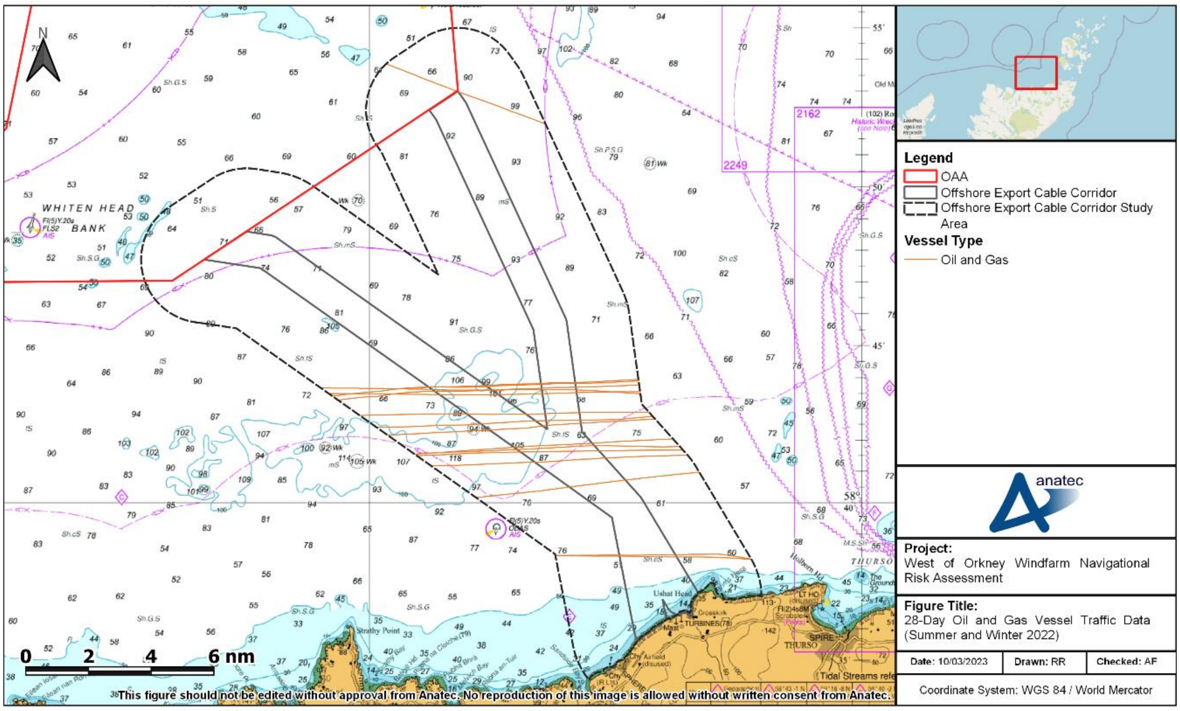

Figure 10.34 Oil and Gas Vessel Traffic within the Offshore ECC and Study Area (28-Days Summer and Winter 2022)

During the summer data period, an average of one unique oil and gas support vessel was recorded every two days within the offshore ECC study area with an average of less than one unique vessels per day was recorded during the winter data period.

Oil and gas support vessels were recorded only in transit and were transiting in an east-west bearing through the center of the offshore ECC study area.

10.2.2.5 Passenger Vessels

The tracks of passenger vessels within the offshore ECC study area throughout the summer data period are presented in Figure 10.35.

It is noted that there were no recorded passenger vessels within the winter data period.

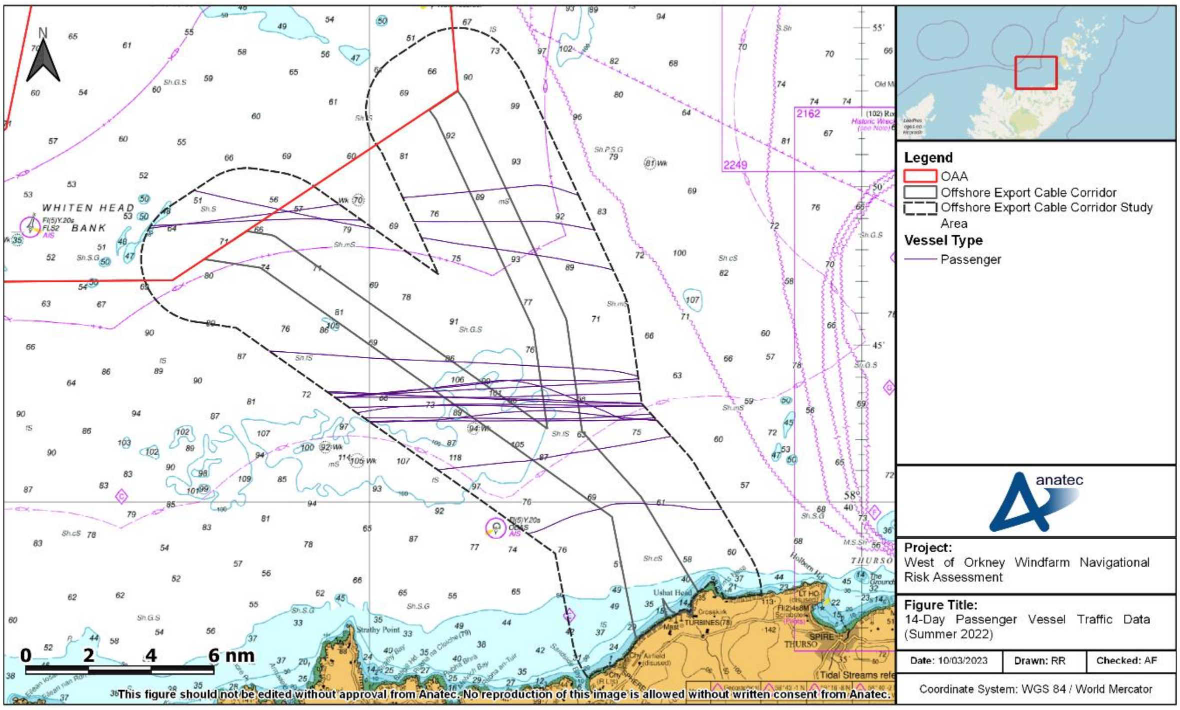

Figure 10.35 Passenger Vessel Traffic within the Offshore ECC and Study Area (14-Days Summer 2022)

An average of one unique passenger vessel per day was recorded within the offshore ECC study area during the summer data period. These vessels were mostly recorded transiting east-west through the centre of the offshore study area. Vessels transiting east were heading to ports and harbours in Orkney and Invergordon and were all passenger cruise liners. Vessels transiting west were heading for islands off the Scottish west coast with Belfast (UK), and Reykjavik (Iceland) also recorded. The majority of these vessels were cruise liners (82%) with a private cruise vessel and a large passenger yacht also present.

10.2.2.6 Recreational Vessels

The tracks of recreational vessels within the offshore ECC study area throughout the summer data period are presented in Figure 10.36.

It is noted that there were no recorded recreational vessels within the winter data period.

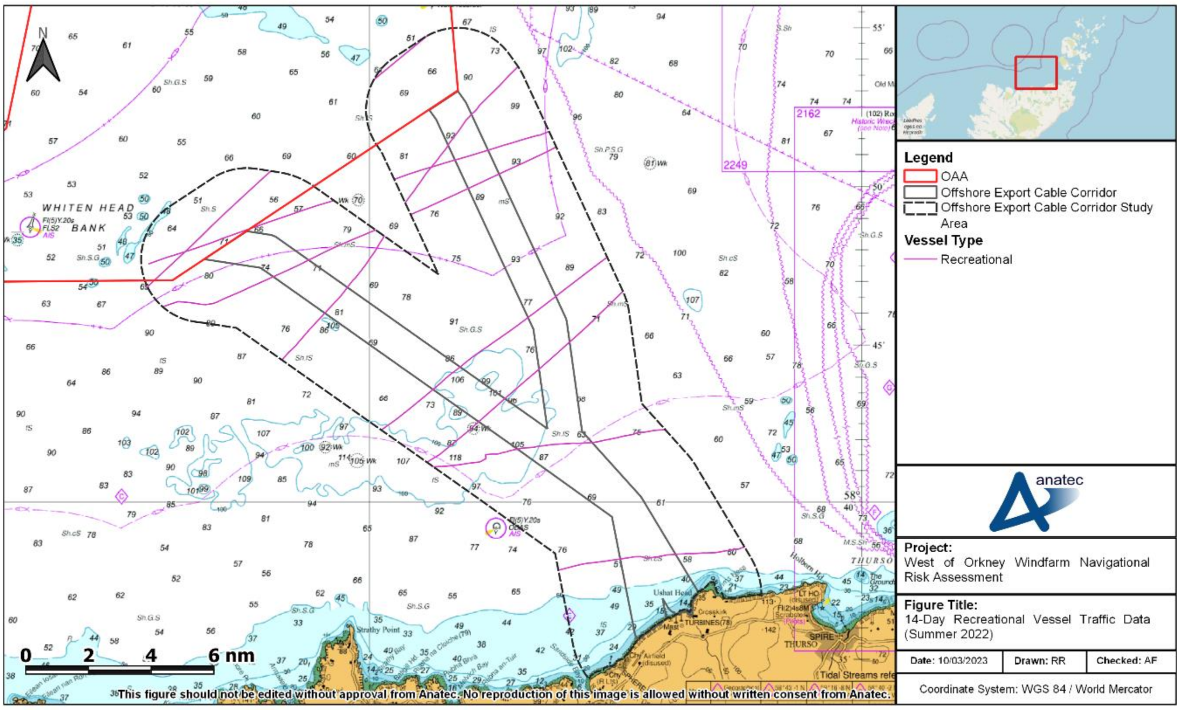

Figure 10.36 Recreational Vessel Traffic within the Offshore ECC and Study Area (14-Days Summer 2022)

An average of one recreational every two days was recorded during the summer data periods. Most vessels were recorded transiting northeast-southwest, with no clearly defined routeing noted.

As shown in Figure 10.15, based on the RYA Coastal Atlas (RYA, 2019 (a)) there is relative low density within the offshore ECC study area, which aligns with the findings of the vessel traffic surveys and the long term assessment of recreational vessels (see Section E.3.7).

10.2.3 Vessel Size

10.2.3.1 Vessel Length

Vessel length information was available for over 99% of all vessels recorded throughout the combined summer and winter data periods. A plot of all vessel tracks (excluding temporary traffic) recorded within the offshore ECC study area throughout the data periods, colour-coded by LOA, is presented in Figure 10.37 Following this, the distribution of these LOA classes, by data period, is presented in Figure 10.38.

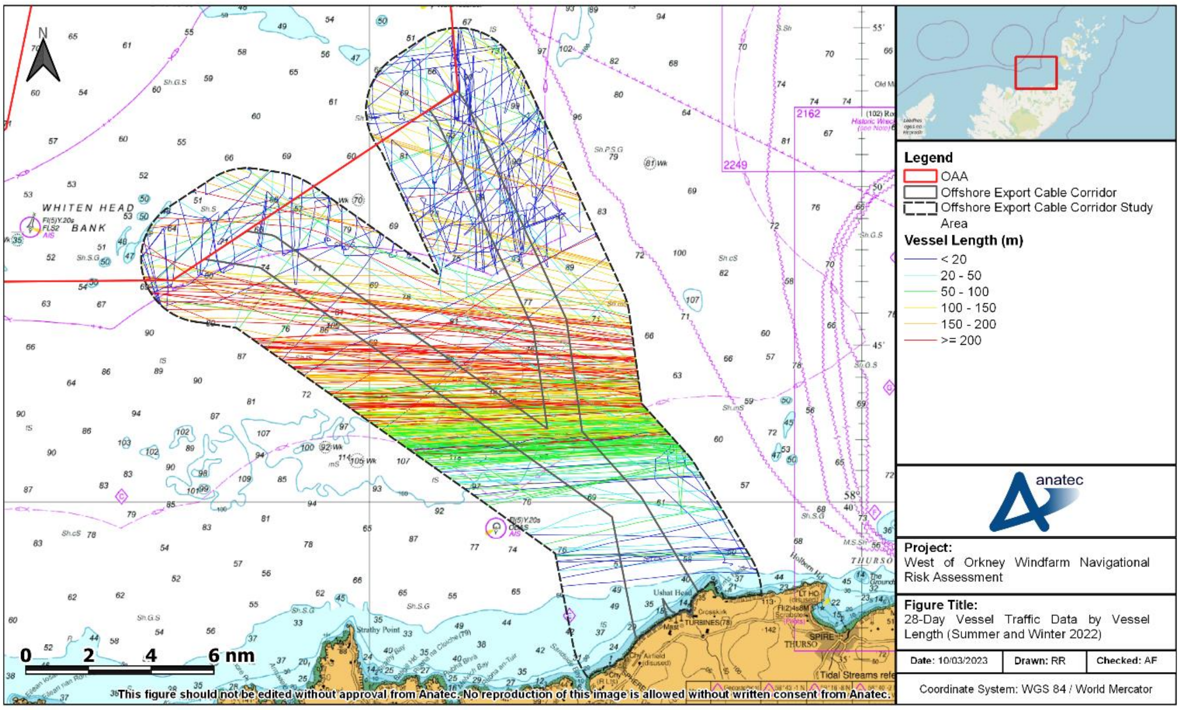

Figure 10.37 Vessel Traffic Data within the Offshore ECC and Study Area by Vessel LOA (28-Days Summer and Winter 2022)

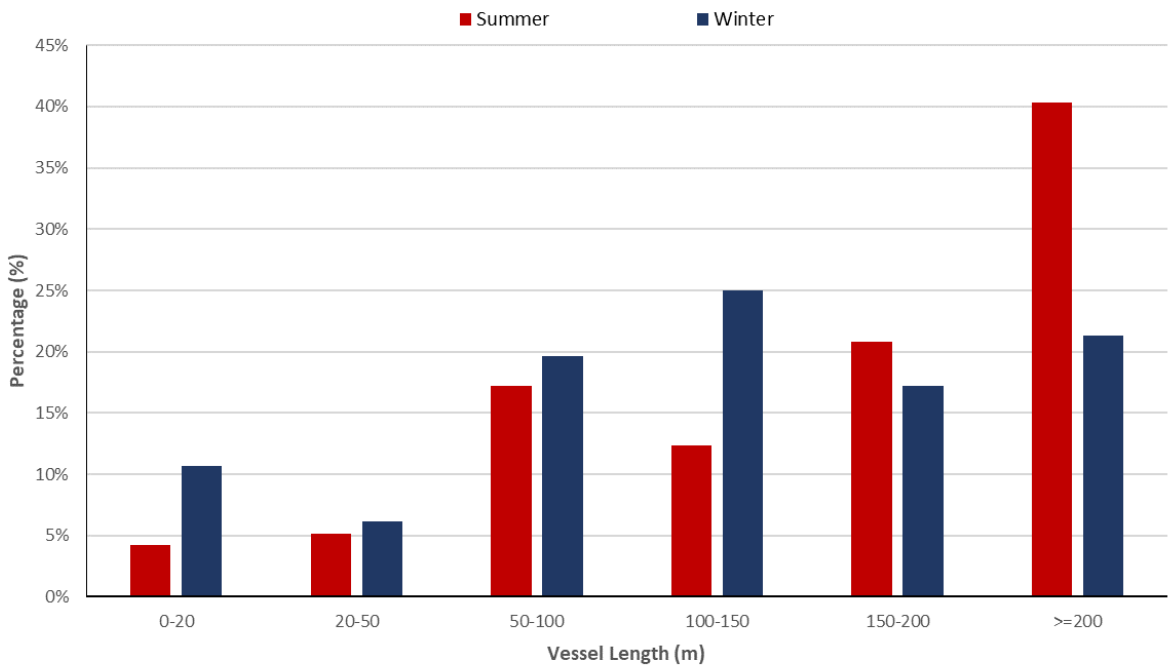

Figure 10.38 Vessel LOA Distribution within the Offshore ECC and Study Area (28-Days Summer and Winter 2022)

Excluding the proportion of vessels for which LOA was not available, the average LOA of vessels within the offshore study area was 167 m and 134 m for the summer and winter surveys, respectively. Over the survey periods, LOA ranged between a 9 m fishing vessel and a 316 m cruise liner.

Those vessels of greater lengths were primarily cargo and passenger vessels with the smaller lengths being fishing and recreational vessels.

10.2.3.2 Vessel Draught

Vessel draught information was available for 95% of all vessels recorded throughout the combined summer and winter data periods. A plot of all vessel tracks (excluding temporary traffic) recorded within the offshore ECC study area throughout the data periods, colour-coded by vessel draught, is presented in Figure 10.39. Following this, the distribution of these draught classes, by data period, is presented in Figure 10.40.

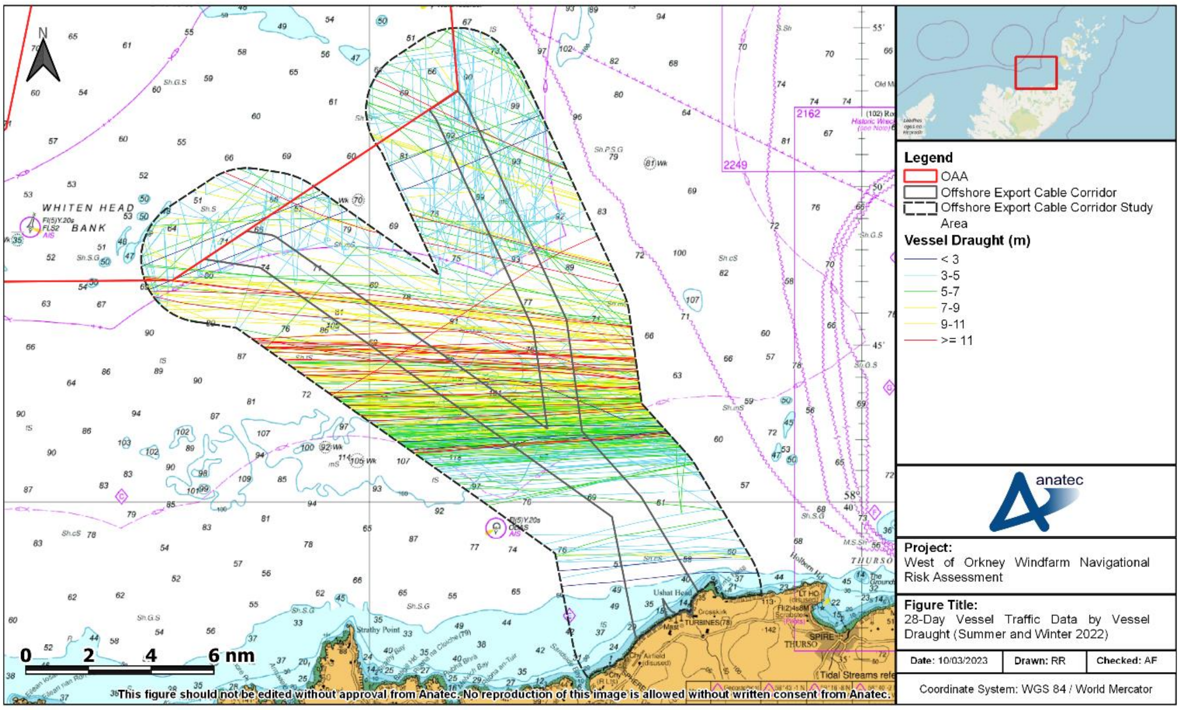

Figure 10.39 Vessel Traffic Data within the Offshore ECC and Study Area by Vessel Draught (28-Days Summer and Winter 2022)

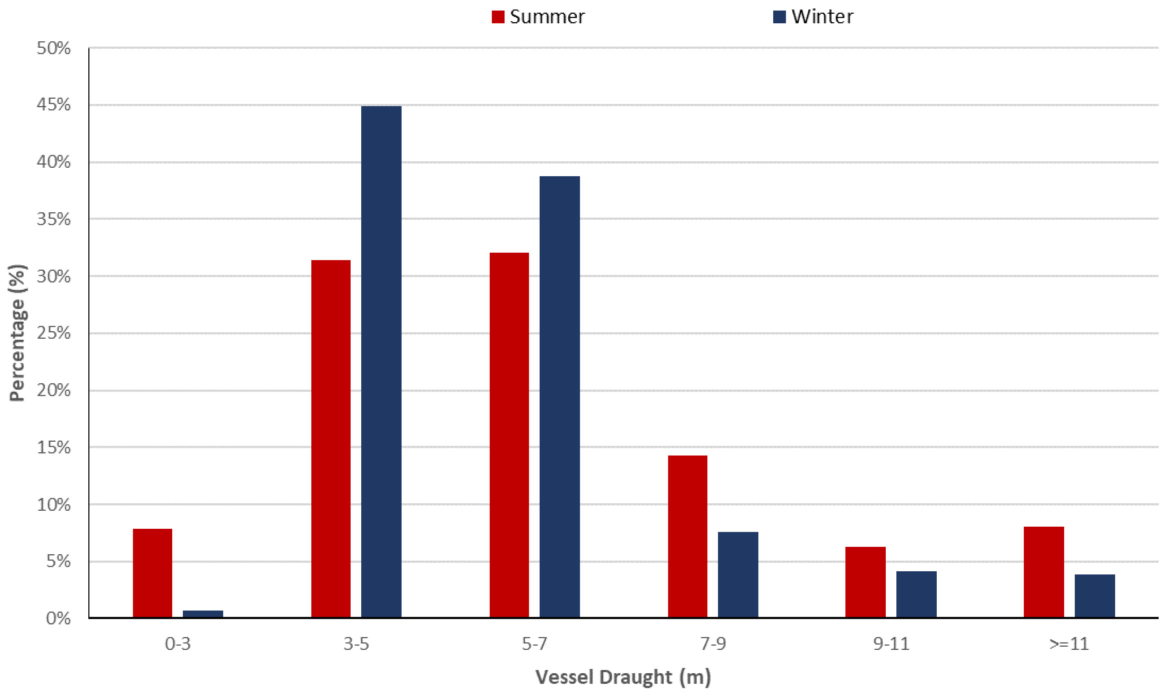

Figure 10.40 Vessel Draught Distribution within the Offshore ECC and Study Area (28-Days Summer and Winter 2022)

Excluding the proportion of vessels for which vessel draught was not available, the average draught of vessels within the offshore study area was 7.8 m and 6.7 m for the summer and winter periods, respectively. Over the data periods, draught ranged between 1.2 m for a windfarm vessel and 15.2 m for a bulk carrier.

Those vessels of greater draughts were primarily cargo vessels and tankers with the smaller draughts being mainly fishing and recreational vessels, with tugs and windfarm vessels also reporting lower draughts.

10.2.4 Anchoring Activity

Applying the methodology described in Section 10.1.4, no vessels were deemed to be at anchor within the offshore ECC study area during either data period.

11 Base Case Vessel Routeing

11.1 Definition of a Main Commercial Route

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 90^{th} percentile rule from the median line of the potential shipping route as shown in Figure 11.1. Additionally, the outputs of consultation undertaken with local stakeholders assisted in the identification of the main commercial routes.

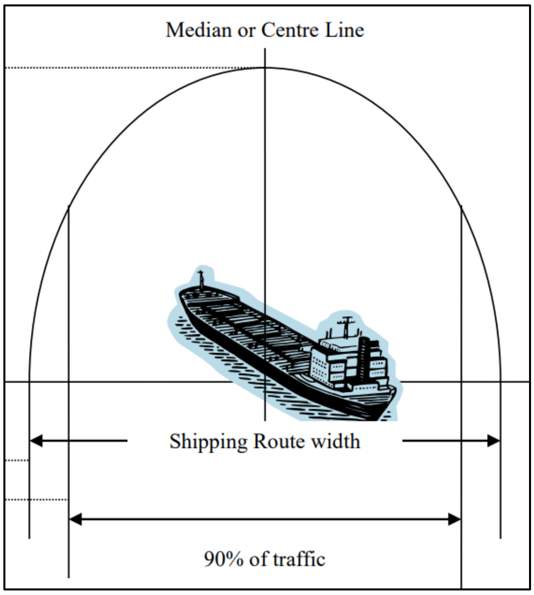

Figure 11.1 Illustration of Main Route Calculation (MCA, 2021)

11.2 Pre Wind Farm Main Commercial Routes

A total of 12 main commercial routes were identified within the routeing study area from the vessel traffic data. These main commercial routes and corresponding 90^{th} percentiles within the routeing study area are shown relative to the OAA 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, start and end locations, and main vessel types. It is noted that the start and end locations are based on the most common destinations transmitted via AIS by vessels on those routes (i.e., there may be vessels on any given route bound for destinations other than those listed).

To ensure all main commercial routes are captured, the long-term vessel traffic AIS data has been used to validate the main commercial routes identified from the vessel traffic survey data. This also ensured low use routeing (less than one vessel a week) was still identified and captured within the modelling (see Section 16). This low use routeing was observed to include vessels avoiding the ATBA (see Section 7.3). This routeing and the relevant vessels are discussed further in Section 15.4.3.

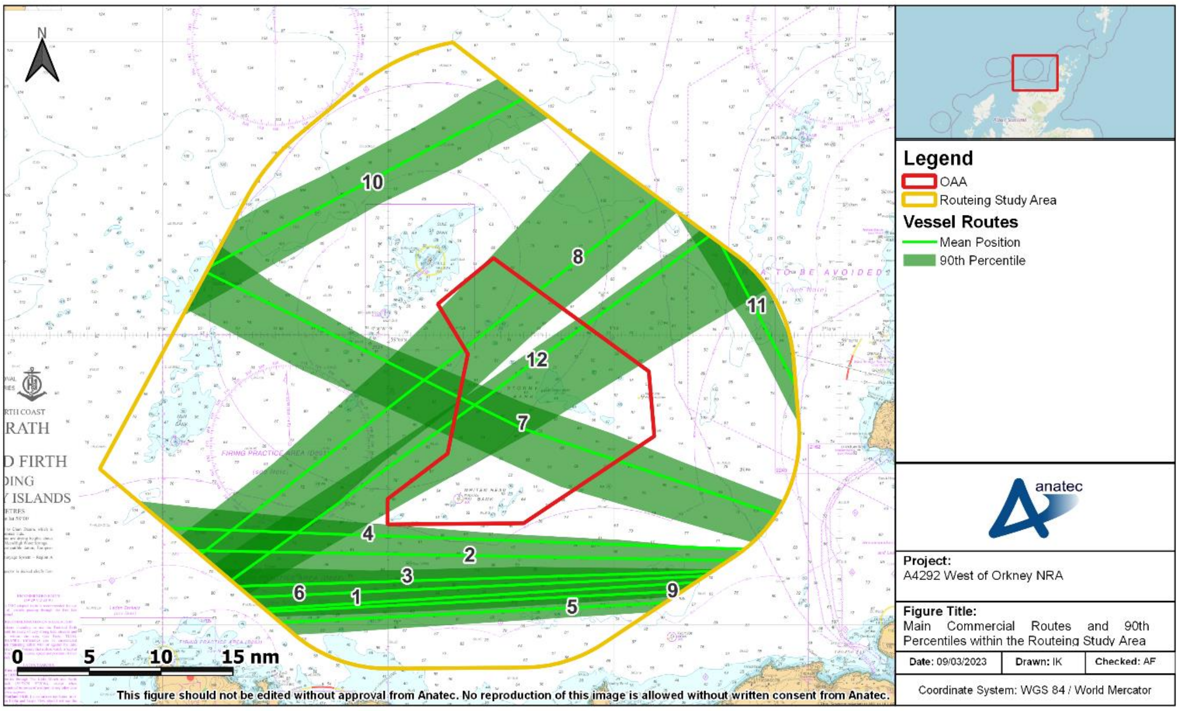

Figure 11.2 Main Commercial Routes and 90th Percentiles within the Routeing Study Area

The majority of vessels on main routes were identified to pass south of the OAA (Routes 1, 2, 3, 4, 5, 6, and 9). These routes equate to a total of approximately four vessels per day.

Table 11.1 Main Commercial Route Descriptions

Route Number	Average Vessels Per Week	Average Vessels Per Day[4]	Description
1	4	1	**Belfast – Baltic Sea Ports e.g., Lithuania**. Mainly cargo vessels.
2	4	1	**Canadian Ports – Hamburg**. Mainly cargo vessels.
3	4	1	**Mersey Ports – Danish Ports**. Mainly cargo vessels.
4	4	1	**Reykjavik – Humber Ports**. Mainly cargo vessels and tankers (50%).
5	4	1	**Belfast – Kattegat**. Mainly cargo vessels.
6	3	< 1	**Kyle of Lochalsh – Humber Ports**. Mainly cargo vessels and tankers.

[4] Noted that an average of greater than 0.5 vessels per day rounded up to 1 per day.

Route Number	Average Vessels Per Week	Average Vessels Per Day[4]	Description
7	2-3	< 1	**Reykjavik – Rotterdam**. Mainly cargo vessels. Includes the Smyril Line-operated RoRo route between Reykavik and Rotterdam.
8	2	< 1	**Belfast – Northern Norwegian/Russian Ports**. Mainly cargo vessels, with tankers also present. Includes the DFDS Seaways-operated RoRo route between Belfast and Skogn.
9	2	< 1	**Glensanda – Amsterdam**. Mainly cargo vessels.
10	1-2	< 1	**Mersey Ports – Mongstad**. Mainly tankers and cargo vessels.
11	1	< 1	**Torshavn – Humber Ports**. Mainly cargo vessels.
12	1	< 1	**Ullapool – Scalloway**. Mainly cargo vessels, with tankers also present.

12 Adverse Weather Vessel Traffic Movements

Some vessels and vessel operators may transit alternative routes during periods of adverse weather. Consideration has been given to the implications of the presence of, or activities associated with, the offshore Project during adverse weather. For example, if a commercial vessel is unable to make passage, or a small craft is unable to access safe havens.

Adverse weather includes wind, wave and tidal conditions as well as reduced visibility due to fog. Adverse weather can hinder a vessel's standard route, its speed of navigation and/or its 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 on the actual stability parameters, hull geometry, vessel type, vessel size and speed.

A number of vessel operators indicated the presence of structures within the OAA would limit routeing options in adverse weather. As per Section 4.2 this included DFDS, Ocean Farm Services, Migdale Transport, and Scotline. Scotline input included that vessels may "tack[5]" through the area under adverse conditions. One example of this behaviour was identified in the long term AIS and is shown in Figure 12.1.

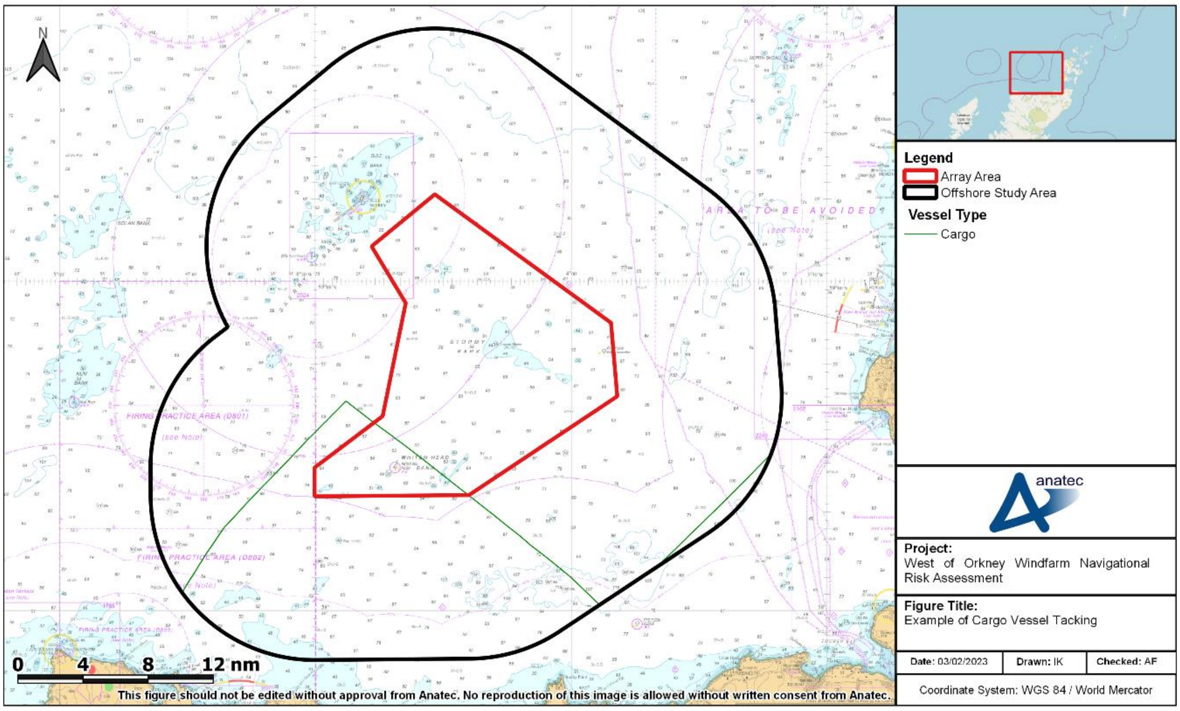

Figure 12.1 Example of "Tacking"

[5] 'Tack' to change course by turning a vessel's bow into and through the wind.

Based on review of the input received, it is likely that no commercial vessels would choose to make transit through the OAA during adverse weather conditions and will instead choose to pass either offshore of the OAA i.e., north of the Sule Skerry, or inshore to the south depending on destination. In either case there is considered to be sufficient searoom to safely accommodate the transits. This has been assessed further in Offshore EIA Report, chapter 15: Shipping and navigation and Section 18 of the NRA.

It is noted that, due to the ATBA to the east of the OAA (see Section 7.3), vessels which are categorised as being prohibited to enter the ATBA may be less likely to transit to the east of the OAA during adverse weather. Further discussion is provided in Section 15.4.3.

With regard to Figure 12.1, vessels would not be able to make the course as shown and it is likely that shorter runs or more frequent tacks to mitigate the weather would be required noting there is considered sufficient searoom between the proposed OAA and the coast to make a safe transit.

13 Navigation, Communication, and Position Fixing Equipment

13.1 Very High Frequency Communications (including Digital Selective Calling)

In 2004, trials were undertaken at the North Hoyle Offshore Wind Farm, 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 DSC) when operated close to WTGs.

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.

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

Furthermore, as part of SAR trials carried out at 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 OAA 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).

In addition to the North Hoyle trials, a desk-based study was undertaken for the Horns Rev 3 Offshore Wind Farm 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).

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 offshore Project is anticipated to have no significant impact upon VHF communications.

13.2 Very High Frequency Direction Finding

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 50 m). This is deemed to be a relatively small-scale impact due to the limited use of VHF DF equipment and would not impact operational or SAR activities (MCA and QinetiQ, 2004).

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 1 nm, the homer system operated as expected with no apparent degradation.

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

13.3 Automatic Identification System

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

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 offshore Project.

13.4 Navigational Telex System

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.

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.

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.

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 offshore Project.

13.5 Global Positioning System

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*”.

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

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

13.6 Electromagnetic Interference

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 may be used to calculate heading, used with a sextant to calculate latitude, and with a marine chronometer to calculate longitude.

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.

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 offshore Project would have a significant impact on vessel navigation. However, some smaller craft (fishing or leisure) may rely on it as their sole means of navigation.

13.6.1 Sub-Sea Cables

The sub-sea cables for the offshore Project will be Alternating Current (AC). Direct Current (DC) is not under consideration.

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). Therefore, electromagnetic interference due to cables associated with the offshore Project are not considered any further.

It is noted that an EMF study (Sumitomo, 2022) of the inter array cables concluded that "EMF is small and less than geomagnetism" for the scenarios assessed.

13.6.2 WTGs

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.

13.6.3 Experience at Operational Offshore Wind Farms

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 offshore wind farms.

13.7 Marine Radar

This section summarises the results of trials and studies undertaken in relation to Radar effects from offshore wind farms 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.

13.7.1 Trials

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.

In 2004 trials undertaken at North Hoyle (MCA, 2005) identified areas of concern 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).

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 1.5 nm) 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 13.1.

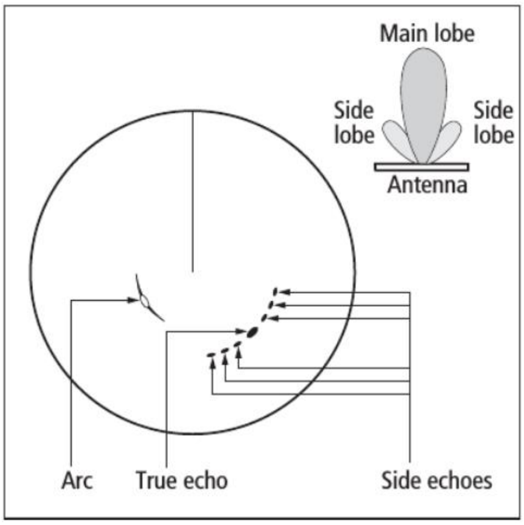

Figure 13.1 Illustration of Side Lobes on Radar Screen

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 13.2.

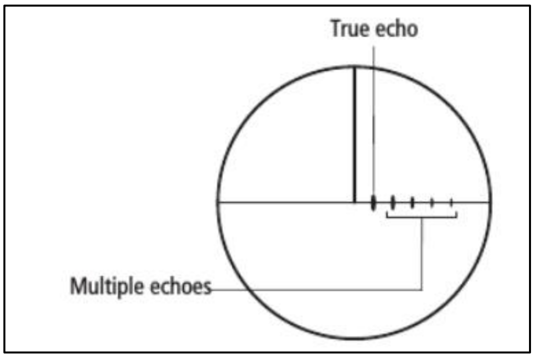

Figure 13.2 Illustration of Multiple Reflected Echoes on Radar Screen

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 offshore wind farms. However, as experience of effects associated with use of marine Radar in proximity to offshore wind farms grew, the MCA refined their guidance, offering more flexibility within the most recent Shipping Route Template contained within MGN 654 (MCA, 2021).

A second set of trials conducted at Kentish Flats Offshore Wind Farm in 2006 on behalf of the British Wind Energy Association (BWEA) (BWEA, 2007) – now called RenewableUK – also found that Radar antennas which are sited unfavourably with respect to components of the vessel's structure may 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.

Theoretical modelling of the effects of the development of the proposed Atlantic Array Offshore Wind Farm, 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[6]. 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 vessels 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 Automatic Radar Plotting Aid (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.

In summary, experience in UK waters has shown that mariners have become increasingly aware of any Radar effects as more offshore wind farms 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 may be effectively mitigated by "*careful adjustment of Radar controls*".

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

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 (a)). The interference buffers presented in Table 13.1 are based on MGN 654 (MCA, 2021), MGN 371 (MCA, 2008 (a)), MGN 543 (MCA, 2016), and MGN 372 (MCA, 2008).

Table 13.1 Distances at which Impacts on Marine Radar Occur

Distance at Which Effect Occurs (nm)	Identified Effects
0.5	▪ Intolerable impacts may be experienced. ▪ X-Band Radar interference is intolerable under 0.25 nm. ▪ Vessels may generate multiple echoes on shore-based Radars under 0.45 nm.
1.5	▪ Under MGN 654, impacts on Radar are considered to be tolerable with mitigation between 0.5 and 3.5 nm. ▪ S-Band Radar interference starts at 1.5 nm. ▪ Echoes develop at approximately 1.5 nm, 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.

As noted in Table 13.1, the onset range from the WTGs of false returns is approximately 1.5 nm, with progressive deterioration in the Radar display as the range closes. If interfering echoes develop, the requirements of the Convention on the 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 Vessel Traffic Service (VTS) or AIS (MCA, 2016).

13.7.2 Experience from Operational Developments

The evidence from mariners operating in proximity to existing offshore wind farms is that they quickly learn to adapt to any effects. Figure 13.3 presents the example of the Galloper and Greater Gabbard Offshore Wind Farms, which are located in proximity to IMO routeing measures. Despite this proximity to heavily trafficked Traffic Separation Scheme (TSS) lanes, there have been no reported incidents or issues raised by mariners operating in close proximity. The interference buffers presented in Figure 13.3 are as per Table 13.1.

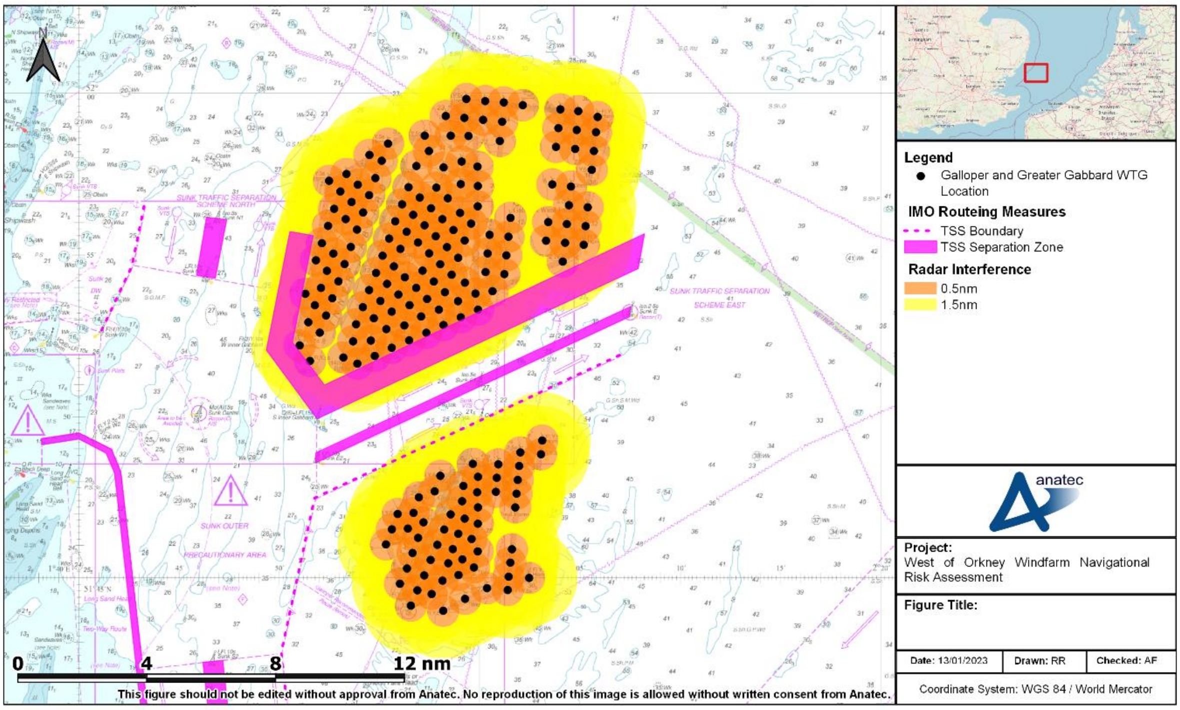

Figure 13.3 Illustration of Potential Radar Interference at Galloper and Greater Gabbard Offshore Wind Farms

As indicated by Figure 13.3, vessels utilising these TSS lanes would experience some Radar interference based on the available guidance. Both developments are operational, and the lanes are used by a minimum of eight vessels per day on average. However, to date, there have been no incidents recorded (including any related to Radar use) or concerns raised by the users.

AIS information may also be used to verify the targets of larger vessels (generally vessels over 15 m LOA – the minimum threshold for fishing vessel AIS carriage requirements). Approximately 1% of the vessel traffic recorded within the offshore study area was under 15 m in length, although throughout the vessel traffic surveys approximately 97% of vessel tracks were recorded on AIS, indicating a high level of AIS take-up among vessels for which AIS carriage is not mandatory.

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 offshore wind farm.

13.7.3 Increased Radar Returns

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.

Larger WTGs (either in height or width) would 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, and at closer distances this five degree width would be limited much further. Therefore, increased WTG height in the OAA would not create any effects in addition to those already identified from existing operational wind farms (interfering side lobes, multiple and reflected echoes). Additionally, the level and way Radar returns occur is not expected to differ significantly for different foundation types (i.e., monopiles and jacket foundations).

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 may be managed effectively.

13.7.4 Fixed Radar Antenna Use in Proximity to an Operational Offshore Wind Farm

It is noted that there are multiple operational offshore wind farms 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.

13.7.5 Application to the Offshore Project

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

Figure 13.4 presents an illustration of potential Radar interference due to the offshore Project. The Radar effects have been applied to the indicative full build out array layout introduced in Section 6.2.

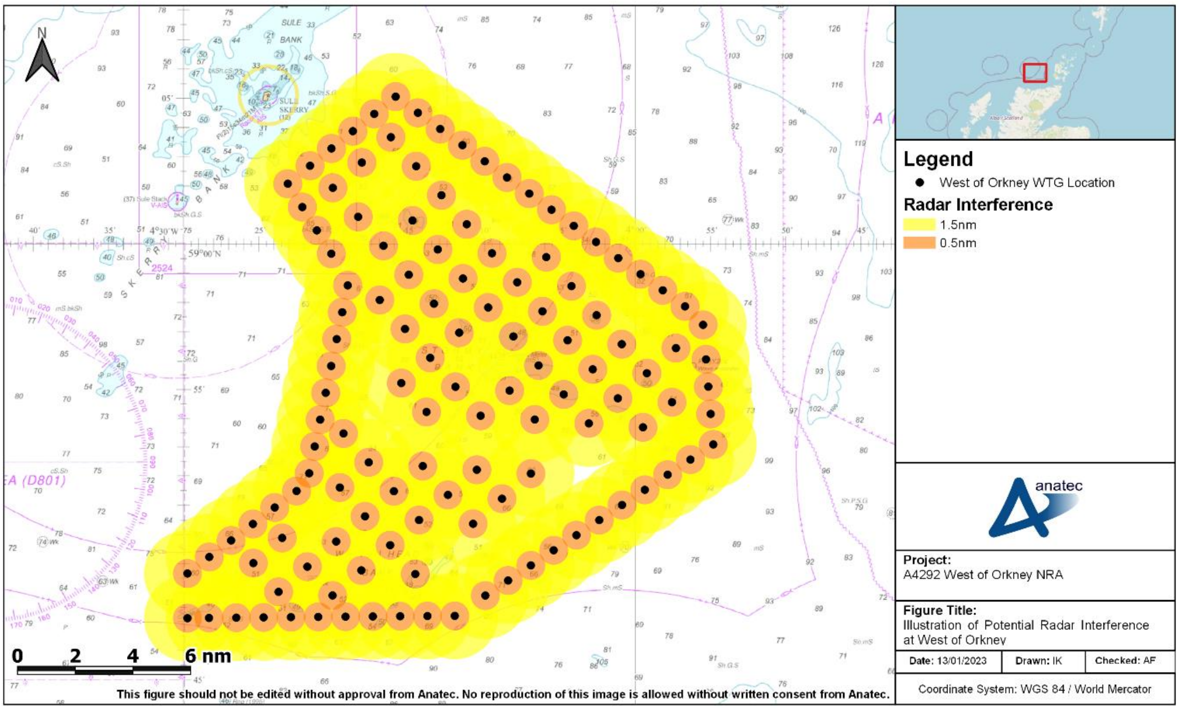

Figure 13.4 Illustration of Potential Radar Interference at West of Orkney

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

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

13.8 Sound Navigation Ranging Systems

No evidence has been found to date with regard to existing offshore wind farms 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 offshore Project.

13.9 Noise

No evidence has been found to date with regard to existing offshore wind farms to suggest that prescribed sound signals are in any way impacted by acoustic noise produced by the wind farm.

13.10 Summary of Potential Effects on Use

Based on the detailed technical assessment of the effects due to the presence of the offshore Project on navigation, communication and position fixing equipment in the previous subsections, Table 13.2 summarises the assessment of frequency of occurrence and severity of consequence and the resulting significance of risk for each component of this hazard as per the FSA methodology referenced in Section 3.2.

Table 13.2 Summary of Risk to Navigation, Communication, and Position Fixing Equipment

Topic	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VHF	Negligible	Minor	Broadly Acceptable
VHF DF	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

On the basis of these findings, associated risks are screened out of the Risk Assessment undertaken in Section 17.2.

14 Cumulative and Transboundary Overview

Cumulative risks have been considered for activities in combination and cumulatively with the offshore Project. This section provides an overview of the baseline used to inform the cumulative risk assessment including the pre wind farm vessel routeing and developments and proposed developments screened into the cumulative risk assessment based upon 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.

It is noted that port developments (and specifically the subsequent changes in vessel traffic movements) are considered as part of the future case vessel traffic scenarios (see Section 15).

14.1 Screened In Developments

In addition to the offshore Project, there are a number of other developments located in the region. Table 14.1 includes details of these developments, whether they are screened into the cumulative risk assessment and the cumulative tier applied (where applicable). The statuses listed are correct as of February 2023.

As per the cumulative risk assessment methodology (see Section 3.3), any development greater than 100 nm from the OAA is not considered.

Figure 14.1 presents the locations of the developments screened into the cumulative assessment.

Table 14.1 Cumulative Screening

Development	Development Type	Development Status	Closest Distance		Data Confidence	Tier
			OAA (nm)	ECC (nm)		
West of Orkney Windfarm – transmission connection to the Flotta Hydrogen Hub	Offshore wind farm export cable	Pre-application	0	0	Medium	1
PFOWF [7]	Offshore wind farm	Consented	11	1	High	3
SHET-L Caithness to Orkney HVAC Link	Subsea cable	Consented	11	0	High	1
Space Hub Sutherland	Space hub	Under Construction	20	24	Medium	3
Northland Mhairi	Offshore wind farm	Pre-scoping	26	37	Medium	1
Cluaran Ear-Thuath	Offshore wind farm	Pre-scoping	48	42	Medium	3
Caledonia	Offshore wind farm	Pre-application	49	34	High	3
Moray West	Offshore wind farm	Consented	52	35	High	3
Stromar	Offshore wind farm	Pre-scoping	54	43	Medium	3
Magnora	Offshore wind farm	Pre-scoping	55	65	Medium	3
Northland Sheena	Offshore wind farm	Pre-scoping	69	79	Medium	3
Broadshore	Offshore wind farm	Pre-scoping	74	61	Medium	3
Buchan	Offshore wind farm	Pre-scoping	85	74	Medium	3

[7] PFOWF will incorporate the currently consented Pentland Floating Offshore Wind Demonstrator turbine, and hence PFOWF only has been considered. The PFOWF Section 36 Consent and Marine Licence was granted for 10 years. However, the cumulative effects assessment has been based on the Project Design Envelope, as specified within the EIA, and therefore, an operational life of up to 30 years for the PFOWF has been considered. Since consent was granted in June 2023, PFOWF have submitted a Screening Report to MD-LOT with the intention to request a variation to the Section 36 Consent. This variation will incorporate refinements to the Project Design Envelope and to extend the operational life to 25 years.

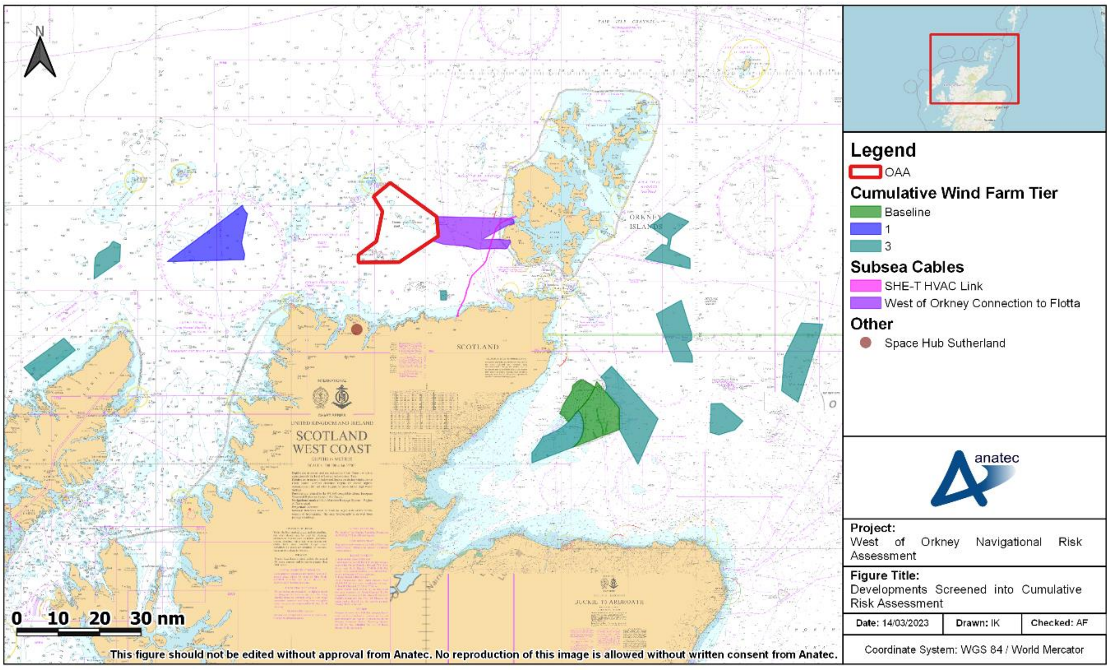

Figure 14.1 Cumulative Developments

14.2 Routeing Interaction with Screened in Developments

As per the methodology for re-routeing due to the offshore Project in isolation (see Section 15.4), it is assumed that any main commercial route within 1 nm of a surface piercing installation will require a deviation. The only development screened into the cumulative risk assessment that may lead to deviations to the main routes identified is Northland Mhairi, which would require deviation of Routes 4 and 7, as demonstrated in Figure 14.2. Routeing assessment is undertaken in Section 15.5.

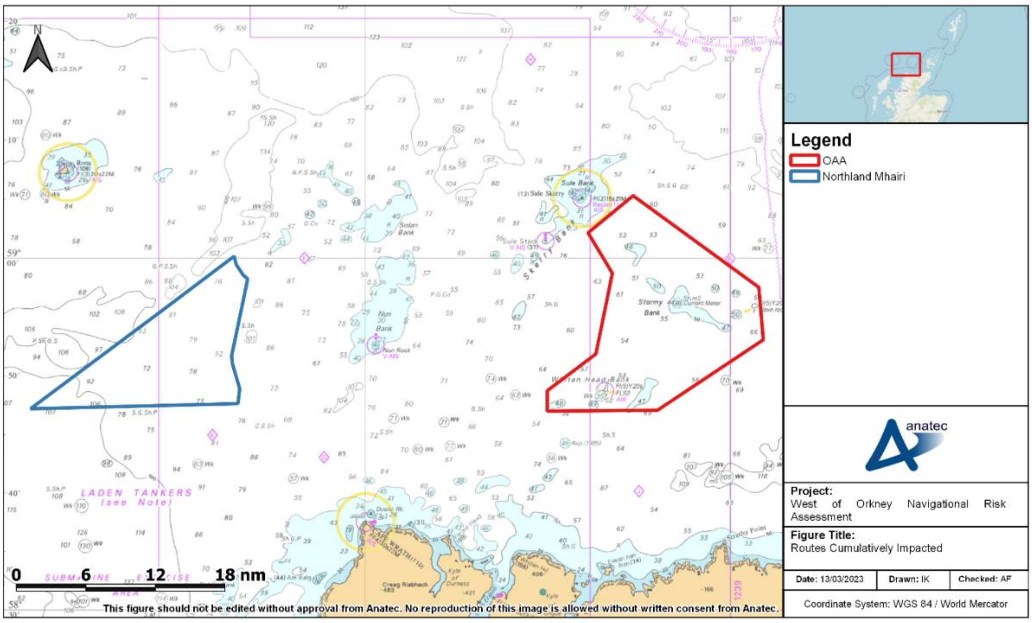

Figure 14.2 Routes Cumulatively Impacted

15 Future Case Vessel Traffic

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 17.2). 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 offshore Project (the post wind farm scenario).

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

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.

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

15.2 Increases in Commercial Fishing Vessel and Recreational Vessel Activity

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. There are no known major developments which would increase commercial fishing or recreational vessel activity in the region.

Therefore, a conservative potential growth in commercial fishing vessel and recreational vessel movements of 10% and 20% has been estimated throughout the lifetime of the offshore Project.

15.3 Increases in Traffic Associated with Project Operations

During the operation and maintenance stage , up to 468 annual round trips to port would be made by vessels involved in the operation and maintenance of the offshore Project (see Section 6.5).

15.4 Commercial Traffic Routeing (Project in Isolation)

15.4.1 Methodology

It is not possible to consider all potential alternative routeing options for commercial traffic and therefore alternatives have been considered where possible in consultation with operators. Assumptions for re-routeing include:

- All alternative routes maintain a minimum mean distance of 1 nm from offshore installations and existing offshore wind farm boundaries in line with industry

experience. This distance is considered for shipping and navigation from a safety perspective as explained below.
- All mean routes take into account sandbanks, aids to navigation and known routeing preferences.
- For vessels likely to deviate to the north, it has been assumed they will pass offshore of the Sule Skerry and Sule Stack (rather than between the rocks and the OAA) (see Section 15.4.1.1).
- The presence of the ATBA has been considered for vessels already recorded avoiding its boundaries (see Section 15.4.3).

Annex 2 of MGN 654 defines as methodology for assessing passing distance from offshore wind farm boundaries but states that it is "*not a prescriptive tool but needs intelligent application*".

To date, internal and external studies undertaken by Anatec on behalf of the UK Government and individual clients (e.g., Anatec, 2016) show that vessels do pass consistently and safely within 1 nm of established offshore wind farms (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 1 nm off established developments.

Evidence also demonstrates that commercial vessels do not transit through offshore wind farm OAAs. It is noted that aquaculture vessel operators using the area indicated during consultation (Migdale, BioFeeder, and Ocean Farm Services as per Section 4.2) that their vessels may choose to transit through the OAA, however this would depend on a number of factors, including layout design, minimum spacing and weather conditions. On this basis, it has still been assumed for the purposes of worst case assessment that all commercial vessels on the main routes identified will deviate.

The NRA also aims to establish the WCS based on navigational safety parameters, and when considering this the most conservative realistic scenario for vessel routeing is when main commercial routes pass 1 nm 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.

15.4.1.1 Sule Skerry and Sule Stack

For the purposes of the commercial route deviations, it has been assumed that the vessels routeing in the western extent of the OAA on northeast-southwest passage (i.e., Routes 8 and 12) will not choose to transit in the area between the OAA and Sule Skerry and Sule Stack. These routes instead will likely deviate offshore of the Sule Skerry and Sule Stack (noting that consultation (Section 4) did not indicate that vessels would choose to transit between the OAA and the Sule Skerry).

For reference, the sea room between the OAA and Sule Skerry / Sule Stack is shown and discussed in more detail in Section 7.1. There is approximately 2.5nm between the OAA and the Sule Skerry as shown in Figure 7.2.

15.4.2 Main Commercial Route Deviations

An illustration of the anticipated worst-case shift in the mean positions of the main commercial routes (see Figure 11.2) within the offshore study area following the development of the offshore Project is colour-coded on if the route will be required to deviate due to the offshore Project, and presented in Figure 15.1. These deviations are based on Anatec's assessment of the WCS and the methodology set out in Section 15.4.2.

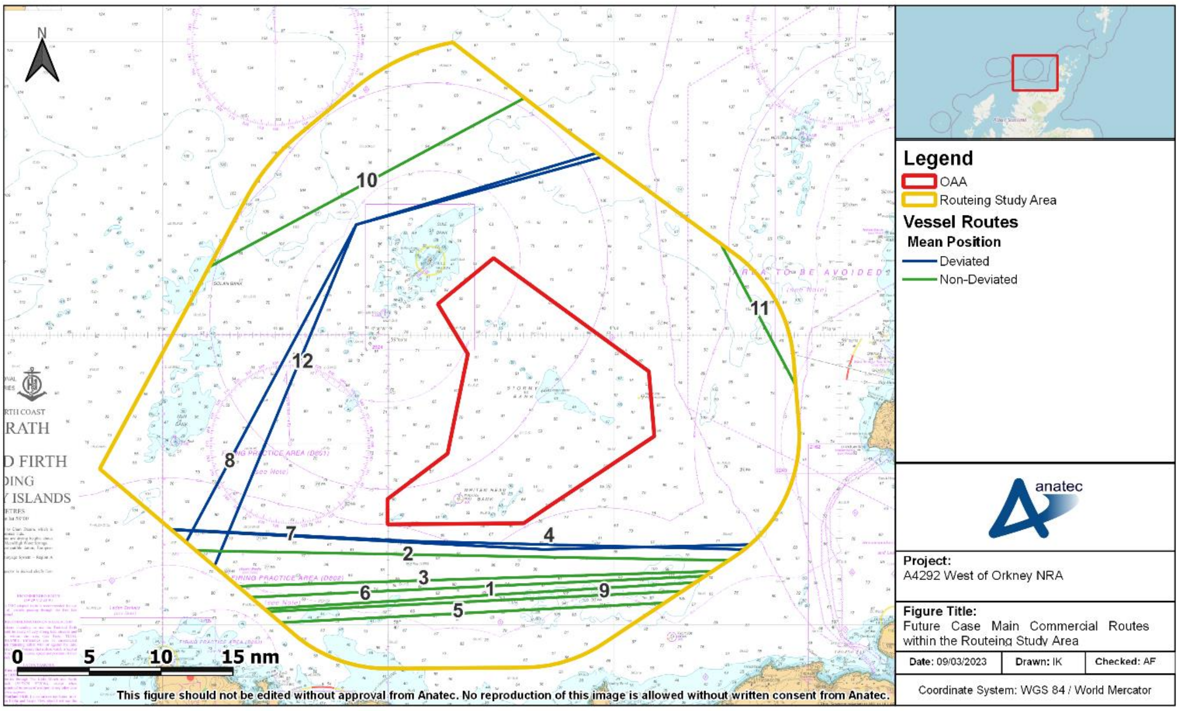

Figure 15.1 Future Case Vessel Traffic Routes

Deviations from the pre wind farm scenario would be required for four out of the 12 main commercial routes identified, with the level of deviation varying between a 0.01 nm increase for Route 4, and a 9.62 nm increase for Route 7. For the displaced routes, the increase in distance from the pre wind farm scenario is presented in Table 15.1.

Table 15.1 Summary of Post Wind Farm Main Commercial Deviations

Route Number	Increase in Route Length (nm)	Percentage Change in Total Route Length (%)	Nature of Deviation
4	0.01	<0.01	Passing slightly further south to avoid the southwestern corner of the OAA.
7	9.62	0.95	Passing further south of the OAA.

Route Number	Increase in Route Length (nm)	Percentage Change in Total Route Length (%)	Nature of Deviation
8	4.49	0.61	Passing further north of the OAA and deviating further offshore of Sule Skerry and Sule Stack.
12	5.31	2.84	Passing further north of the OAA and deviating further offshore of Sule Skerry and Sule Stack.

In the case of Route 7, it is noted that although the increase in route length is relatively high, due to the total distance involved in the transit, the percentage change in total route length is low (<1%). The large change in distance is reflective of the assumptions made around the deviation. Local rock and shallow features (including outside of the study area) mean that vessels on this route may choose to pass south of both these features and the OAA. This has therefore been assumed as a worst case (hence the large deviation).

15.4.3 ATBA

As per Section 11, the use of the long term AIS data (see Appendix E), allowed for identification of low use routeing. Of particular note was vessels observed to be deliberately avoiding the ATBA (see Section 7.3) based on their transit patterns. The tracks of vessels identified on this basis from the long term AIS are shown in Figure 15.2. It is noted that this only includes vessels clearly taking transits that indicate that they are likely to be avoiding the ATBA.

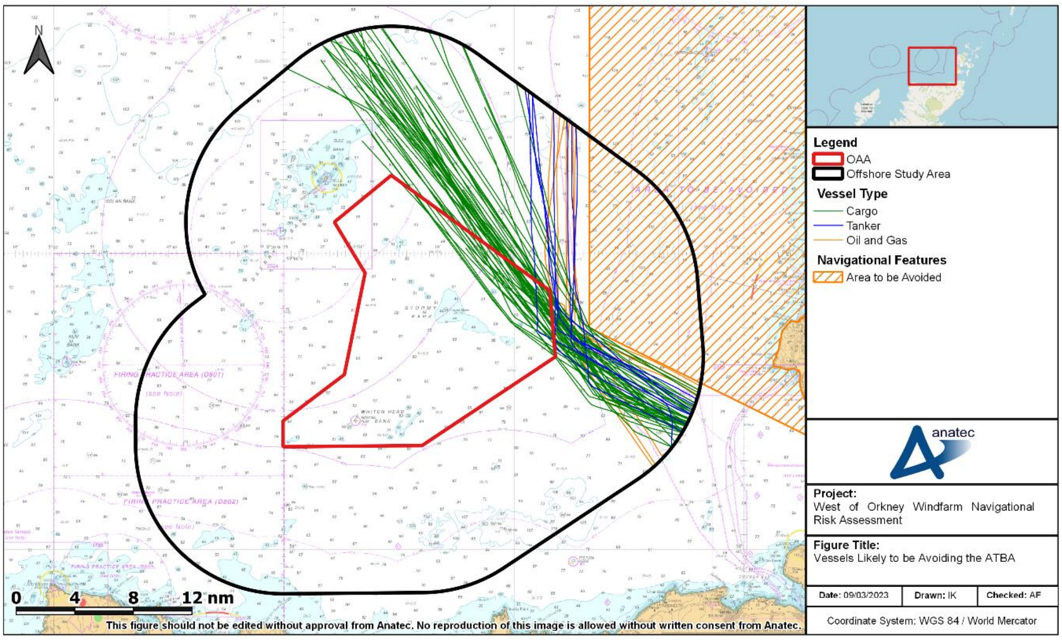

Figure 15.2 Vessels Avoiding the ATBA

Approximately one transit of this nature per week was identified over the year of data. Once the offshore Project has been constructed, these vessels will be required to either pass between the ATBA and the OAA or pass to the south of the OAA.

As per Section 7.3, the minimum distance between the OAA and the ATBA is 2.4 nm. Given the low frequency of the identified transits, this is considered likely to represent sufficient sea space to accommodate the relevant vessels should they choose such transit.

15.5 Commercial Routeing (Cumulative)

An illustration of the anticipated worst-case shift in the mean positions of the main commercial routes that are likely to deviate within the routeing study area following the development of the offshore Project and Tier 1 cumulative developments is presented in Figure 15.3. Again, these deviations are based on Anatec's assessment of the WCS and follow the same methodology outlined for deviations due to the offshore Project in isolation (see Section 15.4.1).

It is noted that while Northland Mhairi has been screened into Tier 1 assessment due to its interaction with main routes that also interact with the OAA, as per Section 14 the project is yet to be scoped, and as such there is not high data confidence in terms of site boundary. The assessment is therefore considered worst case on the basis that full build out of Northland Mhairi has been assumed.

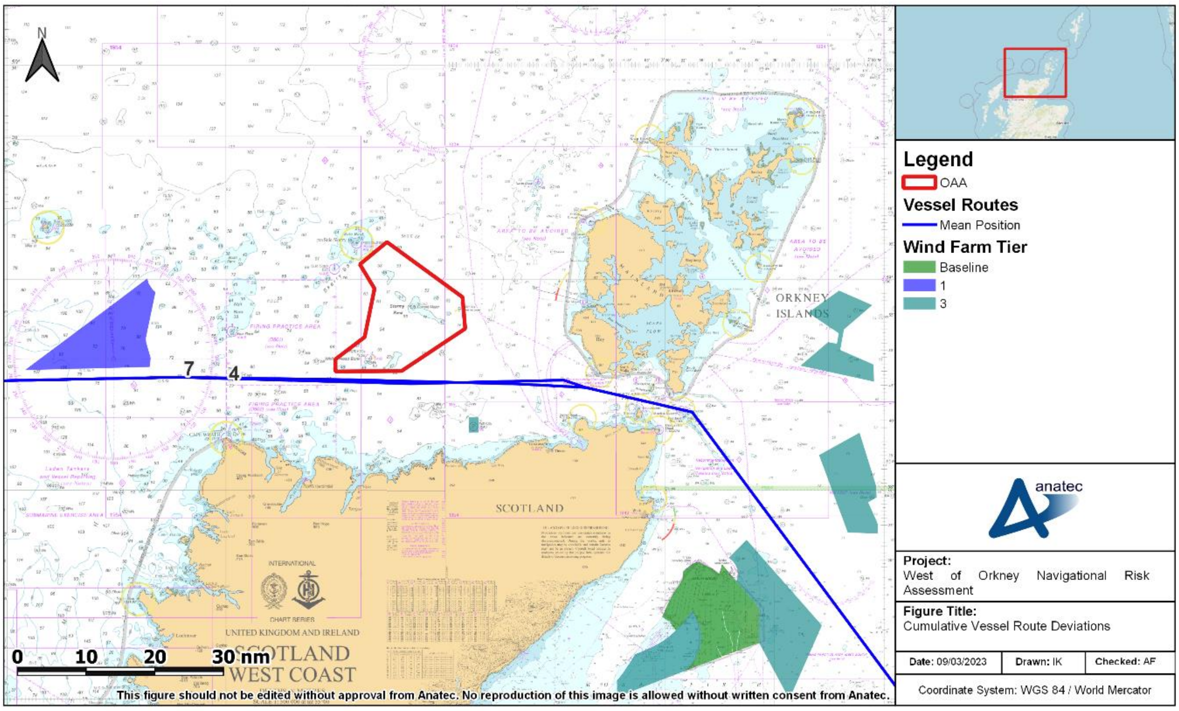

Figure 15.3 Route Deviations due to Cumulative Projects

Based on the cumulative screening, cumulative deviations from the pre wind farm scenario would be required for two out of the 12 main commercial routes identified. These are summarised as follows:

- Route 4: anticipated to pass south of both Northland Mhairi and the OAA, leading to a distance increase of <1%.
- Route 7: anticipated to pass south of both Northland Mhairi and the OAA, leading to a distance increase of <2%.

16 Collision and Allision Risk Modelling

16.1 Overview

To inform the risk assessment, a quantitative assessment of some of the major hazards associated with the offshore Project has been undertaken. The following subsections outline the inputs and methodology used for the collision and allision risk modelling.

16.1.1 Scenarios Under Consideration

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

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

The results of the base case scenarios are detailed in full in the following subsections, with the equivalent results for each future case scenario provided in Section 16.3.

16.1.2 Hazards Under Consideration

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.

The pre wind farm assessment has been informed by the vessel traffic survey data (see Section 10) and other baseline data sources (such as Anatec's ShipRoutes database). Conservative assumptions have been made with regard to route deviations and future shipping growth over the lifetime of the offshore Project (see Section 15.4 for rerouting assumptions).

16.2 Pre Wind Farm Modelling

16.2.1 Vessel to Vessel Encounters

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 offshore wind farm, 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.

Figure 16.1 presents a heat map based upon the geographical distribution of vessel encounter tracks within a density grid. Following this, Figure 16.2 illustrates the daily number of encounters recorded within both the offshore study area and the OAA throughout the survey periods.

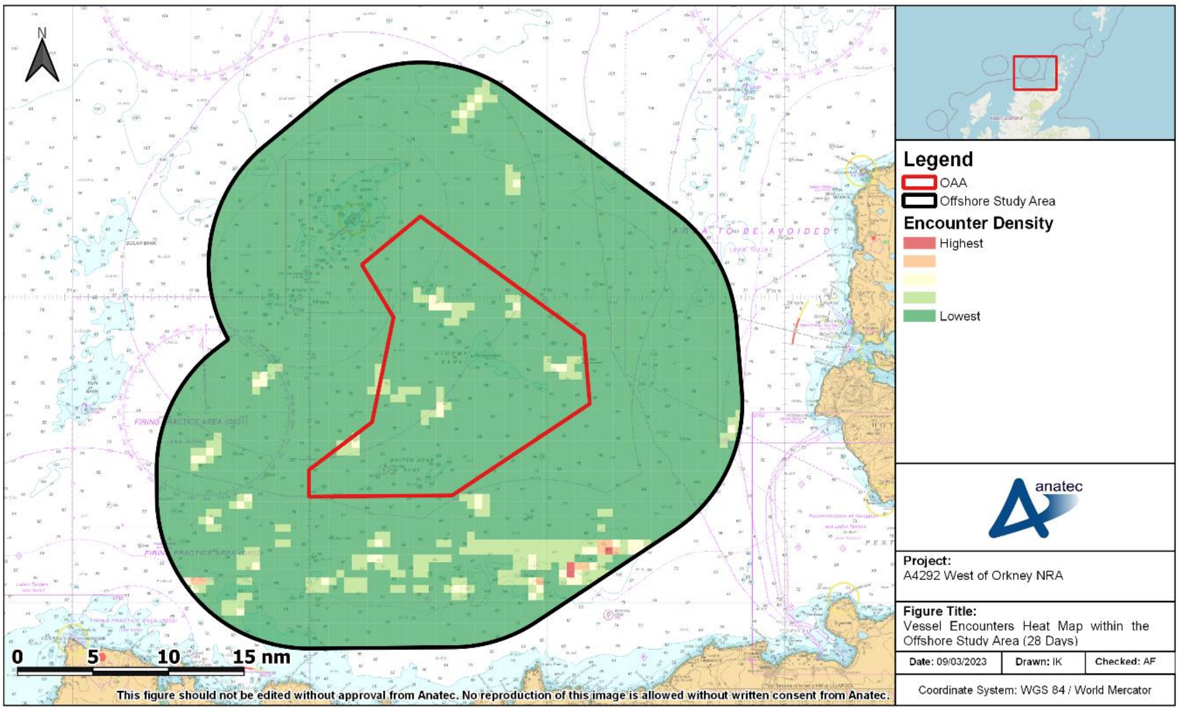

Figure 16.1 Vessel Encounters Heat Map within the Offshore Study Area (28 Days)

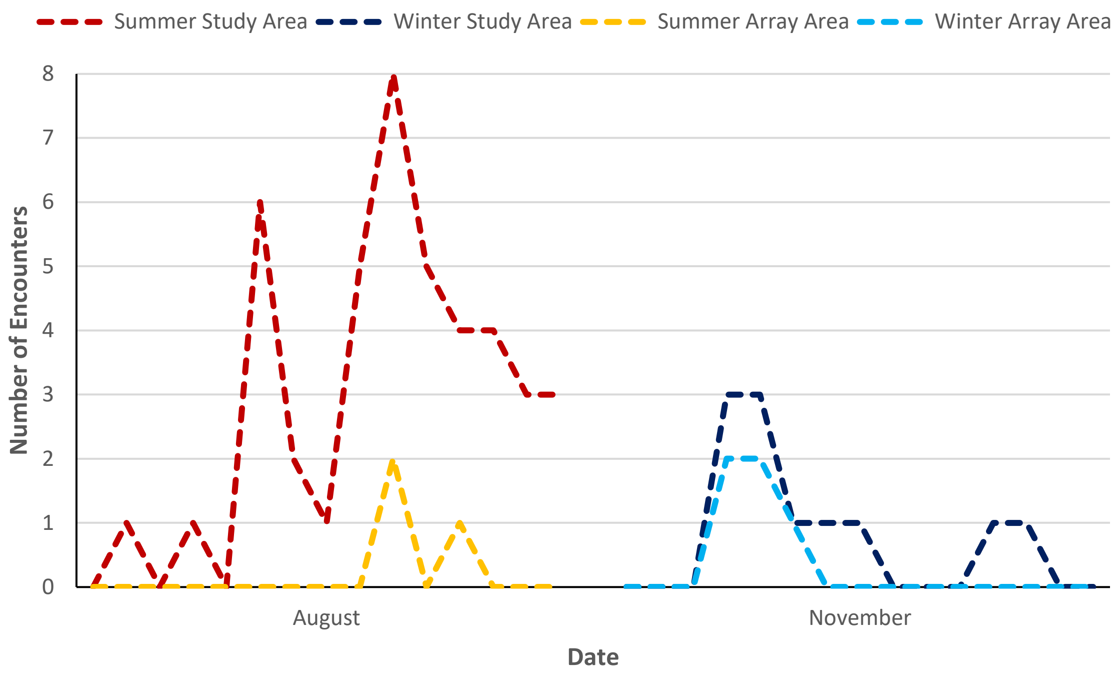

Figure 16.2 Vessel Encounters per Day within the Offshore Study Area (28 Days, August and November 2022)

There was on average two encounters per day within the offshore study area throughout the survey periods. The greatest number of encounters recorded in one day was eight, on 26 August 2022, due to a high number of cargo vessels. Six of these encounters occurred to the south of the OAA, with the other two being within the OAA itself.

The most frequent vessel types involved in encounters within the offshore study area were cargo vessels (58%) and fishing vessels (19%).

16.2.2 Vessel to Vessel Collision Risk

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

A heat map based upon the geographical distribution of collision risk within a density grid for the pre wind farm base case is presented in Figure 16.3.

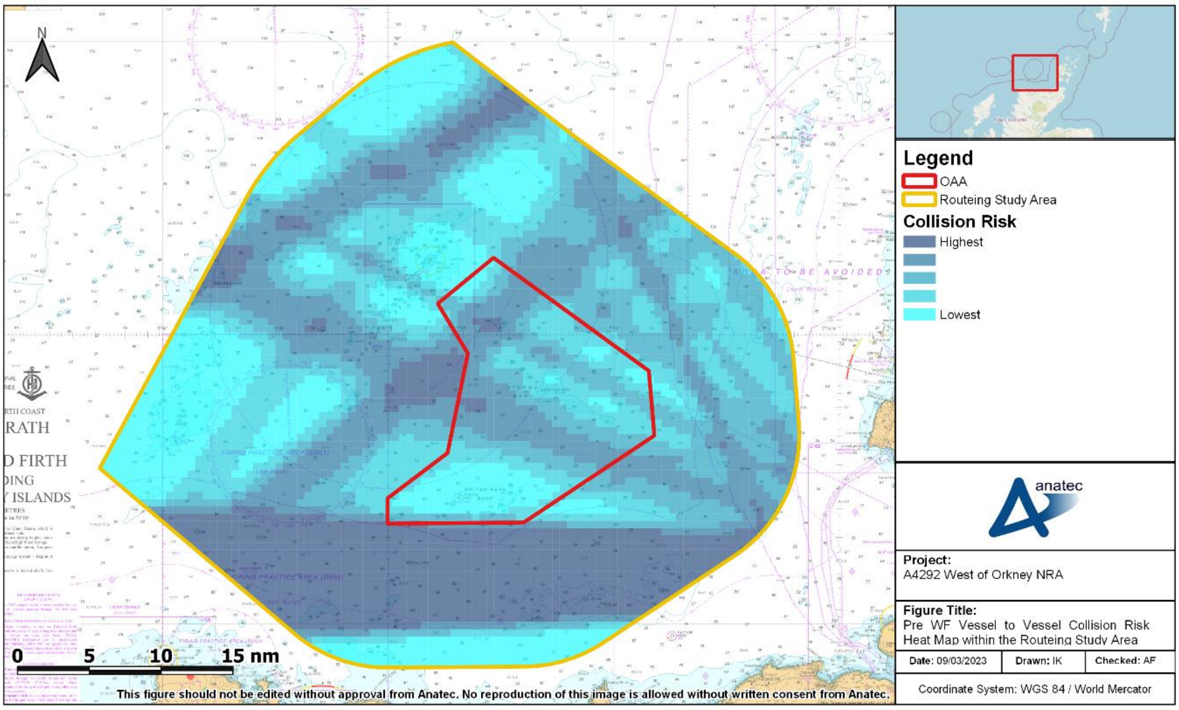

Figure 16.3 Pre Wind Farm Vessel to Vessel Collision Risk Heat Map within the Routeing Study Area

Assuming base case vessel traffic levels, the annual collision frequency pre wind farm was estimated to be 1.52×10^{-3}, corresponding to a return period of approximately one in 658 years. This is below the average for UK offshore wind farm developments and is reflective of the relatively large area covered by the routeing study area. 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. Other incident data, which includes minor incidents, is presented in Section 9.

16.3 Post Wind Farm Modelling

The methodology for determining the post wind farm routeing is outlined in Section 15.

16.3.1 Simulated Automatic Identification System

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

A figure of 28 days of simulated AIS (matching the total duration of the vessel traffic surveys) within the routeing study area, based on the deviated main commercial routes, is presented in Figure 16.4.

It is noted that the simulated AIS represents a WCS based on commercial routes passing at a minimum mean distance of 1 nm from the OAA.

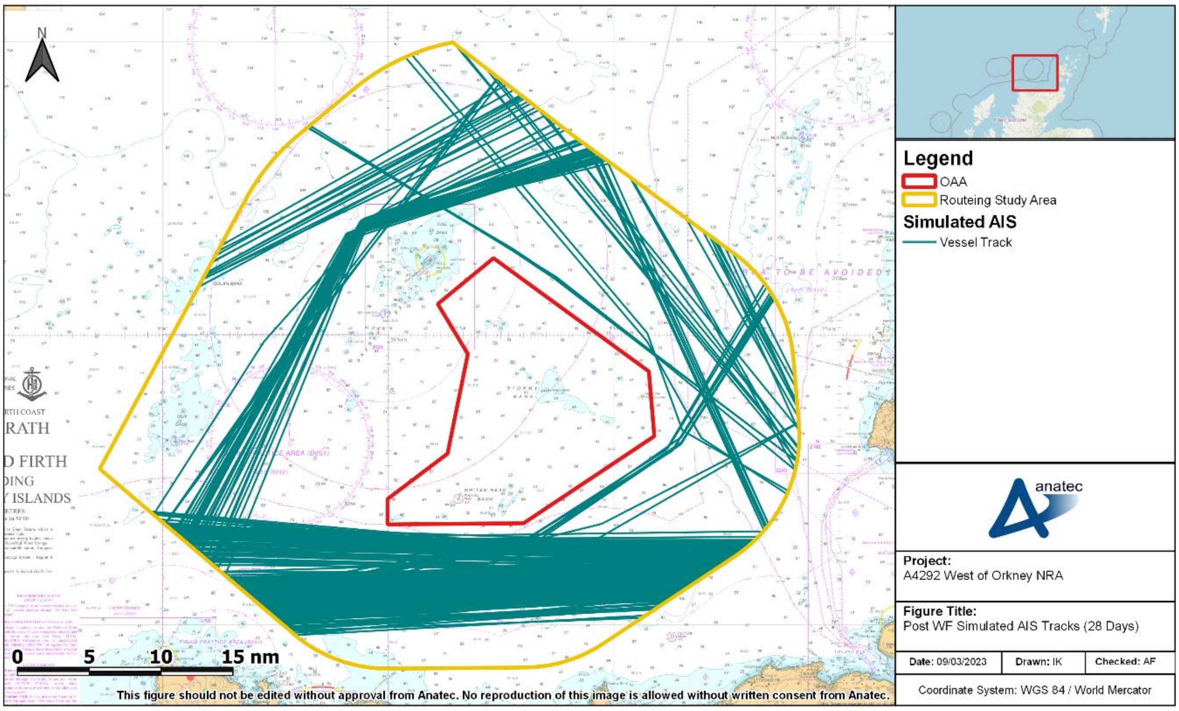

Figure 16.4 Post WF Simulated AIS Tracks (28 Days)

16.3.2 Vessel to Vessel Collision Risk

Using the post wind farm routeing as input, Anatec's COLLRISK model has been run to estimate the anticipated vessel to vessel collision risk within the routeing study area.

A heat map based on the geographical distribution of collision risk within a density grid for post wind farm base case is presented in Figure 16.5.

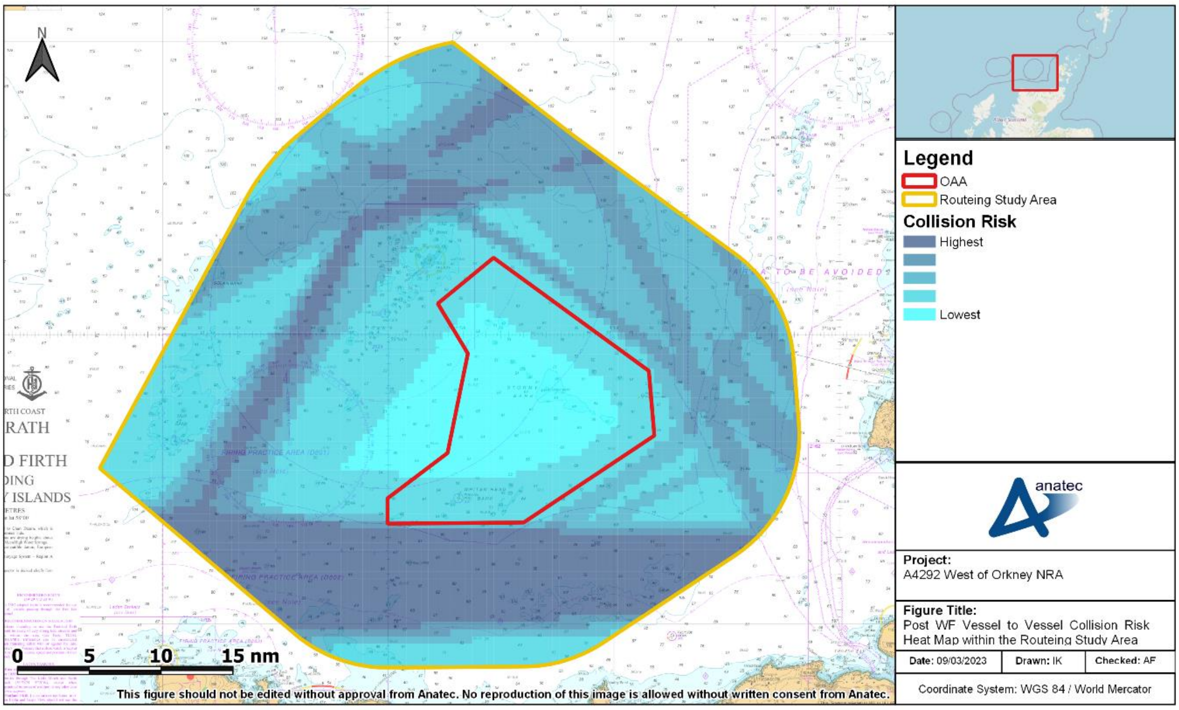

Figure 16.5 Post WF Vessel to Vessel Collision Risk Heat Map within the Routeing Study Area

Assuming base case traffic levels, the annual collision frequency post wind farm was estimated to be 2.04×10^{-3}, corresponding to a return period of approximately one in 491 years. This represents a 34% increase in collision frequency compared to the pre wind farm base case result.

Based on modelling results, approximately 90% of the post wind farm vessel-to-vessel collision risk is related to vessel traffic passing to the south of the OAA, as opposed to offshore of Sule Skerry and Sule Stack.

The change in vessel-to-vessel collision risk between the base case pre wind farm and post wind farm scenarios is presented in a heat map in Figure 16.6.

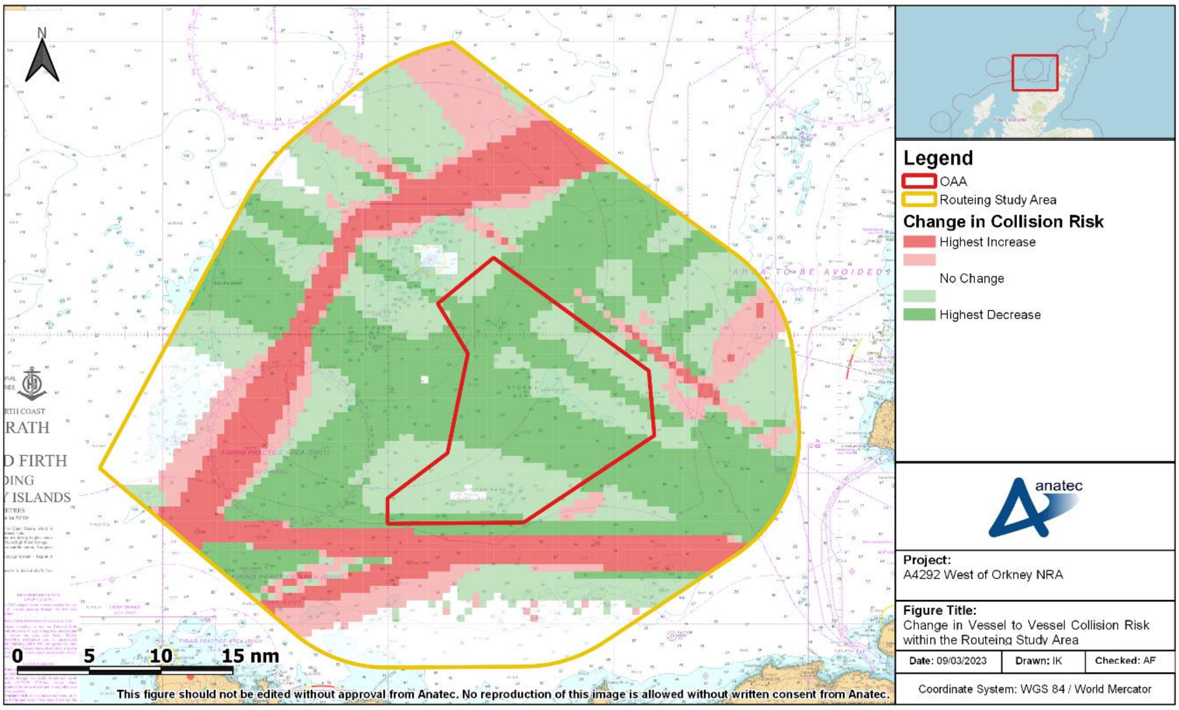

Figure 16.6 Change in Vessel to Vessel Collision Risk within the Routeing Study Area

16.3.3 Powered Vessel to Structure Allision Risk

Based upon the vessel routeing identified in the routeing study area, the anticipated re-routeing as a result of the presence of the offshore Project, and assumptions that relevant embedded mitigation measures are in place (see Section 17), the frequency of an errant vessel under power deviating from its route to the extent that it came into proximity with a wind farm structure associated with the offshore Project is considered to be low.

From consultation with the shipping industry, it is also assumed that commercial vessels would be highly unlikely to navigate between wind farm 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 offshore Project (noting this is observed at other UK wind farms including those with larger minimum spacing than for the Project). During the construction and decommissioning stages this will primarily consist of the buoyed construction area whilst during the operations and maintenance stage this will primarily consist of the lighting and marking of the wind farm structures.

Using the post wind farm 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 wind farm structures within the OAA whilst under power. In order to maintain a WCS, the model did not consider one structure shielding another.

A plot of the annual powered allision frequency per structure for the base case is presented in Figure 16.7, with the chart background removed to increase the visibility of those structures with lower allision frequencies.

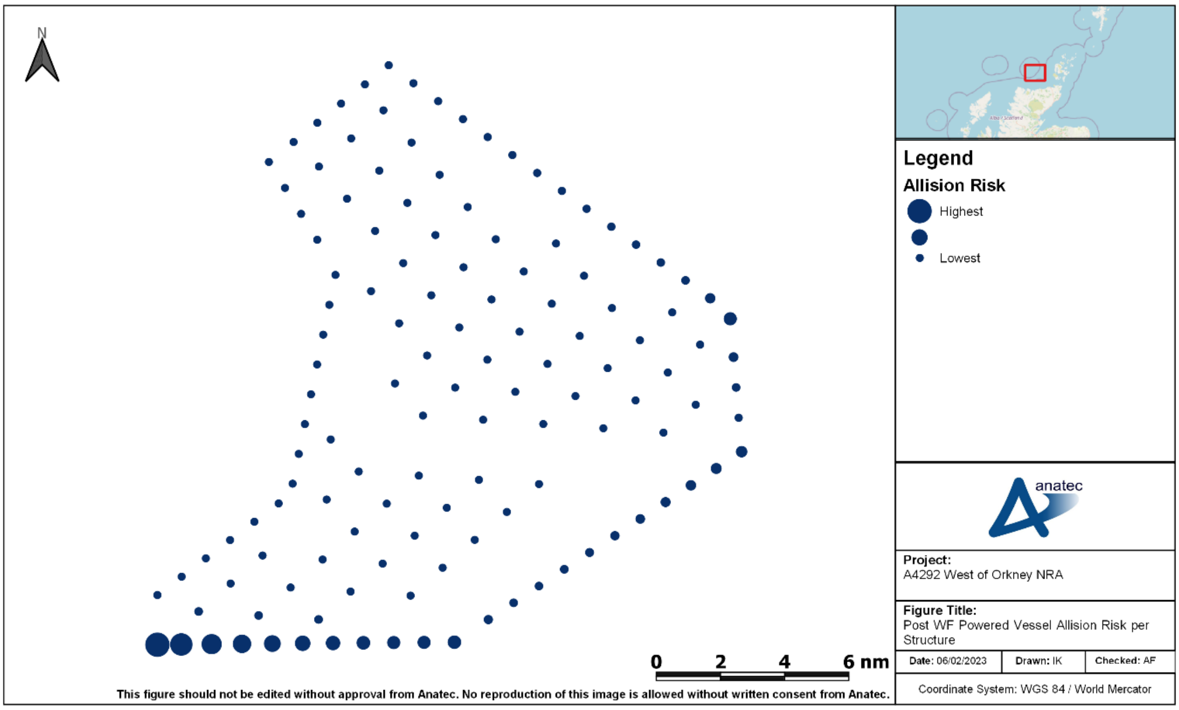

Figure 16.7 Post WF Vessel Allision Risk per Structure

Assuming base case vessel traffic levels, the annual powered allision frequency was estimated to be 7.79×10^{-4}, corresponding to a return period of approximately one in 1,283 years.

The greatest powered vessel to structure allision risk was associated with structures at the southern extent of the OAA where a high volume of traffic from multiple main commercial routes associated with routeing to the West of Scotland, Iceland, and North America pass. The greatest individual allision risk was associated with the most southwestern structure of the OAA (approximately 1.68×10^{-4} or one in 5,947 years).

16.3.4 Drifting Vessel to Structure Allision Risk

Using the post wind farm 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 wind farm structures within the OAA. 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.

The exposure times for a drifting scenario are based upon the vessel hours spent in proximity to the OAA (up to 10 nm from the OAA). 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.

Using this information, the overall rate of mechanical failure in proximity to the OAA was estimated. The probability of a vessel drifting towards a wind farm 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.

After modelling the three drifting scenarios, it was established that the wind 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 16.8, with the chart background removed to increase the visibility of those structures with a low allision frequency.

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 wind farm 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.

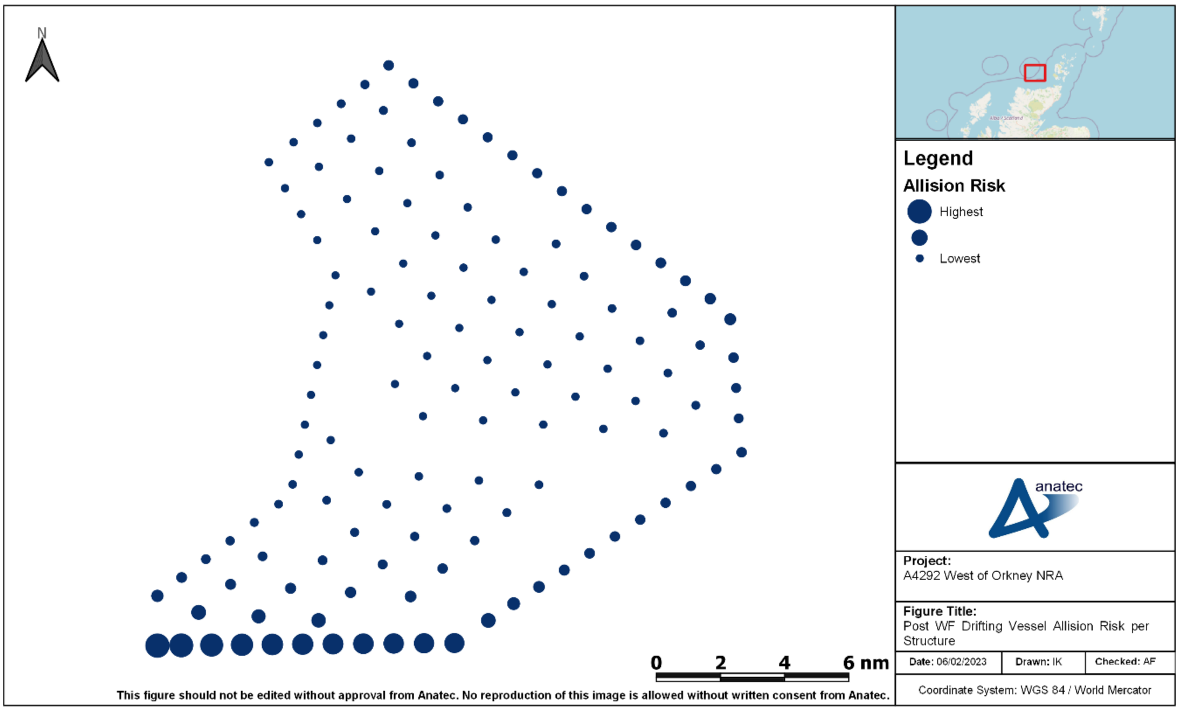

Figure 16.8 Post WF Drifting Vessel Allision Risk per Structure

Assuming base case vessel traffic levels, the annual drifting allision frequency was estimated to be 1.51×10^{-4}, corresponding to a return period of approximately one in 6,647 years.

The greatest drifting vessel to structure allision risk was associated with structures at the southern extent of the OAA where a high volume of traffic from multiple main commercial routes associated with routeing to the West of Scotland, Iceland, and North America pass. The greatest individual allision risk was associated with the most southwestern structure of the OAA (approximately 1.39×10^{-5} or one in 71,819 years).

It is noted that historically there have been no reported drifting allision Incidents with wind farm 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).

16.3.5 Fishing Vessel to Structure Allision Risk

Using the vessel traffic survey data as input, Anatec's COLLRISK model was run to estimate the likelihood of a fishing vessel alluding with one of the wind farm structures within the OAA.

A fishing vessel allision is classified separately from other allisions since fishing vessels may be either in transit or actively fishing within the OAA (unlike the transiting commercial traffic characterised by the main commercial routes). Additionally, fishing vessels could be observed internally within the OAA (i.e., between structures) as well as externally. 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 wind farm arrays. Given that not all fishing vessels broadcast on AIS, the vessel density observed is scaled up to account for non-AIS fishing vessels, with the scaling factor dependent on the distance of the array offshore.

The model conservatively 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 wind farm.

As per Section 5.4, site investigation works meant that the summer vessel traffic survey may underrepresent fishing vessel activity. Therefore, the fishing vessels recorded during the long term AIS data have been used as input. This result was factored to account for non AIS traffic, based on the findings of the vessel traffic surveys and the overarching model calibration process.

A plot of the annual fishing vessel allision frequency per structure for the base case is presented in Figure 16.9.

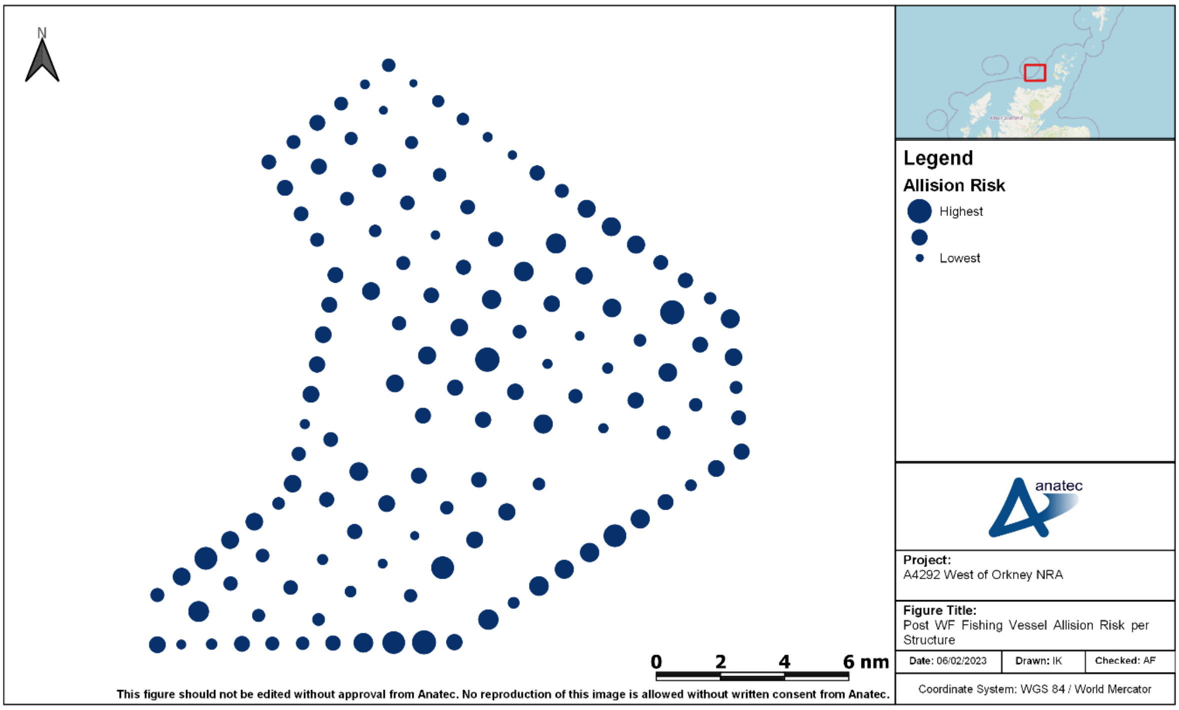

Figure 16.9 Post WF Fishing Vessel Allision Risk per Structure

Assuming base case traffic levels, the annual fishing vessel to structure allision frequency was estimated to be 1.01×10^{-1}, corresponding to a return period of approximately one in 9.9 years.

The fishing vessel to structure allision risk was distributed throughout the OAA, reflective of the fishing activity occurring across the majority of the OAA. The greatest individual allision risk was associated with a WTG in the centre of the OAA (approximately $2.13\text{x}10^{-3}$ or one in 469 years).

The model is calibrated against known allision incidents within UK wind farms (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).

16.4 Risk Results Summary

The previous sections modelled two scenarios, namely the pre and post wind farm scenarios with base case traffic levels. In order to incorporate the potential for future traffic growth, pre and post wind farm scenarios have also been modelled for future case traffic levels (both 10% and 20% increases). Table 16.1 summarises the results of all six scenarios.

Overall, the base case collision and allision frequency due to the presence of the offshore Project was estimated to increase by approximately $1.02\text{x}10^{-1}$ (equating to an additional collision or allision every 9.8 years).

Table 16.1 Summary of Annual Collision and Allision Risk Results

Risk	Scenario	Annual Frequency (Return Period)		
		Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	Base case	1.52×10^{-3} (1 in 658 years)	2.04×10^{-3} (1 in 491 years)	5.14×10^{-4} (1 in 1,945 years)
	Future case (10%)	1.96×10^{-3} (1 in 511 years)	2.61×10^{-3} (1 in 383 years)	6.55×10^{-4} (1 in 1,525 years)
	Future case (20%)	2.32×10^{-3} (1 in 431 years)	3.10×10^{-3} (1 in 322 years)	7.79×10^{-4} (1 in 1,284 years)
Powered vessel to structure allision	Base case	-	7.79×10^{-4} (1 in 1,283 years)	7.79×10^{-4} (1 in 1,283 years)
	Future case (10%)	-	8.57×10^{-4} (1 in 1,167 years)	8.57×10^{-4} (1 in 1,167 years)
	Future case (20%)	-	9.35×10^{-4} (1 in 1,069 years)	9.35×10^{-4} (1 in 1,069 years)
Drifting vessel to structure allision	Base case	-	1.51×10^{-4} (1 in 6,640 years)	1.51×10^{-4} (1 in 6,640 years)
	Future case (10%)	-	1.66×10^{-4} (1 in 6,036 years)	1.66×10^{-4} (1 in 6,036 years)
	Future case (20%)	-	1.81×10^{-4} (1 in 5,533 years)	1.81×10^{-4} (1 in 5,533 years)
Fishing vessel to structure allision	Base case	-	1.01×10^{-1} (1 in 9.9 years)	1.01×10^{-1} (1 in 9.9 years)
	Future case (10%)	-	1.09×10^{-1} (1 in 9.2 years)	1.09×10^{-1} (1 in 9.2 years)
	Future case (20%)	-	1.18×10^{-1} (1 in 8.5 years)	1.18×10^{-1} (1 in 8.5 years)
Total	**Base case**	**1.52×10^{-3} (1 in 658 years)**	**1.04×10^{-1} (1 in 9.6 years)**	**1.02×10^{-1} (1 in 9.8 years)**
	Future case (10%)	**1.96×10^{-3} (1 in 511 years)**	**1.13×10^{-1} (1 in 8.9 years)**	**1.11×10^{-1} (1 in 9.0 years)**
	Future case (20%)	**2.32×10^{-3} (1 in 431 years)**	**1.22×10^{-1} (1 in 8.2 years)**	**1.20×10^{-1} (1 in 8.4 years)**

17 Mitigation Measures

17.1 Embedded Mitigation Measures

As part of the design process for the offshore Project, a number of embedded mitigation measures have been adopted to reduce the risk of hazards identified, including those relevant to shipping and navigation.

These measures typically include those that have been identified as good or standard practice and include actions that will be undertaken to meet existing legislation requirements. As there is a commitment to implementing these measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of the offshore Project.

The embedded mitigation measures within the design relevant to shipping and navigation are outlined in Table 17.1.

Table 17.1 Embedded Mitigation Measures Relevant to Shipping and Navigation

Embedded Mitigation Measure	Details
Application for safety zones	Application for safety zones of up to 500 m around structures during construction and periods of major maintenance, and 50 m around structures pre commissioning.
Buoyed construction area	Construction buoyage in agreement with NLB.
Cable burial risk assessment	Suitable implementation and monitoring of cable protection (via burial, or external protection where adequate burial depth as identified via risk assessment is not feasible).
Compliance with MGN 654	Compliance with MGN 654 and its annexes (particularly annex 5 (MCA, 2021c) and completion of a SAR checklist and ERCoP).
Guard Vessel(s)	Guard vessel(s) as required by risk assessment.
Layout approval via Development Specification and Layout Plan (DSLP) process	Layout to be agreed via the DSLP process which will include MCA, NLB and UKCoS consultation. Minimum spacing of 944m between WTGs.
Lighting and marking	Marking and lighting of the site in agreement with NLB and in line with IALA Guideline G1162 (IALA, 2021 (a) and Recommendation O-139 (IALA, 2021 (b)).
Marine coordination	Marine coordination and communication to manage Project vessel movements.

Embedded Mitigation Measure	Details
Marine Pollution Contingency Plan (MPCP)	Production of an MPCP.
Marking on charts	Appropriate depiction on UKHO Admiralty Charts.
Minimum blade clearance	Blade clearance in excess of minimum requirement of 22 m above Mean High Water Springs (MHWS). Blade clearance will be at least 24.7m above HAT.
Project Vessel AIS Transmission	Project vessel AIS transmission regardless of size.
Project vessel compliance with international marine regulations	Compliance of all Project vessels with international marine regulations as adopted by the Flag State, notably the COLREGs (IMO, 1974) and the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974).
Promulgation of information	Promulgation of information for vessel routes, timings and locations, safety zones and advisory passing distances as required via Notices to Mariners and Kingfisher bulletins.
Navigational Safety Plan and Vessel Management Plan	Sets out project vessel management procedures and navigational safety measures.

17.2 Additional Mitigation Measures

As detailed in Section 18, in addition to the embedded mitigation measures proposed, it is considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate.

17.3 Marine Aids to Navigation

Throughout all stages, aids to navigation will be provided in accordance with NLB and MCA requirements, with consideration being given to IALA Guidance G1162 (IALA, 2021 (a)), IALA Recommendation O-139 (IALA, 2021 (b)), and MGN 654 (MCA, 2021).

17.3.1 Operations and Maintenance Stage

Marking during the operations and maintenance stage will be agreed in consultation with NLB once the final array layout has been selected post consent; however, the following subsections summarise likely requirements.

17.3.1.1 Marking of Individual Array Structures

As per IALA Guideline G1162, each surface structure within the OAA will be painted yellow from the level of Highest Astronomical Tide (HAT) to at least 15 m 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.

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 3 m above sea level and at a distance of at least 150 m from the WTG. The light will be either hooded or baffled so as to avoid unnecessary light pollution or confusion with navigational marks.

17.3.1.2 Marking of Array as a Whole

The marking of the OAA as a whole will be agreed with NLB 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 NLB, it will be ensured that:

- All corner structures will be marked as a Significant Peripheral Structure (SPS) and where necessary, to satisfy the spacing requirements between SPSs, additional periphery structures may also be marked as SPSs;
- Structures designated as an SPS will exhibit a flashing yellow five second (flash yellow every five seconds) light of at least 5 nm nominal range and omnidirectional fog signals as appropriate and where prescribed by NLB, and will be sounded at least when the visibility is 2 nm or less;
- Further periphery structures may be marked as Intermediate Peripheral Structures (IPS) including a flashing yellow light with a distinctly different flash character from those displayed on the SPSs and at least 2 nm nominal range;
- 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 6 m 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 aids to navigation;
- Aviation lighting will be as per Civil Aviation Authority (CAA) requirements; however, will likely be synchronised Morse "W" at the request of NLB; and
- All lighting will be considered cumulatively with existing aids to navigation to avoid the potential for light confusion to passing traffic.

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.

17.4 Design Specifications Noted in Marine Guidance Note 654

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 Risk Assessment – In Isolation

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:

- Vessel displacement and increased collision risk;
- Third-party with project vessel collision risk;
- Creation of vessel to structure allision risk;
- Changes in under keel clearance;
- Increased interaction with subsea cables;
- Adverse weather routeing;
- Reduced access to local ports and harbours; and
- Reduction of emergency response capability.

For each hazard, embedded mitigation measures which have been identified as relevant to reducing risk are listed, with full descriptions provided in Section 17.1. 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.

The risk control log (see Section 20) summarises the risk assessment and a concluding risk statement is provided (see Section 22.5).

18.1 Construction Stage (including pre-construction)

18.1.1 Vessel Displacement and Increased Third-Party Vessel to Vessel Collision Risk

Construction activities associated with the installation of structures and cables may displace existing routes/activity and increase encounters and collision risk with other third-party vessels.

Each element is considered in turn in terms of frequency of occurrence and severity of consequence, with the resulting significance of the residual risk across the various elements summarised at the end of the assessment. The elements considered include:

- Vessel displacement; and
- Increased third-party to third-party vessel collision risk.

18.1.1.1 Vessel Displacement

18.1.1.1.1 Qualification of Risk

The volume of vessel traffic passing within or in proximity to the OAA has been established using vessel traffic data collected during dedicated surveys (28 days over winter and summer 2022) and from coastal receivers (12 months, 2021) as well as Anatec's ShipRoutes database. These datasets were interrogated to identify main routes using the principles set out in MGN 654 (MCA, 2021) (see Section 11).

Although there will be no restrictions on entry into the buoyed construction area, other than through active safety zones, based on experience at previously under construction OWFs and consultation, it is anticipated that the majority of commercial vessels will choose not to navigate internally within the buoyed construction area and therefore some main route deviations will be required (noting this aligns with feedback provided at the hazard workshop). It is noted that operators associated with the aquaculture industry (BioFeeder, Ocean Farm Services, and Migdale) responded to the regular operators outreach (see Section 4.2) stating that their vessels may consider transiting through depending on various factors notably the final layout and sea conditions. On this basis, smaller commercial vessel operators may choose to transit through on an infrequent basis, however it is likely that the majority of commercial vessels will deviate.

The full methodology for main route deviations is provided in Section 15.4, with deviations established in line with MGN 654 (MCA, 2021). A deviation will be required for four of the 12 main routes identified within the routeing study area, with details as follows:

- Route 4 (Reykjavik to Humber ports) – four vessels per week, deviation of 0.01 nm (0.02 km) (<0.01%). Likely these vessels will pass further south to increase passing distance from the OAA leading to a minor deviation;
- Route 7 (Reykjavik to Rotterdam) – two to three vessels per week, deviation of 9.62 nm (17.82 km) (0.95%). Deviations for this route include worst case assumptions on local rock and shallows features.
- Route 8 (Belfast to northern Norwegian/Russian ports) – two vessels per week, deviation of 4.49 nm (8.32 km) (0.61%). Likely these vessels will pass north of the Sule Skerry; and
- Route 12 (Ullapool to Scalloway) – one vessel per week, deviation of 5.31nm (9.83 km) (2.84%) Likely these vessels will pass north of the Sule Skerry.

Regular routeing involving RoRo vessels was recorded by one vessel operated by Smyril Line on route 7, transiting through the shipping and navigation offshore study area approximately twice per week between Rotterdam and Þorlákshöfn (Iceland). DFDS Seaways-operated RoRo routeing was also noted between Belfast and Skogn approximately two to three times per month.

Vessels deviating will be required to account for the presence of the Sule Skerry and Stack Skerry, noting this is of particular relevance to vessels on Routes 8 and 12. It is considered unlikely that vessels would choose to pass between either Sule Skerry / Stack Skerry and the OAA, and therefore any vessels choosing to pass north of the OAA are likely to pass north of the rocks.

It is also noted that certain vessels will need to account for the presence of the ATBA around Orkney (any vessel of greater than 5,000 GT and carrying potentially pollutant cargo). The minimum distance between the ATBA and the OAA is 2.4 nm (4.4 km), and while there would be no restriction on such vessels transiting through this gap, they may have preference to avoid this area given it would be bounded by WTGs on one side and the ATBA on the other, leading to a potentially large deviation depending on terminus ports.

Based on experience at previously under construction OWFs, it is anticipated that fishing vessels and recreational vessels will choose not to routinely navigate internally within the buoyed construction area, noting there would be no restriction on transit other than through active safety zones. There is considered to be sufficient sea room outside of the array for transits from such vessel to be accommodated. It is noted that displacement of active commercial fishing is assessed separately in Offshore EIA Report, chapter 14: Commercial fisheries.

Given the available searoom, it is considered unlikely that cable installation will lead to any notable displacement or disruption, noting any impact would be localised to the spatial area immediately around the vessel and would be temporary in nature.

The main consequence of vessel displacement will be increased journey times and distances for affected third-party vessels, over a large spatial extent, particularly as it is assumed that the buoyed construction area will be deployed around the maximum extent of the OAA. Vessels are expected to comply with international and flag state regulations (including COLREGs (IMO, 1972/77) and SOLAS (IMO, 1974) and will be able to passage plan in advance given the promulgation of information relating to the Project and relevant nautical charts.

18.1.1.1.2 Embedded Mitigation Measures
The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- DSLP approval;
- LMP;
- Marking on charts; and
- Promulgation of information.

18.1.1.1.3 Frequency of Occurrence
The frequency of occurrence in relation to displacement of vessel traffic is considered **frequent**.

18.1.1.1.4 Severity of Consequence
The severity of consequence in relation to displacement of vessel traffic is considered **negligible** in terms of navigational safety.

18.1.1.2 Increased Third-Party to Third-Party Vessel Collision Risk.

It is anticipated that four of the 12 main routes identified will deviate as a result of the construction of the Project. This could lead to increased vessel densities within the area, which could in turn lead to an increase in vessel to vessel encounters and therefore increased collision risk.

Based on the pre OWF modelling, the baseline collision risk levels within the study area are low, with an estimated vessel to vessel collision frequency of one every 658 years. The low level of collision risk is due to the volume of traffic in the area relative to the available sea space. Based on the post OWF scenario, the collision frequency was estimated at one in 491 years, with the change associated with the vessels displaced from the OAA either south or offshore of the Sule Skerry. This represents an increase of 34%, however is still considered a low level of collision risk. This aligns with the findings of the incident data assessment (see Section 9), which showed no recorded collisions in the shipping and navigation offshore study area over the periods studied.

The promulgation of information relating to construction activities, deployment of the buoyed construction area, and charting of infrastructure will allow vessel Masters to passage plan in advance, minimising any displacement and hence collision risk. Appropriate lighting and marking during construction including the buoyed construction area will be agreed with the NLB. These navigational aids will further maximise mariner awareness when in proximity. Additionally, information for fishing vessels will be promulgated through ongoing liaison with fishing fleets via an appointed Fisheries Liaison Officer (FLO).

The minimum spacing between WTGs (944 m) is sufficient to ensure the view of other vessels will not be blocked or hindered, again reducing the likelihood of an encounter occurring in proximity to the offshore Project.

In the event that an encounter does occur, it is likely to be localised and occur for only a short duration, with collision avoidance action implemented by the vessels involved, in line with the COLREGs, thus ensuring that the situation does not develop into a collision incident. This is supported by experience at previous under construction OWFs, where no collision incidents involving two third-party vessels have been reported.

Historical collision incident data (see Section 9.6) also indicates that the most likely consequences will be low should a collision occur, with minor contact between the vessels resulting in minor damage and no injuries to persons, with both vessels able to resume their respective passages and undertake a full inspection at the next port. As an unlikely worst case, one or more of the vessels could be foundered resulting in a Potential Loss of Life (PLL) and pollution.

18.1.1.2.1 Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Buoyed construction area;
- DSLP approval;
- LMP;
- FLO and FMMS;
- Marking on charts; and
- Promulgation of information.

18.1.1.2.2 Frequency of Occurrence

The frequency of occurrence in relation to encounters and collision risk is considered **extremely unlikely**.

18.1.1.2.3 Severity of Consequence

The severity of consequence in relation to encounters and collision risk is considered **serious**.

18.1.1.3 Significance of Risk

Hazard Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Vessel Displacement	Frequent	Negligible	Tolerable
Third party vessel to vessel collision risk	Extremely Unlikely	Serious	Tolerable

Overall, it is predicted that the significance of risk due to vessel displacement leading to increased vessel to vessel collision risk is **Tolerable**. As per Section 17.1, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation, the risk is considered ALARP.

18.1.2 Third-Party to Project Vessel Collision Risk

Vessels associated with construction activities may increase encounters and collision risk for other vessels already operating in the area.

18.1.2.1 Qualification of Risk

Up to 1,722 return trips by construction vessels may be made throughout the construction stage, noting this will include Restricted in Ability to Manoeuvre (RAM) vessels. It is assumed that construction vessels will be on-site throughout the duration of the construction stage.

Encounter and collision risk involving project vessels will be managed by marine coordination including the application of traffic management procedures such as the designation of entry and exit points to and from the OAA and routes to and from construction ports. These measures will be set out in the Navigational Safety and Vessel Management Plan. Additionally, project vessels will carry AIS and be compliant with Flag State regulations including IMO conventions such as the COLREGs, and information for fishing vessels will also be promulgated through ongoing liaison with fishing fleets via an appointed FLO.

An application for safety zones of 500m will be sought during the construction stage around structures where construction activity is ongoing (i.e., where a construction vessel is present). These will serve to protect project vessels engaged in construction activities. Minimum advisory passing distances, as defined by risk assessment, may also be applied where safety zones do not apply (e.g., around cable installation vessels), with advanced warning and details of both safety zones and any minimum advisory safe passing distances provided by Notifications to Mariners and Kingfisher Bulletins.

Appropriate marine lighting and marking during construction including the buoyed construction area will be agreed with the NLB. These navigational aids will further maximise mariner awareness when in proximity to ongoing construction works in the OAA.

Third-party vessels may experience restrictions on visually identifying project vessels entering and exiting the OAA during reduced visibility; however, this hazard will be mitigated by the application of the COLREGs (reduced speeds) in adverse weather conditions and project vessels mandatorily will carry AIS regardless of size. It is noted that the likelihood of a collision is likely to be greater in reduced visibility when the identification of project vessels entering and exiting the OAA may be encumbered. However, again the COLREGs regulate vessel movements in adverse weather conditions and require all vessels operating in reduced visibility to reduce speed to allow more time for reacting to encounters, thus minimising the collision risk.

Based on historical incident data, there have been two instances of a third-party vessel colliding with a project vessel in the UK (see Section 9.6). In both incidents moderate vessel damage was reported with no harm to persons. It is noted that the two incidents occurred in 2011 and 2012, respectively, and awareness of offshore wind developments and application of the measures outlined above has improved and been refined considerably in the interim, with no further collision incidents reported since.

As for third party to project vessel collision risk (see section 18.1.1.2), if an encounter occurs between a third-party vessel and a project vessel, the encounter is likely to be localised and occur for only a short duration. With collision avoidance action implemented in line with the COLREGs, the vessels involved will likely be able to resume their respective passages and/or activities with no long-term consequences.

Should a collision occur, the most likely consequences will be similar to that outlined for the case of a collision between two third-party vessels (see section 18.1.1.2), namely minor contact between the vessels resulting in minor damage and no injuries to persons with both vessels able safely to make their next port to undertake a full inspection. As an unlikely worst case, one or more of the vessels could be foundered resulting in a PLL and pollution. If pollution were to occur in proximity to the offshore Project or involving a project vessel, then the MPCP will be implemented to minimise the environmental risks.

18.1.2.2 Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Application for safety zones;
- Buoyed construction area;
- Guard Vessel(s) as required by risk assessment;
- DSLP approval;
- LMP;
- Marine coordination;

- MPCP;
- Marking on charts;
- Project vessel AIS transmission;
- Project vessel compliance with international marine regulations;
- Promulgation of information; and
- Navigational Safety and Vessel Management Plan.

18.1.2.3 Frequency of Occurrence

The frequency of occurrence is considered to be **extremely unlikely**.

18.1.2.4 Severity of Consequence

The severity of consequence is considered to be **serious**.

18.1.2.5 Significance of Risk

Hazard Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Third-party to project vessel collision risk	Extremely Unlikely	Serious	Tolerable

Overall, it is predicted that the significance of risk due to increased third-party to project vessel collision risk is **Tolerable**. As per Section 17.1, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation, the risk is considered ALARP.

18.1.3 Adverse Weather Routeing

18.1.3.1 Qualification of Risk

Adverse weather includes wind, wave and tidal conditions as well as reduced visibility due to fog. Adverse weather can hinder a vessel's standard route, its speed of navigation and/or its 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 on the actual stability parameters, hull geometry, vessel type, vessel size and speed.

The need to consider routeing in adverse weather conditions was highlighted by the MCA during consultation, and certain vessel operators indicated that the presence of the buoyed construction area may limit routeing options in adverse conditions (see Section 4.2). Based on review of the input received, it is likely that no commercial vessels would choose to make transit through the buoyed construction area during adverse weather conditions and will instead choose to pass either offshore of the OAA i.e., north of the Sule Skerry, or inshore to the south depending on destination. Larger deviations may be required than during more favourable conditions (e.g., vessels may choose to increase passing distance from the OAA or the Sule Skerry), however there is considered to be sufficient searoom to safely accommodate the chosen transits.

Input from Scotline was that their vessels may tack through the area under adverse conditions (see Section 12), noting one example of this behaviour was identified in the long term AIS. Post OWF there will be less seaspace available for this behaviour, however there is considered to be sufficient searoom to safely accommodate shorter more frequent tacks.

It is noted that during periods of adverse weather, some project vessels during the construction stage may depart the buoyed construction area.

The promulgation of information relating to construction activities, deployment of the buoyed construction area, and charting of infrastructure will allow vessel Masters to passage plan in advance accounting for forecast adverse weather conditions.

18.1.3.2 Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Buoyed construction area;
- DSLP approval;
- LMP;
- Marking on charts; and
- Promulgation of information.

18.1.3.3 Frequency of Occurrence

The frequency of occurrence related to adverse weather routeing is considered to be **remote**.

18.1.3.4 Severity of Consequence

The severity of consequence related to adverse weather routeing is considered to be **serious** due to potential safety concerns if vessels routeing options during adverse weather are restricted.

18.1.3.5 Significance of Risk

Hazard Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Adverse Weather Routeing	Remote	Serious	Tolerable

Overall, it is predicted that the significance of risk due to restrictions on adverse weather routeing is **Tolerable**. As per Section 17.1, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation, the risk is considered ALARP.

18.1.4 Creation of Vessel to Structure Allision Risk

Presence of structures (including partially constructed) within the buoyed construction area will lead to creation of powered, drifting and internal allision risk for vessels.

The spatial extent of the hazard is small given that a vessel must be in close proximity to an OWF structure for an allision incident to occur. Each allision element is considered in turn in terms of frequency of occurrence and severity of consequence, with the resulting significance of the residual risk across the various elements summarised at the end of the assessment. The forms of allision considered include:

- Powered allision risk;
- Drifting allision risk; and
- Internal allision risk.

18.1.4.1 Powered Allision Risk

18.1.4.1.1 Qualification and Quantification of Risk

Based on the quantitative assessment undertaken (see Section 16), the base case annual powered vessel to structure allision frequency was estimated to be 7.79×10^{-4}, corresponding to a return period of approximately one in 1,283 years. This is a low return period compared to that estimated for other UK OWF developments and is reflective of the relatively low volume of vessel traffic intersecting or passing in close proximity to the OAA.

Based on historical incident data, there have been two reported instances of a third-party vessel alliding with an operational OWF structure in the UK (in the Irish Sea and Southern North Sea). Both of these incidents involved a fishing vessel.

Operational lighting and marking will not yet be in place, however temporary marine lighting and marking will be implemented including the buoyed construction area in agreement with the NLB. Promulgation of information and display on charts will ensure vessels can passage plan to minimise risk. Pre-commissioning safety zones of 50 m in radius will also be applied for around structures.

Should an allision occur, the consequences will depend on multiple factors including the energy of the impact, structural integrity of the vessel and sea state at the time of the impact. Fishing vessels and recreational vessels are considered most vulnerable to the hazard given the potential for a non-steel construction and possible internal navigation within the OAA by such vessels. In such cases, the most likely consequences will be minor damage with the vessel able to resume passage and undertake a full inspection at the next port. As an unlikely worst case, the vessel could be foundered resulting in a PLL and pollution. If pollution were to occur, then the MPCP will be implemented to minimise the environmental risk.

18.1.4.1.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Application for safety zones;
- Buoyed construction area;
- DSLP approval;
- LMP;
- FLO and FMMS;
- MPCP;
- Marking on charts; and
- Promulgation of information.

18.1.4.1.3 Frequency of Occurrence

The frequency of occurrence in relation to powered allision risk is considered to be **extremely unlikely**.

18.1.4.1.4 Severity of Consequence

The severity of consequence in relation to powered allision risk is considered to be **moderate**.

18.1.4.2 Drifting Allision Risk

18.1.4.2.1 Qualification and Quantification of Risk

Based on the quantitative assessment undertaken (see Section 16), the base case annual drifting vessel to structure allision frequency was estimated to be 1.51×10^{-4}, corresponding to a return period of approximately one in 6,647 years. This is a low return period compared to that estimated for other UK OWF developments and is reflective of the relatively low volume of vessel traffic passing in proximity to or within the OAA.

Based on historical incident data, there have been no instances of a third-party vessel alliding with an operational OWF structure whilst Not Under Command (NUC). However, there is considered to be potential for a vessel to be adrift; this is reflected in the MAIB incident data reviewed in proximity to the offshore Project which indicates that machinery failure is the most common incident type in both the 2010-2019 (approximately 40%) and 2000-2009 (approximately 60%) datasets. A vessel adrift may only develop into an allision situation if in proximity to a OWF structure. This is only the case where the adrift vessel is located internally within or in close proximity to the OAA and the direction of the wind and/or tide directs the vessel towards a structure.

In circumstances where a vessel drifts towards a structure in the OAA, 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 OAA (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).

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). This response will be managed via the coastguard 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.

It is noted that design of the OAA, the boundary of which avoids the south-east corner of the N1 PO area, has considered the specific recreational vessel risk for these vessels sailing between Cape Wrath or the west coast to Stromness (due to tidal restrictions approaching Stromness).

Should an allision occur, the consequences will be similar to those noted for the case of a powered allision including the unlikely worst-case of foundering and pollution; in the highly unlikely scenario of a drifting allision incident resulting in pollution, the implementation of the MPCP will minimise the environmental risk. Additionally, a drifting vessel is likely to transit at a reduced speed compared to a powered vessel, thus reducing the energy of the impact, including in the case of a recreational vessel under sail.

18.1.4.2.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- MPCP;
- Marking on charts;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

18.1.4.2.3 Frequency of Occurrence

The frequency of occurrence in relation to drifting allision risk is considered to be **extremely unlikely.**

18.1.4.2.4 Severity of Consequence

The severity of consequence in relation to drifting allision risk is considered to be **moderate**.

18.1.4.3 Internal Allision Risk

18.1.4.3.1 Qualification and Quantification of Risk

As noted previously, based on experience at existing operational OWFs, it is anticipated that commercial vessels will be unlikely to navigate internally within the OAA. Fishing and recreational vessels may be more likely to transit through noting they may be less likely to do so while the buoyed construction area is in place.

The base case annual fishing vessel to structure allision frequency (see Section 16), is estimated to be 1.01×10^{-1}, corresponding to a return period of approximately one in 9.6 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 that baseline activity in terms of proximity to WTGs will not change. This is a very conservative assumption, and in reality fishing vessels will account for the presence of the WTGs. Further, the worst consequences reported for vessels involved in an allision incident involving a UK offshore wind farm development has been flooding, with no life-threatening injuries to persons reported (the model is calibrated against known reported incidents). It is also noted that the result aligns with that of other publicly available NRAs, for example the NRA for the now consented Moray West OWF (Anatec, 2018) estimated a fishing vessel allision return period of one in seven years.

The minimum spacing between structures of 944 m is considered sufficient for safe internal navigation i.e. for vessels to keep clear of the OWF structures within the buoyed construction area. It is noted that this spacing is greater than that associated with many other operational OWFs in the UK. Further, the final layout will be agreed through the DSLP process which will include MCA and NLB consultation to ensure it is safe from a surface navigation perspective.

As with any passage, any vessel navigating within the OAA is expected to passage plan in accordance with SOLAS Chapter V (IMO, 1974) and promulgation of information including through ongoing liaison with fishing fleets via an appointed FLO to ensure that such vessels have good awareness of the Offshore Project. Pre-commissioning safety zones of 50m in radius will also be applied for around structures. Operational lighting and marking will not yet be in place, however temporary marine lighting and marking will be implemented in agreement with the NLB.

Should a recreational vessel under sail enter the proximity of a WTG, 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, 2008) 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. For recreational vessels with a mast there is an additional allision risk when navigating internally within the array associated with the WTG blades. However, the minimum blade tip clearance exceeds 22 m above MHWS which is aligned with the minimum clearance the RYA recommend for minimising allision risk (RYA, 2019) and which is also noted in MGN 654.

It is also noted that design of the OAA has considered the specific recreational vessel risk for these vessels sailing between Cape Wrath or the west coast to Stromness (due to tidal restrictions approaching Stromness).

18.1.4.3.2 Relevant embedded mitigation measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Application for safety zones;
- Buoyed construction area;
- Compliance with MGN 654;
- DSLP approval;
- LMP;
- FLO and FMMS;
- Marking on charts;
- Minimum blade clearance; and
- Promulgation of information.

18.1.4.3.3 Frequency of Occurrence

The frequency of occurrence in relation to internal allision risk is considered to be **remote**.

18.1.4.3.4 Severity of Consequence

The severity of consequence in relation to internal allision risk is considered to be **moderate**.

18.1.4.4 Significance of Risk

Hazard Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Powered Allision Risk	Extremely Unlikely	Moderate	Broadly Acceptable
Drifting Allision Risk	Extremely Unlikely	Moderate	Broadly Acceptable
Internal Allision Risk	Remote	Moderate	Tolerable

Overall, it is predicted that the significance of risk due to creation of allision risk is **Tolerable**. As per Section 17.1, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation, the risk is considered ALARP.

18.1.5 Reduced Access to Local Ports and Harbours

18.1.5.1 Qualification of Risk

Up to 1,722 return trips by construction vessels (excluding site preparation activities) may be made throughout the construction stage and will include vessels which are RAM. Project vessels will be managed by marine coordination, including the use of traffic management procedures such as the designation of entry and exit points to and from the buoyed construction area, and designated routes to and from construction ports. Project vessels will also carry AIS and be compliant with Flag State regulations including the COLREGs.

The closest port or harbour to the OAA is Stromness Harbour, located approximately 20 nm (37.0 km) to the east, on the Orkney coast. Scrabster Harbour is located approximately 22 nm (40.7 km) to the southeast on the northern mainland Scotland coast. Given the relative distance to ports in the area and the anticipated deviations for the main commercial routes, it is not anticipated that there will be any substantial effect on vessel approaches to and from the local ports beyond the deviations already outlined for impacts on vessel displacement (see section 18.1.1.1). This aligns with feedback received during the hazard workshop.

The closest port/harbour to the offshore ECC is Scrabster, located 5 nm (9.3 km) to the east of the landfall. On this basis it is considered unlikely that cable installation would have any impact on port access, again beyond what has already been assessed in terms of general vessel displacement (see section 18.1.1.1).

The most likely consequences of the impact are increased journey times and distances due to the presence of the buoyed construction area and project vessels, as per the vessel displacement impact. No effect is anticipated on port related services such as pilotage.

18.1.5.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Buoyed construction area;
- LMP;
- Marine coordination;
- Marking on charts;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

18.1.5.3 Frequency of Occurrence

The frequency of occurrence for reduced access to local ports and harbours is considered to be **frequent**.

18.1.5.4 Severity of Consequence

The severity of consequence for reduced access to local ports and harbours is considered to be **negligible**.

18.1.5.5 Significance of Risk

Hazard Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Reduced access to local ports and harbours	Frequent	Negligible	Tolerable

Overall, it is predicted that the significance of risk due to changes in access to local ports is of **Tolerable** significance.

18.2 Operations and Maintenance Stage

18.2.1 Vessel Displacement and Increased Third-Party Vessel to Vessel Collision Risk

Presence of structures may displace existing routes/activity, increase encounters and collision risk with other third-party vessels.

As with the construction stage version of this hazard, each element is considered in turn in terms of frequency of occurrence and severity of consequence, with the resulting significance of the residual risk across the various elements summarised at the end of the assessment. The elements considered include:

- Vessel displacement; and
- Increased third-party to third-party vessel collision risk.

18.2.1.1 Vessel Displacement

18.2.1.1.1 Qualification of Risk

Based on experience at existing operational OWFs, it is anticipated that commercial vessels will choose not to navigate internally within the OAA and therefore the main route deviations established for the equivalent construction stage hazard in line with MGN 654 (MCA, 2021) are again considered (see Section 18.1.1.1.1).

A deviation will be required for four of the 12 main routes identified within the routeing study area as discussed in Section 18.1.1.1.1.

As for the construction stage, vessels deviating will be required to account for the presence of the Sule Skerry, noting this is of particular relevance to vessels on Routes 8 and 12. It is considered unlikely that vessels would choose to pass between the Sule Skerry and the OAA, and therefore any vessels choosing to pass north of the OAA are likely to pass north of the rocks.

It is also noted that certain vessels will need to account for the presence of the ATBA (any vessel of greater than 5,000GT and carrying potentially pollutant cargo). The minimum distance between the ATBA and the OAA is 2.4nm, and while there would be no restriction on such vessels transiting through this gap, they may have preference to avoid this area given it would be bounded by WTGs on one side and the ATBA on the other, leading to a potentially large deviation depending on terminus ports.

It is noted that vessel behaviours and routeing in relation between the OAA and the ATBA and Sule Skerry will likely be well established by the time of the operational stage, based on experience during the construction stage of the Project.

Minimum spacing in the OAA of 944 m is considered sufficient to accommodate transits of any smaller vessels that chose to transit through, noting there will be no restrictions on entry into the OAA for any vessel other than through any active 500m major maintenance safety zones.

With the main route deviations matching those established for the equivalent construction stage hazard (see Section 18.1.1.1.1), the main consequences of vessel displacement during the operational stage are also considered to be equivalent, in particular potential for increased journey times and distances. As for the construction stage, promulgation of information relating to the offshore Project and relevant nautical charts will allow vessels to passage plan in advance.

18.2.1.1.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- DSLP approval;
- LMP;
- Marking on charts; and
- Promulgation of information.

18.2.1.1.3 Frequency of Occurrence

The frequency of occurrence in relation to displacement of vessel traffic is considered **frequent**.

18.2.1.1.4 Severity of Consequence

The severity of consequence in relation to displacement of vessel traffic is considered **negligible** in terms of navigational safety.

18.2.1.2 Increased Third-Party Vessel to Vessel Collision Risk

18.2.1.2.1 Qualification And Quantification of Risk

Given the main route deviations are anticipated to remain as per those established for the equivalent construction stage hazard (see Section 18.1.1.1), the likelihood of an encounter occurring are also likely to be similar. As discussed in Section 18.1.1.2, the annual collision frequency for the post OWF scenario (one in 491 years) represents a 34% increase compared to the pre OWF base scenario. This relatively low level of estimated collision risk aligns well with the incident datasets assessed (see Section 9)

In the event that an encounter or collision does occur, the respective consequences are expected to be the same as for the equivalent construction stage hazard, with the most likely consequences of a collision being minor damage incurred. The worst-case consequences could include the foundering of one of the vessels resulting in a PLL and pollution.

As with the equivalent construction stage hazard, for all vessels the risk will be present throughout the operation and maintenance stage, but the promulgation of information relating to maintenance activities and charting of infrastructure will allow vessel Masters to passage plan in advance, minimising disruption. Additionally, as with the construction stage, mariner awareness will be further maximised by promulgation of information and deployment of lighting and marking.

18.2.1.2.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- DSLP approval;
- LMP;
- Marking on charts; and
- Promulgation of information.

18.2.1.2.3 Frequency of Occurrence

The frequency of occurrence in relation to encounters and collision risk is considered **extremely unlikely**.

18.2.1.2.4 Severity of Consequence

The severity of consequence in relation to encounters and collision risk is considered **serious**.

18.2.1.3 Summary

Hazard component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Vessel displacement	Frequent	Negligible	Tolerable
Third party vessel to vessel collision risk	Extremely Unlikely	Serious	Tolerable

Overall, it is predicted that the significance of risk due to vessel displacement is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.2.2 Third-Party to Project Vessel Collision Risk

18.2.2.1 Qualification of Risk

Up to 468 return trips per year by operation and maintenance vessels may be made throughout the operation and maintenance stage, including RAM vessels. It is assumed that operation and maintenance vessels will be on-site throughout the operation and maintenance stage, with likely seasonal differences present – it is estimated that there will be more vessel movements in summer months. It is noted that the movement of project vessels during the operation and maintenance stage represents a decrease in movements in comparison to the construction stage.

As with the equivalent construction stage hazard, encounter and collision risk involving a project vessel will be well mitigated, including through marine coordination, and carriage of AIS and compliance with Flag State regulations by project vessels.

Furthermore, an application for safety zones of 500 m radius will be sought during the operation and maintenance stage around structures where major maintenance is ongoing. These will serve to protect project vessels engaged in major maintenance activities. Minimum advisory passing distances, as defined by risk assessment, may also be implemented where safety zones do not apply, with advanced warning and accurate locations of both safety zones and any minimum advisory safe passing distances provided by Notifications to Mariners and Kingfisher Bulletins.

As with the equivalent construction stage hazard, third party vessels may experience restrictions on visually identifying project vessels entering and exiting the OAA during reduced visibility; however, this hazard will be mitigated by the application of the COLREGs (reduced speeds) in adverse weather conditions and project vessels mandatorily will carry AIS regardless of size.

As stated for the equivalent construction stage hazard, based on historical incident data, there have been two instances of a third-party vessel colliding with a project vessel in the UK (see Section 9.6). In both incidents moderate vessel damage was reported with no harm to persons. It is noted that the two incidents occurred in 2011 and 2012, respectively, and awareness of offshore wind developments and application of the measures outlined above (and in Section 17) has improved and been refined considerably in the interim, with no further collision incidents reported since.

The structures within the OAA will exhibit lights, marks, sounds, signals and other aids to navigation as required by NLB and the MCA, maximising mariner awareness to the potential for project vessel presence when in proximity, both in day and night conditions including in poor visibility.

Should an encounter or collision occur between a third-party vessel and a project vessel, the consequences are expected to be as for the equivalent construction stage hazard, with the most likely consequences being moderate damage incurred and no injuries to persons based on historical incident data (see Section 9.6). The worst-case consequences could include the foundering of one of the vessels resulting in a PLL and pollution, with the environmental risk of the latter minimised by the implementation of the MPCP.

18.2.2.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Application for safety zones;

- Guard Vessel(s) as required by risk assessment;
- DSLP approval;
- LMP;
- Marine coordination;
- MPCP;
- Marking on charts;
- Project vessel AIS transmission;
- Project vessel compliance with international marine regulations;
- Promulgation of information; and
- Navigational Safety and Vessel Management Plan.

18.2.2.3 Frequency of Occurrence

The frequency of occurrence in relation to increased third-party to project vessel collision risk is considered to be **extremely unlikely**.

18.2.2.4 Severity of Consequence

The severity of consequence in relation to increased third-party to project vessel collision risk is considered to be **serious**.

18.2.2.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Extremely unlikely	Serious	Tolerable

Overall, it is predicted that the significance of risk due to increased third-party to project vessel collision risk is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.2.3 Creation of Vessel to Structure Allision Risk

Presence of structures within the OAA will lead to creation of powered, drifting and internal allision risk for vessels.

The spatial extent of the hazard is small given that a vessel must be in close proximity to an OWF structure for an allision incident to occur. Each allision element is considered in turn in terms of frequency of occurrence and severity of consequence, with the resulting significance of the residual risk across the various elements summarised at the end of the assessment. The forms of allision considered include:

- Powered allision risk;
- Drifting allision risk; and
- Internal allision risk.

18.2.3.1 Powered Allision Risk

18.2.3.1.1 Qualification And Quantification of Risk

Based on the quantitative assessment undertaken (see Section 16), the base case annual powered vessel to structure allision frequency was estimated to be 7.79×10^{-4}, corresponding to a return period of approximately one in 1,283 years. This is a low return period compared to that estimated for other UK OWF developments and is reflective of the relatively low volume of vessel traffic intersecting or passing in close proximity to the OAA. Based on historical incident data, there have been two reported instances of a third-party vessel alliding with an operational OWF structure in the UK (in the Irish Sea and Southern North Sea). Both of these incidents involved a fishing vessel, with an RNLI lifeboat attending on both occasions and a helicopter deployed in one case.

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 Offshore Project, including the charting of infrastructure on relevant nautical charts. On approach, the operational marine lighting and marking on the structures (which will be agreed with the MCA and NLB) will also assist in maximising awareness. Further, the final layout will be agreed through the DSLP process which will include MCA and NLB consultation to ensure it is safe from a surface navigation perspective.

Should an allision occur, the consequences will depend on multiple factors including the energy of the impact, structural integrity of the vessel and sea state at the time of the impact. Fishing vessels and recreational vessels are considered most vulnerable to the impact given the potential for a non-steel construction and possible internal navigation within the OAA by such vessels. In such cases, the most likely consequences will be minor damage with the vessel able to resume passage and undertake a full inspection at the next port. As an unlikely worst case, the vessel could be foundered resulting in a PLL and pollution. If pollution were to occur, then the MPCP will be implemented to minimise the environmental risk.

18.2.3.1.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- DSLP approval;
- LMP;
- MPCP;
- Marking on charts; and
- Promulgation of information.

18.2.3.1.3 Frequency of Occurrence

The frequency of occurrence in relation to powered allision risk is considered to be **extremely unlikely.**

18.2.3.1.4 Severity of Consequence

The severity of consequence in relation to powered allision risk is considered to be **moderate**.

18.2.3.2 Drifting Allision Risk

18.2.3.2.1 Qualification and Quantification of Risk

Based on the quantitative assessment undertaken (see Section 16), the base case annual drifting vessel to structure allision frequency was estimated to be 1.51×10^{-4}, corresponding to a return period of approximately one in 6,647 years. This is a low return period compared to that estimated for other UK OWF developments and is reflective of the relatively low volume of vessel traffic passing in proximity to or within the OAA.

Based on historical incident data, there have been no instances of a third-party vessel alliding with an operational OWF structure whilst NUC. However, there is considered to be potential for a vessel to be adrift in the area; this is reflected in the MAIB incident data reviewed in proximity to the offshore Project which indicates that machinery failure is the most common incident type (approximately 40%). A vessel adrift may only develop into an allision situation if in proximity to an OWF structure. This is only the case where the adrift vessel is located internally within or in close proximity to the OAA and the direction of the wind and/or tide directs the vessel towards a structure.

In circumstances where a vessel drifts towards a structure in the OAA, 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 OAA (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).

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). This response will be managed via the coastguard 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.

It is noted that design of the OAA has considered the specific recreational vessel risk for these vessels sailing between Cape Wrath or the west coast to Stromness (due to tidal restrictions approaching Stromness).

Should an allision occur, the consequences will be similar to those noted for the case of a powered allision including the unlikely worst-case of foundering and pollution; in the highly unlikely scenario of a drifting allision incident resulting in pollution, the implementation of the MPCP will minimise the environmental risk. Additionally, a drifting vessel is likely to transit at a reduced speed compared to a powered vessel, thus reducing the energy of the impact, including in the case of a recreational vessel under sail.

18.2.3.2.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Guard Vessel(s) as required by risk assessment;
- MPCP;
- Marking on charts;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

18.2.3.2.3 Frequency of Occurrence

The frequency of occurrence in relation to drifting allision risk is considered to be **extremely unlikely**.

18.2.3.2.4 Severity of Consequence

The severity of consequence in relation to drifting allision risk are considered to be **moderate**.

18.2.3.3 Internal Allision Risk

18.2.3.3.1 Qualification And Quantification of Risk

As noted previously, based on experience at existing operational OWFs, it is anticipated that commercial vessels will be unlikely to navigate internally within the OAA. Fishing and recreational vessels may be more likely to transit through noting they may be less likely to do so while the buoyed construction area is in place.

The base case annual fishing vessel to structure allision frequency (see Section 16) is estimated to be 1.01×10^{-1}, corresponding to a return period of approximately one in 9.6 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 that baseline activity in terms of proximity to WTGs will not change. This is a very conservative assumption, and in reality fishing vessels will account for the presence of the WTGs. Further, the worst consequences reported for vessels involved in an allision incident involving a UK offshore wind farm development has been flooding, with no life-threatening injuries to persons reported (the model is calibrated against known reported incidents). It is also noted that the result aligns with that of other publicly available NRAs, for example the NRA for the now consented Moray West OWF (Anatec, 2018) estimated a fishing vessel allision return period of one in seven years.

The minimum spacing between structures of 944 m is considered sufficient for safe internal navigation i.e., for vessels to keep clear of the OWF structures within the OAA. It is noted that this spacing is greater than that associated with many other operational OWFs in the UK. Further, the final layout will be agreed through the DSLP process which will include MCA and NLB consultation to ensure it is safe from a surface navigation perspective.

As with any passage, any vessel navigating within the array is expected to passage plan in accordance with SOLAS Chapter V (IMO, 1974) and promulgation of information to ensure that such vessels have good awareness. Operational marine lighting and marking will be in place as required by and agreed with the NLB.

This will include unique identification marking of each OWF structure in an easily understandable pattern to minimise the risk of a mariner navigating internally within the OAA becoming disoriented.

Should a recreational vessel under sail enter the proximity of a WTG, 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, 2008) 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. For recreational vessels with a mast there is an additional allision risk when navigating internally within the array associated with the WTG blades. However, the minimum blade tip clearance exceeds the minimum clearance the RYA recommend (22 m) for minimising allision risk (RYA, 2019) and which is also noted in MGN 654. As per Section 18.2.3.2, it is also noted that design of the OAA has considered the specific recreational vessel risk for these vessels sailing between Cape Wrath or the west coast to Stromness (due to tidal restrictions approaching Stromness).

18.2.3.3.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Application for safety zones;
- Compliance with MGN 654;
- DSLP approval;
- LMP;
- Marking on charts;
- Minimum blade clearance; and
- Promulgation of information.

18.2.3.3.3 Frequency of Occurrence

The frequency of occurrence in relation to internal allision risk is considered to be **remote**.

18.2.3.3.4 Severity of Consequence

The severity of consequence in relation to internal allision risk is considered to be **moderate**.

18.2.3.4 Summary

Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Powered allision risk	Extremely unlikely	Moderate	Broadly Acceptable
Drifting allision risk	Extremely unlikely	Moderate	Broadly Acceptable
Internal allision risk	Remote	Moderate	Tolerable

Overall, it is predicted that the significance of risk due to creation of vessel to structure allision risk is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.2.4 Changes in Under-Keel Clearance

18.2.4.1 Qualification of Risk

The presence of protection over subsea cables may reduce charted water depths leading to increased risk of under keel interaction for passing vessels. For all subsea cables relating to the Project, the target burial depth is 1.0 – 3.0 m, noting actual burial depths will be determined via the cable burial risk assessment process which will be undertaken post consent once geotechnical survey data is available. Given existing water depths, it is not anticipated that there will be any notable changes in navigable depths other than potentially near the landfall location (where depths are between 10 and 40m). It is noted that RYA Scotland indicated during consultation recreational activity in the vicinity of the landfall was likely to be limited.

Where cable burial is not possible, alternative cable protection methods may be deployed which will again be determined within the cable burial risk assessment. The requirements of MGN 654 in relation to cable protection will apply, namely cable protection will not change the charted water depth by more than 5% unless appropriate mitigation is agreed with the MCA. 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).

Should an underwater allision occur, minor damage incurred is the most likely consequence, and foundering of the vessel resulting in a PLL and pollution the unlikely worst case consequences, with the environmental risks of the latter minimised by the implementation of the MPCP.

18.2.4.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Cable burial risk assessment;
- Compliance with MGN 654;
- MPCP;
- Marking on charts; and
- Promulgation of information.

18.2.4.3 Frequency Of Occurrence

The frequency of occurrence for changes in under keel clearance is considered to be **negligible**.

18.2.4.4 Severity Of Consequence

The severity of consequence for changes in under keel clearance is considered to be **moderate**.

18.2.4.5 Significance Of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Negligible	Moderate	Broadly Acceptable

Overall, it is predicted that the significance of risk due to changes in under keel clearance is of **Broadly Acceptable** significance.

18.2.5 Increased Interaction with Sub-Sea Cables

18.2.5.1 Qualification of Risk

Presence of export cables, array cables and interconnector cables may increase the potential for interaction with sub-sea cables.

The spatial extent of the hazard is small given that a vessel must be in close proximity to an export cable, array cable or interconnector cable for an interaction to occur.

There are three anchoring scenarios which are considered for this hazard:

- Planned anchoring – most likely as a vessel awaits a berth to enter port but may also result from adverse weather conditions, machinery failure or sub-sea operations;
- Unplanned anchoring – generally resulting from an emergency situation where the vessel has experienced steering failure; and
- Anchor dragging – caused by anchor failure.

Although the second of these scenarios may involve limited decision-making time if drifting towards a hazard, in all three scenarios it is anticipated that the charting of infrastructure including the sub-sea cables will inform the decision to anchor, as per Regulation 34 of SOLAS (IMO, 1974).

No anchored vessels were identified within the vessel traffic survey data assessed, and no anchorages (preferred or charted) were identified in immediate proximity to the Offshore Project. Risk of interaction on a planned anchoring or dragged anchoring basis is therefore anticipated to be low. In terms of emergency anchoring, any areas of high traffic volume are likely to represent the areas of highest risk, particularly where there are hazards nearby (e.g., structures, rocks, shallows).

The likelihood of anchor interaction with a subsea cable is further minimised by the burial of the cables and use of external cable protection where required, which will be informed by the cable burial risk assessment process, which will account for traffic volumes and sizes. It is noted that the CA indicated limited concerns with the export cables from a recreational perspective during the hazard workshop.

Should an anchor interaction incident occur, the most likely consequences will be low based on historical anchor interaction incidents, with no damage incurred to the cable or the vessel. As an unlikely worst case, a snagging incident could occur and/or the vessel's anchor and the cable could be damaged, and lead to risk of loss of stability of a small vessel. However, with the mitigation measures above in place, this risk will be minimised.

18.2.5.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Cable burial risk assessment;
- Compliance with MGN 654;
- Marking on charts; and
- Promulgation of information.

18.2.5.3 Frequency of Occurrence

The frequency of occurrence is considered to be **negligible**.

18.2.5.4 Severity of Consequence

The severity of consequence is considered to be **minor**.

18.2.5.5 Significance Of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Negligible	Minor	Broadly Acceptable

Overall, it is predicted that the significance of risk due to increased interaction with subsea cables is of **Broadly Acceptable** significance.

18.2.6 Adverse Weather Routeing

18.2.6.1 Qualification of Risk

The need to consider routeing in adverse weather conditions was highlighted by the MCA during consultation, and certain vessel operators indicated that the presence of the OAA may limit routeing options in adverse conditions (see Section 4). Based on review of the input received, it is likely that no commercial vessels would choose to make transit through the OAA during adverse weather conditions and will instead choose to pass either offshore of the OAA i.e., north of the Sule Skerry, or inshore to the south depending on destination. Larger deviations may be required than during more favourable conditions (e.g., vessels may choose to increase passing distance from the OAA or the Sule Skerry), however there is considered to be sufficient searoom to safely accommodate the chosen transits. Further, it is noted that any adverse weather routeing preferences accounting for the OAA are likely to be established during the construction stage.

Input from Scotline was that their vessels may "tack[8]" through the area under adverse conditions, noting one example of this behaviour was identified in the long term AIS (see Section 12). Post OWF there will be less seaspace available for this behaviour, however there is considered to be sufficient searoom to safely accommodate shorter more frequent tacks.

The promulgation of information relating to construction activities, lighting and marking, and charting of infrastructure will allow vessel Masters to passage plan in advance accounting for forecast adverse weather conditions.

18.2.6.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- DSLP approval;
- LMP;
- Marking on charts; and
- Promulgation of information.

18.2.6.3 Frequency of Occurrence

The frequency of occurrence is considered to be **remote**.

[8] 'Tack' to change course by turning a vessel's bow into and through the wind.

18.2.6.4 Severity of Consequence

The severity of consequence is considered to be **serious** due to potential safety concerns if vessels routeing options during adverse weather are restricted.

18.2.6.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Remote	Serious	Tolerable

Overall, it is predicted that the significance of risk due to adverse weather routeing is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.2.7 Reduced Access to Local Ports and Harbours

18.2.7.1 Qualification of Risk

Up to 468 return trips per year by operation and maintenance vessels may be made throughout the operation and maintenance stage and will include vessels which are RAM. As per the construction stage, Project vessels will be managed by marine coordination, carry AIS and be compliant with relevant Flag State regulations.

Based on experience at existing operational OWFs, it is anticipated that commercial vessels will generally choose not to navigate internally within the OAA. Therefore, the anticipated deviations for the main commercial routes defined for the construction stage (around the buoyed construction area) are directly applicable for the operation and maintenance stage.

As noted for the equivalent construction stage impact, the closest port or harbour to the OAA is Stromness Harbour (20 nm) (37 km), with Scrabster harbour 22 nm (40.7 km) from the OAA. Again, given the relative distance to ports in the area and the anticipated deviations for the main commercial routes, it is not anticipated that there will be any substantial effect on vessel approaches to and from local ports above and beyond the deviations outlined for the vessel displacement impact. This aligns with feedback received during the hazard workshop.

The closest port/harbour to the offshore ECC is Scrabster, located 5 nm (9.3 km) to the east of the landfall. On this basis it is considered unlikely that cable maintenance activities would have any impact on port access, noting any such activity would be infrequent.

The most likely consequences of the impact are as per the equivalent construction stage impact, namely increased journey times and distances. No effect is anticipated on port related services such as pilotage.

18.2.7.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- LMP;
- Marine coordination;
- Marking on charts;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

18.2.7.3 Frequency Of Occurrence

The frequency of occurrence for reduced access to local ports and harbours is considered to be **frequent**.

18.2.7.4 Severity of Consequence

The severity of consequence for reduced access to local ports and harbours is considered to be **negligible**.

18.2.7.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Frequent	Negligible	Tolerable

Overall, it is predicted that the significance of risk due to impacts on port access is of **Tolerable** significance.

18.2.8 Reduction of Emergency Response Provision Including SAR Capability

18.2.8.1 Qualification of Risk

Presence of structures, increased vessel activity and personnel numbers may reduce emergency response capability by increasing the number of incidents, increase consequences or reducing access for the responders.

Given the distances that may be covered by air-based SAR support (the SAR helicopter base at Stornoway is located approximately 67 nm (124 km) from the OAA), the spatial extent of this hazard is considered reasonably large. The OAA covers approximately 192 nm^2 (657 km^2) which represents a large area to search compared to other OWFs. However, it is unlikely that a SAR operation will require the entire OAA to be searched; it is much more likely that a search could be restricted to a smaller area within which a casualty is known to be located (noting account of assumptions on any potential drift of the casualty).

Up to 468 return trips per year by operation and maintenance vessels may be made throughout the operation and maintenance stage. It is assumed that operation and maintenance vessels will be on-site throughout the majority of the operation and maintenance stage, although it is noted that there may be instances of severe weather conditions where they may be withdrawn. The presence of such vessels will increase the likelihood of an incident and subsequently increase the likelihood of multiple incidents occurring simultaneously, diminishing emergency response capability. As an unlikely worst case, the consequences of such a situation could include a failure of emergency response to an incident, resulting in a PLL and pollution.

However, with project vessels to be managed through marine coordination and compliance with Flag State regulations, the likelihood of an incident is minimised. Additionally, should an incident occur, project vessels would likely be well equipped to assist, either through self-help capability or through SOLAS obligations (IMO, 1974), noting this would be undertaken in liaison with the MCA. The MPCP will also be implemented to minimise the environmental risks of any incident involving pollution.

From recent SAR helicopter taskings data, the frequency of SAR operations in proximity to the offshore Project is low, with no SAR helicopter incidents occurring within the OAA. The frequency of SAR operations in proximity to the OAA is not anticipated to change markedly from the current level given the measures noted above which will be in place. The layout will be agreed through the DSLP process including consultation with the MCA and in line with MGN 654 requirements to ensure any SAR operations that do occur within the OAA are facilitated. Additionally, an ERCoP will be submitted to the MCA in line with the requirements of MGN 654 (MCA, 2021), and a SAR checklist will be completed and agreed with the MCA.

18.2.8.2 Relevant Embedded Mitigation Measures

The embedded mitigation measures which have been identified as relevant to reducing risk are as follows:

- Compliance with MGN 654;
- Guard vessel(s) as required by risk assessment;
- DSLP approval;
- Marine coordination;
- MPCP; and
- Project vessel compliance with international marine regulations.

18.2.8.3 Frequency of Occurrence

The frequency of occurrence is considered extremely **unlikely**.

18.2.8.4 Severity of Consequence

The severity of consequence is considered **moderate**.

18.2.8.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Extremely unlikely	Moderate	Broadly Acceptable

Overall, it is predicted that the significance of risk due to reduction of emergency response provision including SAR capability is of **Broadly Acceptable** significance.

18.3 Decommissioning Stage

18.3.1 Vessel Displacement and Increased Third-Party Vessel to Vessel Collision Risk

18.3.1.1 Qualification And Quantification of Risk

Decommissioning activities associated with the removal of structures and cables may displace existing routes/activity and increase encounters and collision risk with other third-party vessels.

Since the methods used to remove structures and subsea cables are expected to be similar to those used to install them, this hazard is expected to be similar in nature to the equivalent construction stage hazard (see Section 18.1.1). It is noted that in the case of subsea cables sections may be left in situ to avoid unnecessarily disturbing the seabed. This would be confirmed through consultation and assessment to ensure the most suitable approach was taken. But for the purposes of this assessment (as a worst-case) it has been assumed that all subsea cables will be removed during decommissioning with only cable protection left in situ.

The use of a buoyed decommissioning area analogous to the buoyed construction area is assumed and will result in similar main route deviations to those established for the equivalent construction stage hazard.

18.3.1.2 Relevant Embedded Mitigation Measures

Analogous to construction stage (see Section 18.1.1.1.2 and Section 18.1.1.2.1).

18.3.1.3 Frequency of Occurrence

The frequency of occurrence is considered to be **frequent** for vessel displacement, and **extremely unlikely** for third party vessel to vessel collision risk.

18.3.1.4 Severity of Consequence

The severity of consequence is considered to be **negligible** for vessel displacement and **serious** for third party vessel to vessel collision risk.

18.3.1.5 Significance of Risk

Hazard component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Vessel displacement	Frequent	Negligible	Tolerable
Third party vessel to vessel collision risk	Extremely Unlikely	Serious	Tolerable

Overall, it is predicted that the significance of risk due to vessel displacement is of **Tolerable** significance. As per Section17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.3.2 Third-Party to Project Vessel Collision Risk

18.3.2.1 Qualification of Risk

Vessels associated with decommissioning activities may increase encounters and collision risk for other vessels already operating in the area.

Since the methods used to remove structures and subsea cables are expected to be similar to those used to install them, including the vessels involved, this hazard is expected to be similar in nature to the equivalent construction stage hazard (see Section 18.1.2), including the number of return trips by decommissioning vessels. It is noted that in the case of sub-sea cables it is expected that they will be left in situ but for the purposes of this assessment (as a worst-case) it has been assumed that all cables will be removed during decommissioning, with only cable protection left in situ.

18.3.2.2 Relevant Embedded Mitigation Measures

Analogous to construction stage (see Section 18.1.2.2).

18.3.2.3 Frequency of Occurrence

The frequency of occurrence is considered to be **extremely unlikely**.

18.3.2.4 Severity of Consequence

The severity of consequence is considered to be **serious**.

18.3.2.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Extremely unlikely	Serious	Tolerable

Overall, it is predicted that the significance of risk due to increased third-party to project vessel collision risk is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.3.3 Creation of Vessel to Structure Allision Risk

18.3.3.1 Qualification of risk

It is likely that allision risk during decommissioning will be similar to that observed for the construction stage (Section 18.1.4), noting similar scenarios on-site, including partially removed structures within a buoyed decommissioning area.

18.3.3.2 Frequency of Occurrence

As per Section 18.1.4, worst-case frequency of occurrence is **remote**.

18.3.3.3 Severity of Consequence

As per Section 18.1.4, worst-case severity of consequence is **moderate**.

18.3.3.4 Significance of Risk

Component	Frequency of Occurrence	Severity of Consequence	Significance of Risk
Powered allision risk	Extremely unlikely	Moderate	Broadly Acceptable
Drifting allision risk	Extremely unlikely	Moderate	Broadly Acceptable
Internal allision risk	Remote	Moderate	Tolerable

Overall, it is predicted that the significance of risk due to creation of vessel to structure allision risk is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.3.4 Adverse Weather Routeing

18.3.4.1 Qualification of Risk

As with the construction and operations and maintenance stages, it is likely that no commercial vessels would choose to make transit through the OAA during adverse weather conditions and will instead choose to pass either offshore of the OAA i.e., north of the Sule Skerry, or inshore to the south depending on destination. This impact is therefore considered analogous to the construction stage impact.

18.3.4.2 Relevant Embedded Mitigation Measures

Analogous to construction stage (see Section 18.1.3.2).

18.3.4.3 Frequency of Occurrence

The frequency of occurrence is considered to be **remote**.

18.3.4.4 Severity of Consequence

The severity of consequence is considered to be **serious**.

18.3.4.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Remote	Serious	Tolerable

Overall, it is predicted that the significance of risk due to adverse weather routeing is of **Tolerable** significance. As per Section 17, embedded mitigation includes layout approval via the DSLP process, however it considered that once site constraints are further understood, additional post consent consultation is required with the MCA in advance of the DSLP process to ensure the overarching spatial area covered by the layout is appropriate. Assuming this mitigation the risk is considered ALARP.

18.3.5 Reduced Access to Local Ports and Harbours

18.3.5.1 Qualification of Risk

Decommissioning activities associated with the removal of structures and cables may displace existing routes/activity restricting access to ports/harbours.

Since the methods used to remove structures and subsea cables are expected to be similar to those used to install them, this hazard is expected to be similar in nature to the equivalent construction stage hazard, including the number of return trips by decommissioning vessels. It is noted that in the case of sub-sea cables it is expected that they will be left in situ but for the purposes of this assessment (as a worst-case) it has been assumed that all cables will be removed during decommissioning, with only cable protection will be left in situ.

As with the construction stage, it is not yet known from which port(s) decommissioning activity will be based for the offshore Project.

18.3.5.2 Relevant Embedded Mitigation Measures

Analogous to construction stage (see Section 18.1.5.2).

18.3.5.3 Frequency of Occurrence

The frequency of occurrence for reduced access to local ports and harbours is considered to be **frequent**.

18.3.5.4 Severity of Consequence

The severity of consequence for reduced access to local ports and harbours is considered to be **negligible**.

18.3.5.5 Significance of Risk

Frequency of Occurrence	Severity of Consequence	Significance of Risk
Frequent	Negligible	Tolerable

Overall, it is predicted that the significance of risk due to reduced access to local ports is of **Tolerable** significance.

19 Cumulative Risk Assessment

19.1 Vessel Displacement and Increased Third-Party Vessel to Vessel Collision Risk

Based on the cumulative assessment of vessel routeing (see Section 15.5), two routes are expected to deviate on a cumulative basis, namely Routes 4 and 7. It is anticipated that these routes will pass south of both Northland Mhairi and the OAA, leading to journey distance percentage increases of between 1 and 2% (noting these assumptions include worst case deviations accounting for local rock and shallow features). There is considered to be searoom available to safely accommodate these deviations, noting that the PFOWF is located in excess of 10 nm (18.5 km) south of the OAA. Further the routes are used by a low number vessels (0-1 per day).

Any cumulative displacement associated with simultaneous operations with the SHET-L Caithness to Orkney Link installation will be temporary and spatially limited to the areas around the works noting there will be available searoom to safely accommodate any such deviations.

Under the Space Industries Regulations 2021 and the Space Industry Act 2018, the Space Hub Sutherland developer will be required to implement exclusion zones during launches. The developer would not have powers under this legislation to formally prohibit vessels from entry into such exclusion zones, however entry before and during launches would be advised against. On this basis there may be some cumulative displacement associated with the Space Hub Sutherland. However, frequency of any such cumulative displacement is low, with only up to 12 launches a year anticipated. Further, the Space Hub Sutherland operator will be responsible for defining the exclusion zones extent with consideration for navigational impacts, and to notify mariners of the associated details.

In terms of collision risk, again given the low volume of traffic and available searoom to accommodate the deviations, there is not anticipated to be a large change in terms of third party to third party collision.

On this basis, accounting for the size of the overall cumulative area assessed, cumulative displacement is assessed as being of **serious** severity of consequence in terms of navigational safety given the potential for collision but of **negligible** frequency of occurrence, meaning significance is **broadly acceptable**.

19.2 Increased Third-Party to Project Vessel Collision Risk

There is the potential that the same ports or similarly located ports could be used by cumulative developments in terms of base ports for construction, maintenance vessels, and or decommissioning vessels. On this basis, there may be an overall cumulative increase in project vessel presence within the general area, and as such the potential for increased encounters and collision risk with third party traffic. However, all developers (including the SHET-L Caithness to Orkney Link) should be establishing appropriate vessel management systems including through marine coordination, and as such any encounters will be managed, including by COLREGS and SOLAS.

On this basis, when taking account of the size of the cumulative area assessed, the cumulative increase in collision risk (third party to project vessel) is assessed as being of **serious** consequence in terms of navigational safety but of **negligible** occurrence, meaning significance is **broadly acceptable**.

19.3 Vessel to Structure Allision Risk

The nearest screened in cumulative development is the PFOWF, located in excess of 10 nm (18.5 km) south of the OAA and 1 nm (1.9km) southwest of the offshore ECC. All other screened in OWF developments are in excess of 25 nm (46.3 km) from the OAA. Given this available sea space between the OAA and the screened in developments, it is unlikely that vessels will experience increased allision risk beyond the localised risk when passing any given development.

All developments will be required to implement marine lighting and marking in agreement with NLB and in compliance with IALA G1162 (IALA, 2021), meaning the localised risk is managed.

On this basis, taking into account the size of the overall cumulative area assessed, cumulative increase in allision risk is assessed as being of **serious** consequence in terms of navigational safety but of **negligible** occurrence, meaning significance is **broadly acceptable**.

19.4 Reduction of Under-Keel Clearance

On a cumulative basis, the Flotta Hydrogen Hub transmission connection and the SHET-L Caithness to Orkney Link have both been screened into the cumulative assessment noting close proximity to and crossing (respectively) of the offshore ECC.

Impacts associated with under keel clearance tend to be localised to individual cables, in particular in areas where water depths are low (e.g., landfalls). As per the in isolation assessment (see section 18.2.4), the localised risk from the offshore Project will be managed via MGN 654 compliance in terms of limiting any reductions in charted water depth to less than a 5% change unless agreed otherwise with the MCA. The same mitigations will apply for other subsea cable developments (including the SHET-L Caithness to Orkney Link).

On this basis, cumulative reduction in underkeel clearance is assessed as being of **moderate** consequence in terms of navigational safety but of **negligible** occurrence, meaning significance is **broadly acceptable**.

19.5 Interaction with Subsea Cables

As for the cumulative assessment of underkeel clearance reduction (see Section 19.4), the risk of anchor interaction is considered localised to individual cables. The cable burial risk assessment undertaken by the Project will ensure cable burial and protection is suitable including account of existing cables, with similar assessments being required to be undertaken by any other subsea cable developments.

Baseline anchoring activity is low in the area, and therefore any interaction is more likely to occur following an unplanned (emergency) anchoring event. Consideration of vessel traffic volumes and sizes will feed into the cable burial risk assessment processes to ensure burial / protection is suitable.

On this basis, cumulative anchor interaction risk is assessed as being of **min**or consequence in terms of navigational safety and of **negligible** occurrence, meaning significance is **broadly acceptable.**

19.6 Reduction of Emergency Response Capability

Given baseline incident rates, and noting the additional resources that would be available for the Project and other cumulative developments, there is not considered likely to be a notable effect on emergency response resources on a cumulative level. This takes account of historical data showing that allisions and collisions caused by OWFs do not occur at a high frequency (see Section 9.6).

Under MGN 654, all OWF developments will be required to agree a layout with the MCA to ensure suitable SAR access is available. As such no cumulative impact on SAR access is anticipated noting SAR operations are likely to be localised to individual areas (i.e., unlikely to span both the Project and other cumulative developments given the nearest screened in development is in excess of 10 nm (18.5 km) from the OAA).

On this basis, cumulative impacts on emergency response capability are assessed as being of **moderate** consequence and of **extremely unlikely** frequency of occurrence, meaning the significance is **broadly acceptable**.

20 Risk Control Log

Table 20.1 presents a summary of the risk assessment of shipping and navigation hazards. This includes (per hazard) the proposed embedded mitigation measures, frequency of occurrence, severity of consequence, and resulting significance of risk.

Any additional mitigation measures proposed are then listed per hazard alongside the residual risk.

Table 20.1 Risk Control Log

Hazard	Stage	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
Vessel displacement and increased collision risk	Construction	▪ DSLP approval; ▪ LMP; ▪ Marking on charts; and ▪ Promulgation of information.	Extremely Unlikely	Serious	**Tolerable**	▪ Post consent consultation is required with the MCA in advance of the DSLP process	**Tolerable with Mitigation**
	O&M		Extremely Unlikely	Serious	**Tolerable**		**Tolerable with Mitigation**
	Decommissioning		Extremely Unlikely	Serious	**Tolerable**		**Tolerable with Mitigation**
	Cumulative		Negligible	Serious	**Broadly Acceptable**		**Broadly Acceptable**
Third-party with project vessel collision risk	Construction	▪ Application for safety zones; ▪ Guard Vessel(s) as required by risk assessment; ▪ DSLP approval; ▪ LMP; ▪ Marine coordination; ▪ MPCP; ▪ Marking on charts;	Extremely Unlikely	Serious	**Tolerable**	▪ Post consent consultation is required with the MCA in advance of the DSLP process	**Tolerable with Mitigation**
	O&M		Extremely Unlikely	Serious	**Tolerable**		**Tolerable with Mitigation**
	Decommissioning		Extremely Unlikely	Serious	**Tolerable**		**Tolerable with Mitigation**
	Cumulative		Negligible	Serious	**Broadly Acceptable**		**Broadly Acceptable**

Hazard	Stage	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
		▪ Project vessel AIS transmission; ▪ Project vessel compliance with international marine regulations; ▪ Promulgation of information; and ▪ Navigational Safety and Vessel Management Plan.					
Creation of vessel to structure allision risk	Construction	▪ DSLP approval; ▪ LMP; ▪ MPCP; ▪ Marking on charts; ▪ Promulgation of information; ▪ Guard Vessel(s) as required by risk assessment; ▪ Project vessel compliance with international marine regulations. ▪ Application for safety zones;	Remote	Moderate	**Tolerable**	▪ Post consent consultation is required with the MCA in advance of the DSLP process	**Tolerable with Mitigation**
	O&M		Remote	Moderate	**Tolerable**		**Tolerable with Mitigation**
	Decommissioning		Remote	Moderate	**Tolerable**		**Tolerable with Mitigation**
	Cumulative		Negligible	Serious	**Broadly Acceptable**		**Broadly Acceptable**

Hazard	Stage	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
		▪ Compliance with MGN 654; ▪ FLO and FMMS; and ▪ Minimum blade clearance.					
Changes in under keel clearance	O&M	▪ Cable burial risk assessment; ▪ Compliance with MGN 654; ▪ MPCP; ▪ FLO and FMMS; ▪ Marking on charts; and ▪ Promulgation of information.	Negligible	Moderate	**Broadly Acceptable**	N/A	**Broadly Acceptable**
Increased interaction with subsea cables	O&M	▪ Cable burial risk assessment; ▪ Compliance with MGN 654; ▪ Marking on charts; and ▪ Promulgation of information.	Negligible	Minor	**Broadly Acceptable**	N/A	**Broadly Acceptable**

Hazard	Stage	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
	Cumuylative		Negligible	Minor	**Broadly Acceptable**	N/A	**Broadly Acceptable**
Adverse weather routeing	Construction	▪ DSLP approval; ▪ LMP; ▪ Marking on charts; and ▪ Promulgation of information.	Remote	Serious	**Tolerable**	▪ Post consent consultation is required with the MCA in advance of the DSLP process	**Tolerable with Mitigation**
	O&M		Remote	Serious	**Tolerable**		**Tolerable with Mitigation**

Hazard	Stage	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
	Decommissioning		Remote	Serious	**Tolerable**		**Tolerable with Mitigation**
Reduced access to local ports and harbours	Construction	▪ LMP; ▪ Marine coordination; ▪ Marking on charts; ▪ Project vessel compliance with international marine regulations; and ▪ Promulgation of information.	Frequent	Negligible	**Tolerable**	N/A	**Tolerable with Mitigation**
	O&M		Frequent	Negligible	**Tolerable**		**Tolerable with Mitigation**
	Decommissioning		Frequent	Negligible	**Tolerable**		**Tolerable with Mitigation**
Reduction of emergency response capability	O&M	▪ Compliance with MGN 654; ▪ Guard vessel(s) as required by risk assessment; ▪ DSLP approval; ▪ Marine coordination; ▪ MPCP; and ▪ Project vessel compliance with international marine regulations.	Extremely Unlikely	Moderate	**Broadly Acceptable**	N/A	**Broadly Acceptable**

Hazard	Stage	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
	Cumulative		Extremely Unlikely	Moderate	**Broadly Acceptable**	N/A	**Broadly Acceptable**

21 Through Life Safety Management

21.1 Quality, Health, Safety and Environment

Quality, Health, Safety and Environment (QHSE) documentation including a Safety Management System (SMS) will be in place for the offshore Project and will be continually updated throughout the development process. The following subsections provide an overview of this documentation and how it will be maintained and reviewed with reference, where required, to specific marine documentation.

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.

21.2 Incident Reporting

After any incidents, including near misses, an incident report form will be completed in line with the offshore Project QHSE documentation. This will then be assessed for relevant outcomes and reviewed for possible changes required to operations.

The Project will maintain records of investigation and analyse incidents in order to:

- Determine underlying deficiencies and other factors that may be causing or contributing to the occurrence of incidents;
- Identify the need for corrective action;
- Identify opportunities for preventative action;
- Identify opportunities for continual improvement; and
- Communicate the results of such investigations.

All investigations shall be performed in a timely manner.

A database (lessons learnt) of all marine incidents will be developed. It will include the outcomes of investigations and any resulting actions. The Project will promote awareness of their potential occurrence and provide information to assist monitoring, inspection and auditing of documentation.

When appropriate, the designated person (noted within the Emergency Response Cooperation Plan (ERCoP)) should inform the MCA of any exercise or incidents including any implications on emergency response. If required, the MCA should be invited to take part in incident debriefs.

21.3 Review of Documentation

The Project will be responsible for reviewing and updating all documentation including the risk assessments, ERCoP, SMS and, if required, will convene a review panel of stakeholders to quantify risk.

Reviews of the risk register should be made after any of the following occurrences:

- Changes to the development, conditions of operation and prior to decommissioning;
- Planned reviews; and
- Following an incident or exercise.

A review of potential risks should be carried out annually. A review of the response charts should be undertaken annually to ensure that response procedures are up to date and should include any amendments from audits, incident reports and identified deficiencies.

21.4 Inspection of Resources

All vessels, facilities, and equipment necessary for marine operations are to be subject to appropriate inspection and testing to determine fitness for purpose and availability in relation to their performance standards. This will include monitoring and inspection of all aids to navigation to determine compliance with the performance standards specified by NLB.

21.5 Audit Performance

Auditing and performance review are the final steps in QHSE management systems. The feedback loop enables an organisation to reinforce, maintain and develop its ability to reduce risks to the fullest extent, and to ensure the continued effectiveness of the system. The Project will carry out audits and periodically evaluate the efficiency of the marine safety documentation.

The audits and possible corrective actions should be undertaken in accordance with standard procedures and results of the audits and reviews should be brought to the attention of all personnel having responsibility in the area involved.

21.6 Safety Management System

An integrated SMS, which ensures that the safety and environmental risks of those activities are ALARP, will be established. This includes the use of remote monitoring and switching for aids to navigation to ensure that if a light is faulty a quick fix can be instigated, which will allow IALA availability requirements to be met.

21.7 Cable Monitoring

The subsea cable routes will be subject to periodic inspection post-construction to monitor the cable protection, including burial depths. Maintenance of the protection will be undertaken as necessary.

If exposed cables or ineffective protection measures are identified during post-construction monitoring, these would be promulgated to relevant sea users including via Notice to Mariners and Kingfisher Bulletins. Where immediate risk was observed, the Project would also employ additional temporary measures (such as a guard vessel or temporary buoyage) until such time as the risk was permanently mitigated.

Details will be included in full within the assessment of cable burial and protection document, to be produced post-consent.

21.8 Hydrographic Surveys

As required by Annex 4 of MGN 654, detailed and accurate hydrographic surveys will be undertaken periodically at intervals agreed with the MCA.

21.9 Decommissioning Plan

A Decommissioning Plan will be developed post consent. With regards to hazards to shipping and navigation, this will also include consideration of the scenario where upon decommissioning and completion of removal operations, an obstruction is left on-site (attributable to the offshore Project) which is considered to be a danger to navigation and which it has not proved possible to remove. Such an obstruction may require marking until such time as it is either removed or no longer considered a danger to navigation, the continuing cost of which would need to be met by the Project. The Decommissioning Plan will be based on good decommissioning offshore wind farm practices at the time of decommissioning.

22 Summary

22.1 Consultation

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, and a Hazard Workshop. Key stakeholders consulted include:

- MCA;
- NLB;
- UK Chamber of Shipping;
- RYA Scotland;
- CA;
- Orkney Islands Council Harbour Authority;
- Scrabster Harbour;
- Orkney Fisheries Association;
- Scottish White Fish Production Association;
- Serco Northlink; and
- DFDS Seaways.

22.2 Existing Environment

22.2.1 Navigational Features

Key navigational features in the area include the nearby ATBA surrounding Orkney. The closest port or harbour is Stromness Harbour, located approximately 20 nm to the east, on the mainland Orkney coast. There is one charted wreck located within the OAA (noting none were detected in geophysical surveys). Shallow waters at Sule Skerry are present approximately 2.5 nm northwest of the OAA, with Sule Stack 3.6 nm to the west. Two military firing areas are located immediately west of the OAA, and a number of preferred anchorages are located to the south.

22.2.2 Maritime Incidents

From DfT SAR helicopter taskings data recorded between April 2015 and March 2022, there was an average of one SAR tasking per year within the offshore study area. There was one SAR tasking within the offshore ECC study area.

Within the offshore study area there was an average of one unique RNLI incident per year with machinery failure (27%) and person in danger (18%) the most frequently recorded incident types. One incident was responded to by the RNLI within the OAA itself.

Within the offshore ECC study area there was again an average of one unique RNLI incident per year with machinery failure (67%) and person in danger (22%) the most frequently recorded incident types. Three incidents were responded to by the RNLI within the offshore ECC itself.

Within the offshore study area there was an average of one to two unique MAIB incidents per year with machinery failure (40%), accident to person (13%), and loss of control (13%) the most frequently recorded incident types. Three incidents were recorded by the MAIB within the OAA itself.

Within the offshore ECC study area there was an average of one unique MAIB incident every two to three years, composed of two accidents to person, one instance of grounding, and one of machinery failure. One incident was recorded by the MAIB within the offshore ECC itself.

22.2.3 Vessel Traffic Movements

22.2.3.1 OAA

From the 28-days of vessel traffic survey data recorded in August and December 2022 within the offshore study area, there was an average of 23 unique vessels per day recorded within the offshore study during the summer survey period, with an average of six to seven unique vessels recorded within the OAA. During the winter survey period, an average of 18 unique vessels were recorded within the offshore study area per day with an average of five to six within the OAA. Approximately 28% of all vessel traffic across the 28-days intersected the OAA.

The main vessel types within the offshore study area during the summer survey period were cargo vessels (54%) and fishing vessels (15%). The main vessel types within the offshore study area during the winter survey period were also cargo vessels (47%) and fishing vessels (29%).

22.2.3.2 Offshore ECC

During the 28-days of AIS only vessel traffic data from August and December 2022 within the offshore ECC study area, there was an average of 15 unique vessels per day recorded within the offshore ECC study during the summer data period, with an average of 14 to 15 unique vessels recorded within the offshore ECC. During the winter survey period, an average of 13 unique vessels were recorded within the offshore ECC study area per day with an average of 12 to 13 within the offshore ECC. Approximately 95% of all vessel traffic across the 28-days intersected the offshore ECC.

The main vessel types within the offshore ECC study area during the summer data period were cargo vessels (65%) and fishing vessels (9%). The main vessel types within the offshore ECC study area during the winter data period were also cargo vessels (58%) and fishing vessels (13%).

22.2.3.3 Main Commercial Vessel Routes

A total of 12 main commercial routes were identified from the vessel traffic survey data. The highest use main commercial routes were between Belfast and Baltic ports; between Canadian ports and Hamburg; between Mersey ports and Danish ports; between Reykjavik and Humber ports; and between Belfast and Kattegat – each of these routes with an average of four unique vessels per week.

22.3 Future Case Vessel Traffic

Of the 12 main routes identified, it is anticipated that four will deviate as a result of the OAA. The largest percentage increase in terms of overall change in route length was to Routes 12, with a 2.84% increase. The largest change on an absolute basis was to Route 7, with a 9.62 nm increase; however, this is a transatlantic route, and as such this represented a small change on a relative percentage basis.

22.4 Collision and Allision Risk Modelling

The NRA process included quantitative modelling of the change in allision and collision frequency as a result of the offshore Project, with consideration given to future cases in terms of potential future traffic increases.

It was estimated that the return period of a vessel being involved in a collision post wind farm was 491 years assuming base case traffic levels. This represents a 34% increase in collision frequency compared to the pre wind farm base case result.

The powered allision return period post wind farm was estimated at 1,283 years assuming base case traffic levels. The corresponding drifting allision return period post wind farm was estimated at 6,640 years. The fishing vessel allision return period was estimated at 9.9 years.

22.5 Risk Statement

Overall, the risk assessment concluded that there will be no significant risks arising from the Project in isolation with embedded mitigations in place during the construction, operation and maintenance or decommissioning stages, assuming the implementation of additional mitigation where appropriate as identified by the FSA (see Section 17.2). The cumulative risk assessment concluded that there will be no significant cumulative risks arising from the Project in combination with cumulative developments with embedded mitigations in place during the construction, operation and maintenance or decommissioning stages

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24 Abbreviations Table

Abbreviation	Definition
AC	Alternating Current
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ALB	All-Weather Lifeboat
ARPA	Automatic Radar Plotting Aid
ASV	Autonomous Surface Vehicle
ATBA	Area to be Avoided
BWEA	British Wind Energy Association
CA	Cruising Association
CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CD	Chart Datum
CfD	Contract for Difference
CHIRP	Confidential Human Factors Incident Reporting Programme
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
CTV	Crew Transfer Vessel
DC	Direct Current
DF	Direction Finding
DfT	Department for Transport
DSC	Digital Selective Calling
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMEC	European Marine Energy Centre
EMF	Electromagnetic Field
ERCoP	Emergency Response Cooperation Plan
ESRI	Environmental Systems Research Institute
ETRS89	European Terrestrial Reference System 1989
EU	European Union
FSA	Formal Safety Assessment
GIS	Geographical Information System
GLA	General Lighthouse Authority
GMDSS	Global Maritime Distress and Safety System

Abbreviation	Definition
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
GT	Gross Tonnes
HAT	Highest Astronomical Tide
HF	High Frequency
HMCG	His Majesty's Coastguard
HSE	Health, Safety, and Environment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ILB	Inshore Lifeboat
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structure
JRCC	Joint Rescue Coordination Centre
kHz	Kilohertz
km	Kilometres
km^2	Square Kilometres
kt	Knot
LAT	Lowest Astronomical Tide
LOA	Length Overall
m	Metre
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
WCS	Worst Case Scenario
MEPC	Marine Environment Protection Committee
Metocean	Meteorological Ocean
MF	Medium Frequency
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MOD	Ministry of Defence
MPCP	Marine Pollution Contingency Plan
MRCC	Maritime Rescue Coordination Centre
MSC	Maritime Safety Committee

Abbreviation	Definition
MSI	Maritime Safety Information
NAVTEX	Navigational Telex
NLB	Northern Lighthouse Board
nm	Nautical Mile
nm^2	Square Nautical Mile
NRA	Navigational Risk Assessment
OAA	Option Agreement Area
OREI	Offshore Renewable Energy Installation
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PDE	Project Design Envelope
PLA	Port of London Authority
PLL	Potential Loss of Life
QHSE	Quality, Health, Safety, and Environment
Racon	Radar Beacon
Radar	Radio Detection and Ranging
REZ	Renewable Energy Zone
RNLI	Royal National Lifeboat Institution
RoPax	Roll-on/Roll-off Passenger
RoRo	Roll-on/Roll-off Cargo
ROV	Remotely Operated Vehicle
RYA	Royal Yachting Association
SAR	Search and Rescue
SCADA	Supervisory Control and Data Acquisition
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea
SONAR	Sound Navigation Ranging
SOV	Service Operations Vessel
SPS	Significant Peripheral Structure
TCE	The Crown Estate
TSS	Traffic Separation Scheme
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency

Abbreviation	Definition
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service
WGS84	World Geodetic System 1984
WTG	Wind Turbine Generator
WTW	Walk-to-Work

Appendix A Marine Guidance Note 654 Checklist

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.

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	Reference and Notes
Site and Installation Co-ordinates. 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' use, appropriate 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 for the OAA (see 10.1) and ECC (see Section 10.2) study areas.
At least 28 days duration, within either 12 or 24 months prior to submission of the ES.	✓	**Section 5.2: Vessel Traffic Surveys** A total of 28 full days of vessel traffic survey data from August and November 2022 has been assessed within the OAA and ECC study areas.
Multiple data sources	✓	**Section 5.2: Vessel Traffic Surveys** The vessel traffic survey data includes AIS, visual observations and radar for the summer and winter periods in order to ensure maximal coverage of vessels not broadcasting on AIS. **Section 5: Data Sources** Additional data sources including the long term AIS data and consultations input have also been considered.
Seasonal variations	✓	**Section 5.2: Vessel Traffic Surveys** A total of 28 full days of vessel traffic survey data from August and November 2022 has been assessed within OAA and ECC study areas. **Section 5: Data Sources** Additional long term data sources including the long term AIS data have also been considered.

Issue	Compliance	Reference and Notes
MCA consultation	✓	**Section 4: Consultation** The MCA has been consulted as part of the NRA process including through the Hazard Workshop.
General Lighthouse Authority (GLA) consultation	✓	**Section 4: Consultation** NLB has been consulted as part of the NRA process including through the Hazard Workshop.
UK Chamber of Shipping consultation	✓	**Section 4: Consultation** The UK Chamber of Shipping has been consulted as part of the NRA process including through the Hazard Workshop.
Recreational and fishing vessel consultation	✓	**Section 4: Consultation** The CA, Orkney Fisheries Association, and the Scottish White Fish Production Association have been invited to consult as part of the NRA process including through the Hazard Workshop. Extensive fisheries consultation through the Project Fisheries Working Group.
Port and navigation authorities consultation, as appropriate	✓	**Section 4: Consultation** Orkney Islands Council Harbour Authority and Scrabster Harbour have been consulted as part of the NRA process including through the Hazard Workshop.
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 offshore Project has been analysed.
ii. Numbers, types and sizes of vessels presently using such areas.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the offshore Project has been analysed and includes breakdowns of daily vessel count, vessel type and vessel size.
iii. Non-transit uses of the area, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, personal watercraft etc.	✓	**Section 7: Navigational Features** There are no marine aggregate dredging areas in proximity to the offshore Project. **Section 10: Vessel Traffic Movements** Non-transit users were identified in the vessel traffic survey data and included fishing vessels engaged in fishing activities.
iv. Whether these areas contain transit routes used by coastal or deep-draught or international scheduled vessels on passage.	✓	**Section 10: Vessel Traffic Movements** Main routes have been identified using the principles set out in MGN 654 in proximity to the OAA (see Section 11.2), with these routes taking into account coastal, deep-draught and internationally scheduled vessels.
v. Alignment and proximity of the site relative to adjacent shipping routes.	✓	**Section 7: Navigational Features** There are no IMO routeing measures in proximity to the offshore Project.
vi. Whether the nearby area contains prescribed routeing	✓	**Section 7: Navigational Features**

Issue	Compliance	Reference and Notes
schemes or precautionary areas.		The ATBA is shown in Section 7.3. Section 7.6 identifies relevant areas such as military practice and exercise areas in proximity to the offshore Project.
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 nearby ports. There are no anchorages or safe havens in the proximity of the offshore Project.
viii. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 7: Navigational Features** Section 7.2 identifies nearby ports. The offshore Project area does not lie within any jurisdiction of a port and / or harbour authority.
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 and activities are considered within the OAA (Section 10.1.2.2) and ECC (Section 10.2.2.2) study areas.
x. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 7: Navigational Features** Section 7.6 identifies military practice and exercise areas in proximity to the offshore Project.
xi. Proximity of the site to existing or proposed submarine cables or pipelines, offshore oil/gas platform, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Area or other exploration/exploitation sites.	✓	**Section 7: Navigational Features** There are no marine aggregate dredging areas in the region. Section 7.5 identifies charted wrecks in proximity to the offshore Project. Section 7.8 considers subsea cables. **Section 14: Cumulative and Transboundary Overview** Planned submarine cables are identified in Section 14.1.
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** There are no baseline OREIs in proximity to the offshore Project. **Section 14: Cumulative and Transboundary Overview** Planned nearby OREIs presented are shown in Section 14.1.
xiii. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping grounds.	✓	**Section 7: Navigational Features** There are no spoil grounds or other dumping grounds in proximity to the offshore Project.
xiv. Proximity of the site to aids to navigation and/or VTS	✓	**Section 7: Navigational Features** Section 7.4 identifies aids to navigation in proximity to the offshore Project.

Issue	Compliance	Reference and Notes
in or adjacent to the area and any impact thereon.		
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 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the OAA.
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 9: Emergency Response** Historical vessel incident data published by the MAIB (Section 9.5), RNLI (Section 9.2) and DfT (Section 9.1) in proximity to the offshore Project has been considered alongside historical offshore wind farm 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 limited recreational activity.
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 wind farm routeing is outlined and includes a minimum distance of 1 nm from offshore installations and WTG boundaries.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	No defined navigation corridors have been noted in relation to the Project.
OREI structures. The following should be determined:		
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	✓	**Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the OAA.

<table>
<tr><th>Issue</th><th>Compliance</th><th>Reference and Notes</th></tr>
<tr><td>fishing anchoring and emergency response.</td><td></td><td></td></tr>
<tr><td>b. Clearances of fixed or floating WTG blades above the sea surface are not less than 22 m (above MHWS for fixed). Floating turbines allow for degrees of motion.</td><td>✓</td><td>Section 17: Mitigation Measures
The minimum blade tip height is included in the WCS for WTGs (see Table 17.1).</td></tr>
<tr><td>c. Underwater devices:
i. Changes to charted depth;
ii. Maximum height above seabed; and
iii. Under keel clearance.</td><td>✓</td><td>Section 6.7: Worst Case Scenario
Inter array, interconnector and export cable specifications are included in the WCS for cables (see Table 6.5).</td></tr>
<tr><td>d. Whether structure block or hinder the view of other vessels or other navigational features.</td><td>✓</td><td>Section 18: Risk Assessment – In Isolation
The hazards due to the Project have been assessed for each stage and include consideration of the potential for vessels navigating in proximity to structures to be visually obscured</td></tr>
<tr><td colspan="3">The effects of tides, tidal streams and weather. It should be determined whether:</td></tr>
<tr><td>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.</td><td>✓</td><td>Section 6.7: Worst Case Scenario
The range of water depths within the OAA is provided in the WCS for the site boundary.

Section 8: Meteorological Ocean Data
Various states of the tide local to the offshore Project are provided.

Section 10: Vessel Traffic Movements
Vessel traffic data in proximity to the offshore Project has been analysed.

Section 16: Collision and Allision Risk Modelling
Collision and allision risk models take into account tidal conditions.</td></tr>
<tr><td>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.</td><td>✓</td><td rowspan="3">Section 8: Meteorological Ocean Data
Various states of the tide local to the offshore Project are provided.

Section 16: Collision and Allision Risk Modelling
The collision and allision risk models take into account tidal conditions.</td></tr>
<tr><td>c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.</td><td>✓</td></tr>
<tr><td>d. The set is across the major axis of the layout at any time, and, if so, at what rate.</td><td>✓</td></tr>
</table>

Issue	Compliance	Reference and Notes
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 8: Meteorological Ocean Data** Various states of the tide local to the offshore Project are provided and it is noted that hazards are not anticipated at high or low water only. **Section 16: Collision and Allision Risk Modelling** The drifting allision risk model takes into account tidal conditions and assesses 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 8: Meteorological Ocean Data** Provides meteorological data in proximity to the offshore Project relating to various states of the tide and notes that no effects are anticipated.
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 wind farm area or adjacent to the area.	✓	**Section 8: Meteorological Ocean Data.** Provides meteorological data in proximity to the offshore Project relating to various states of the tide.
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 8: Meteorological Ocean Data** Weather and visibility data local to the offshore Project is provided. **Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the offshore Project has been analysed including recreational vessels. **Section 12: Adverse Weather Vessel Traffic Movements** Alternative routeing used by Regular Operators during periods of adverse weather have been identified.
i. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 8: Meteorological Ocean Data.** The hazards due to the Project have been assessed for each stage 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 16: Collision and Allision Risk Modelling** The drifting allision risk model takes into account weather and tidal conditions and assesses whether machinery failure could cause vessels to be set into danger.
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:		

Issue	Compliance	Reference and Notes
i. For all vessels.	✓	**Section 4: Consultation** Section 4.1 outlines Regular Operator consultation undertaken following the vessel traffic surveys. **Section 12: Adverse Weather Vessel Traffic Movements** Alternative routeing used by Regular Operators during periods of adverse weather are discussed. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the OAA and includes use of post wind farm routeing, as well as taking account of tidal and weather conditions.
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 13: Navigation, Communication and Position Fixing Equipment** Potential hazards on navigation of the different communications and position fixing devices used in and around offshore wind farms are assessed. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the OAA and includes use of post wind farm routeing which assumes commercial vessel traffic avoids the OAA. **Section 17: 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.
ii. In respect of specific activities.	✓	
iii. In all areas or directions.	✓	
iv. Prohibited in specified areas or directions.	✓	
v. In specified tidal or whether conditions.	✓	
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 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the OAA and includes use of post wind farm routeing which assumes commercial vessel traffic avoids the array.
d. Guidance on the calculation of safe distance of OREI boundaries from shipping routes has been considered.	✓	**Section 15: Future Case Vessel Traffic** The methodology applied when considering the safe distance at which main routes should be deviated around offshore installations has been described and includes consideration of the Shipping Route Template (see Section 15.4.1).

Issue	Compliance	Reference and Notes
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 stages of the OREI.	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including compliance with MGN 654, which requires the creation 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 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including compliance with MGN 654, which requires the fulfilment of requirements in the stated guidance document.
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: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including compliance with MGN 654, which requires the SAR checklist to be completed.
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 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including compliance with MGN 654, which requires the specified hydrographic surveys to be completed.
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.	✓	

Issue	Compliance	Reference and Notes
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 13: Navigation, Communication and Position Fixing Equipment** Potential hazards on navigation of the different communications and position fixing devices used in and around offshore wind farms are assessed.
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 13: Navigation, Communication and Position Fixing Equipment** Potential hazards on navigation of the different communications and position fixing devices used in and around offshore wind farms are assessed.
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 13: Navigation, Communication and Position Fixing Equipment** Section 13.8 assesses the potential risk of SONAR interference due to the offshore Project.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 13: Navigation, Communication and Position Fixing Equipment** Section 13.9 assesses the potential risk of noise due to the offshore Project.
e. Generators and the seabed cabling within the site onshore might produce EMFs affecting compasses and other navigation systems.	✓	**Section 13: Navigation, Communication and Position Fixing Equipment** Section 13.6 assesses the potential risk of electromagnetic interference due to the offshore Project.

Issue	Compliance	Reference and Notes
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 EIAR. These will be consistent with international standards contained in, for example, Chapter V of SOLAS (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: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including the promulgation of information.
ii. Continuous watch by multi-channel VHF, including DSC.	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including marine coordination.
iii. Safety Zones of appropriate configuration, extent and application to specified vessels[9].	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including use of Safety Zones.
iv. Designation of the site as an area to be avoided (ATBA)	✓	**Section 6: Project Design Envelope Relevant to Shipping and Navigation** It is not planned to designate the OAA as an ATBA (see Section 6.1.1).
v. Provision of aids to navigation as determined by the GLA.	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including the provision of aids to navigation in accordance with NLB and MCA requirements.
vi. Implementation of routeing measures within or near to the development.	✓	It is not planned to implement any new routeing measures within or near to the offshore Project.
vii. Monitoring by radar, AIS, Closed Circuit Television (CCTV) or other agreed means.	✓	**Section 17: Mitigation Measures** As required under MGN 654 (MCA, 2021) the offshore Project will agree suitable site mitigation with the MCA via the SAR checklist.
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of Safety Zones.	✓	Means for notifying and providing evidence of the infringement of Safety Zones will be provided in the Safety Zone Application, submitted post consent.
ix. Creation of an ERCoP with the MCA's SAR branch for the construction stage onwards.	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including compliance with MGN 654, which requires the creation of an ERCoP.

[9] As per SI 2007 No 1948 "The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

Issue	Compliance	Reference and Notes
x. Use of guard vessels, where appropriate.	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including the use of guard vessels where appropriate.
xi. Update NRAs every two years, e.g. at testing sites.	✓	Not applicable to the offshore Project.
xii. Device-specific or array-specific NRAs.	✓	**Section 6.7: Worst Case Scenario** All offshore elements of the offshore Project have been considered in this NRA including OAA and ECC (surface and subsea) infrastructure. **Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17 including a cable burial risk assessment undertaken prior to construction which will serve as additional assessment relating to shipping and navigation.
xiii. Design of OREI structures to minimise risk to contacting vessels or craft.	✓	There is no additional risk posed to craft compared to previous offshore wind farms and so no additional measures are identified.
xiv. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 17: Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Section 17.

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 18: Risk Assessment – In Isolation** The risk assessment provides a risk claim for a range of hazards based on a number of inputs including baseline data, expert opinion, stakeholder concerns and lessons learnt from existing offshore developments.
Description of the marine environment.	✓	**Section 7: Navigational Features** Navigational features in proximity to the offshore Project have been described including (but not limited to) other offshore wind farm developments, key aids to navigations, and charted wrecks. **Section 14: Cumulative and Transboundary Overview** Potential future offshore developments have been screened into the cumulative risk assessment where a cumulative or in combination activity has been identified based upon the location and distance from the offshore Project. Developments screened include other offshore wind farms, oil and gas infrastructure, and sub-sea cables.
SAR overview and assessment.	✓	**Section 9: Emergency Response and Incident Overview** Existing SAR resources in proximity to the offshore Project are summarised including the UK SAR operations contract, RNLI stations, and HMCG stations.

Item	Compliance	Comments
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 offshore Project for which any shipping and navigation hazards are assessed is provided including a description of the offshore Project, associated infrastructure, construction stage programme, and indicative vessel and helicopter numbers during the construction and operation and maintenance stages.
Analysis of the vessel traffic, including base case and future traffic densities and types.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to the OAA has been analysed and includes vessel density and breakdowns of vessel type. **Section 15: Future Case Vessel Traffic** Future vessel traffic levels have been considered, with consideration of increases in commercial vessel activity, commercial fishing vessel and recreational vessel activity, and traffic associated with the offshore Project operations. Additionally, worst case alternative routeing for commercial traffic has been considered.
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. **Appendix 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 IMOs FSA guidelines are the primary guidance documents used for the assessment. **Section 16: Collision and Allision Risk Modelling** Provides quantification of collision and allision risk resulting from the with the results outlined numerically and graphically, where appropriate.
Risk control log	✓	**Section 20: 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.

Appendix B Hazard Log

The complete hazard log, created following the Hazard Workshop, is presented in Table B.1.Definitions of the rankings used in the Hazard Log are detailed in Section 3.

Table B.1 Hazard Log

Hazard Type	Hazard Title	Stage (C/O/D)	Possible Causes	Embedded Mitigation	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation and 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	
Commercial Vessels																					
Displacement (adverse weather routeing)	Commercial vessels may be displaced from their existing adverse weather routes due to the buoyed construction area and construction / decommissioning vessels	C/D	▪ Adverse weather ▪ Buoyed construction area ▪ Presence of project vessels during construction/ decommissioning	▪ Promulgation of information ▪ Marking on Admiralty Charts ▪ Allowable weather limits on work activities ▪ Buoyed construction area	Vessels displaced from existing adverse weather routes, no safety consequences	4	1	1	1	1	1.0	Broadly Acceptable	Vessels displaced from routes or pushed to unsafe routes (transit between buoyed construction area and Sule Skerry) resulting in potential safety impacts i.e., vessel grounding, vessel damage.	1	5	5	5	4	5.0	Tolerable	Further consideration required of proximity to Sule Skerry
Displacement (adverse weather routeing)	Commercial vessels may be displaced from their existing adverse weather routes due to the presence of structures and associated work vessels	O	▪ Presence of structures associated with the project ▪ Presence of project vessels during operations and maintenance	▪ Promulgation of information ▪ Marking on Admiralty Charts ▪ Allowable weather limits	Vessels displaced from existing adverse weather routes, no safety consequences.	2	1	1	1	1	1.0	Broadly Acceptable	Vessels displaced from routes or pushed to unsafe routes (transit between RLB and Sule Skerry) resulting in potential safety impacts i.e., vessel grounding, vessel damage	3	5	5	5	4	5.0	Unacceptable	Further consideration required of proximity to Sule Skerry

			▪ Adverse weather	on operations and maintenance activities																	
Displacement leading to increased Collision risk	Displaced vessels may lead to increased traffic densities in certain areas and subsequently increase the collision risk for commercial vessels	C/D	▪ Presence of project vessels during construction/ decommissioning ▪ Buoyed construction area ▪ Adverse weather ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Marking on Admiralty Charts	Vessels displaced from existing routes, no safety consequences	5	1	1	1	2	1.3	**Tolerable**	Vessels displaced from existing routes, creating congestion leading to increased collision risk and possible safety consequences	2	5	5	4	4	4.5	**Tolerable**	Further consideration required of proximity to Sule Skerry & Sule Stack and overall shape / design of RLB
Displacement leading to increased Collision risk	Displaced vessels may lead to increased traffic densities in certain areas and a subsequent increase in collision risk for commercial vessels	O	▪ Presence of structures associated with the project ▪ Presence of project vessels during maintenance ▪ Adverse weather Non-adherence to COLREGS	▪ Promulgation of information ▪ Marking on Admiralty Charts	Vessels displaced from existing routes, no safety consequences	5	1	1	1	2	1.3	**Tolerable**	Vessels displaced from existing routes, creating congestion leading to increased collision risk and possible safety consequences	3	5	5	4	4	4.5	**Tolerable**	Further consideration required of proximity to Sule Skerry & Sule Stack and overall shape / design of RLB
Collision Risk with project vessels	The presence of project vessels during construction may increase the likelihood of vessel-to-vessel encounters and subsequently increase the collision risk between	C/D	▪ Presence of project vessels during construction / decommissioning. ▪ Lack of familiarity of 3rd party vessels with the project.	▪ Promulgation of information ▪ Navigational Safety and Vessel Management Plan ▪ Marine coordination	Increased encounters involving commercial vessels and project vessels that do not have safety consequences	3	1	1	1	1	1.0	**Broadly Acceptable**	Increased encounters involving commercial vessels and project vessels that result in safety consequences	3	4	4	4	4	4.0	**Tolerable**	

	commercial vessels and project vessels		▪ Vessels restricted in manoeuvrability at times. ▪ Non-adherence to COLREGS.	▪ Compliance of project vessels with international marine regulations ▪ Application for safety zones																	
Collision Risk with project vessels	The presence of project vessels during operation may increase the likelihood of vessel-to-vessel encounters and subsequently increase the collision risk between third party commercial vessels and project vessels	O	▪ Presence of project vessels during maintenance ▪ Unfamiliarity with project ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Navigational Safety and Vessel Management Plan ▪ Marine coordination ▪ Compliance of project vessels with international marine regulations ▪ Application for safety zones	Increased encounters involving commercial vessels and project vessels that do not have safety consequences	2	1	1	1	1	1.0	Broadly Acceptable	Increased encounters involving commercial vessels and project vessels that result in safety consequences	1	4	4	4	4	4.0	Broadly Acceptable	
Allision risk	Structures within the array could create an allision risk to a passing commercial vessel under power or drifting	C/D	▪ Presence of new structures associated with the project ▪ Watchkeeper failure ▪ Bad visibility and ineffective radar use ▪ Unfamiliarity with project ▪ Failure of aid to navigation	▪ Marking on Admiralty Charts ▪ Development Specification and Layout Plan (DSLP) ▪ Promulgation of information ▪ Application for safety zones ▪ Lighting and marking	Commercial vessel has to make late alteration to course or deploy anchors resulting in near miss	2	1	1	1	1	1.0	Broadly Acceptable	Commercial vessel allides with or drifts into structure resulting in vessel damage, injury / fatality and/or pollution	1	5	5	4	4	4.5	Broadly Acceptable	Hazards with construction specific stage allision risk (i.e., partial structures, components) are managed via construction stage specific mitigation (e.g., buoyed construction area, temporary lighting of all structures).

				▪ Guard vessel(s) where required ▪ Buoyed construction area																	Lighting and marking including temporary construction lighting will be agreed via LMP process.
Allision risk	Structures within the array could create an allision risk to a passing commercial vessel under power or drifting	O	▪ Presence of structures associated with the project ▪ Watchkeeper failure ▪ Bad visibility and ineffective radar use ▪ Unfamiliarity with project ▪ Failure of aid to navigation	▪ Marking on Admiralty Charts ▪ DSLP ▪ Promulgation of information ▪ Lighting and marking ▪ Guard vessel(s) where required	Commercial vessel has to make late alteration to course or deploy anchors resulting in near miss	3	1	1	1	1	1.0	Broadly Acceptable	Commercial vessel allides with or drifts into structure resulting in vessel damage, injury / fatality and/or pollution	2	5	5	4	4	4.5	**Tolerable**	
Commercial Fishing Vessels																					
Displacement (adverse weather routeing)	Commercial fishing vessels may be displaced from existing adverse weather behaviour due to the buoyed construction area and construction / decommissioning vessels	C/D	▪ Adverse weather ▪ Buoyed construction area ▪ Presence of project vessels during construction/ decommissioning	▪ Promulgation of information ▪ Marking on Admiralty Charts ▪ Allowable weather limits on work activities ▪ Buoyed construction area	Commercial fishing vessels displaced due to adverse weather, no safety consequences	4	1	1	1	1	1.0	Broadly Acceptable	Commercial fishing vessels displaced from routine resulting in potential safety impacts i.e., vessel grounding, vessel damage	1	4	2	3	3	3.0	Broadly Acceptable	Noted that impacts on commercial fishing are covered in the Commercial Fisheries Assessment.

Displacement (adverse weather routeing)	Commercial fishing vessels may be displaced from their existing adverse weather behaviour due to the presence of structures and associated work vessels	O	▪ Presence of structures associated with the project ▪ Presence of project vessels during operations and maintenance ▪ Adverse weather	▪ Promulgation of information ▪ Marking on Admiralty Charts ▪ Allowable weather limits on operations and maintenance activities	Commercial fishing vessels displaced due to adverse weather, no safety consequences	3	1	1	1	1	1.0	Broadly Acceptable	Commercial fishing vessels displaced from routine resulting in potential safety impacts i.e., vessel grounding, vessel damage	2	4	2	3	3	3.0	Broadly Acceptable	Noted that impacts on commercial fishing are covered in the Commercial Fisheries Assessment.
Displacement leading to increased Collision risk	Displaced commercial fishing vessels may lead to increased traffic densities in certain areas and subsequently increase the collision risk with other vessels	C/D	▪ Presence of project vessels during construction/ decommissioning ▪ Buoyed construction area ▪ Adverse weather ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Marking on Admiralty Charts	Commercial fishing vessels displaced from existing routine, no safety consequences	5	1	1	1	1	1.0	Tolerable	Commercial fishing vessels displaced from existing routine, creating increased encounters leading to increased collision risk and possible safety consequences	3	4	2	3	3	3.0	Tolerable	Noted that impacts on commercial fishing are covered in the Commercial Fisheries Assessment.
Displacement leading to increased Collision risk	Displaced commercial fishing vessels may lead to increased traffic densities in certain areas and subsequently increase the collision risk with other vessels	O	▪ Presence of structures associated with the project ▪ Presence of project vessels during maintenance ▪ Adverse weather ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Marking on Admiralty Charts	Commercial fishing vessels displaced from existing routine, no safety consequences	4	1	1	1	1	1.0	Broadly Acceptable	Commercial fishing vessels displaced from existing routine, creating increased encounters leading to increased collision risk and possible safety consequences	2	4	2	3	3	3.0	Broadly Acceptable	Noted that impacts on commercial fishing are covered in the Commercial Fisheries Assessment.
Collision Risk with project vessels	The presence of project vessels during construction may increase the likelihood of vessel-to-vessel	C/D	▪ Presence of project vessels during construction / decommissioning.	▪ Promulgation of information ▪ Navigational Safety and Vessel	Increased encounters involving commercial fishing vessels and project	5	1	1	1	1	1.0	Tolerable	Increased encounters involving commercial fishing vessels and project vessels that result in safety consequences	2	4	2	3	3	3.0	Broadly Acceptable	

	encounters and subsequently increase the collision risk between commercial fishing vessels and project vessels		▪ Lack of familiarity of 3rd party vessels with the project. ▪ Vessels restricted in manoeuvrability at times. ▪ Non-adherence to COLREGS.	Management Plan ▪ Marine coordination ▪ Compliance of project vessels with international marine regulations ▪ Application for safety zones	vessels that do not have safety consequences																
Collision Risk with project vessels	The presence of project vessels during operation may increase the likelihood of vessel-to-vessel encounters and subsequently increase the collision risk between commercial fishing vessels and project vessels	O	▪ Presence of project vessels during maintenance ▪ Unfamiliarity with project ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Navigational Safety and Vessel Management Plan ▪ Marine coordination ▪ Compliance of project vessels with international marine regulations ▪ Application for safety zones	Increased encounters involving commercial fishing vessels and project vessels that do not have safety consequences	3	1	1	1	1	1.0	Broadly Acceptable	Increased encounters involving commercial fishing vessels and project vessels that result in safety consequences	1	4	2	3	3	3.0	Broadly Acceptable	
Allision risk	Structures within the array could create an allision risk to a passing commercial fishing vessel under power or drifting	C/D	▪ Presence of new structures associated with the project ▪ Watchkeeper failure ▪ Bad visibility and ineffective radar use	▪ Marking on Admiralty Charts ▪ DSLP ▪ Promulgation of information ▪ Application for safety zones	Commercial fishing vessel has to make late alteration to course resulting in near miss	2	1	1	1	1	1.0	Broadly Acceptable	Commercial vessel allides with or drifts into structure resulting in vessel damage, injury / fatality and/or pollution	1	4	2	3	3	3.0	Broadly Acceptable	Hazards with construction specific stage allision risk (i.e., partial structures, components) are managed via construction stage specific mitigation (e.g.,

			▪ Unfamiliarity with project ▪ Failure of aid to navigation	▪ Lighting and marking ▪ Guard vessel(s) where required ▪ Buoyed construction area																buoyed construction area, temporary lighting of all structures). Lighting and marking including temporary construction lighting will be agreed via LMP process.
Allision risk	Structures within the array could create an allision risk to a passing commercial fishing vessel under power or drifting	O	▪ Presence of structures associated with the project ▪ Watchkeeper failure ▪ Bad visibility and ineffective radar use ▪ Unfamiliarity with project ▪ Failure of aid to navigation	▪ Marking on Admiralty Charts ▪ DSLP ▪ Promulgation of information ▪ Lighting and marking ▪ Guard vessel(s) where required	Commercial vessel has to make late alteration resulting in near miss	4	1	1	1	1	1.0	**Broadly Acceptable**	Commercial vessel allides with or drifts into structure resulting in vessel damage, injury / fatality and/or pollution	3	4	2	3	3	3.0	**Tolerable**	Post workshop, the importance of facilitating internal navigation including in terms of lighting was raised. Internal lighting requirements (via the project ID boards) are formalised under MGN 654 and will be agreed through the LMP process.
Displacement (adverse weather routeing)	Commercial fishing vessels may be displaced from existing adverse weather behaviour due to the buoyed construction area and construction / decommissioning vessels	C/D	▪ Adverse weather ▪ Buoyed construction area ▪ Presence of project vessels during construction/ decommissioning	▪ Promulgation of information ▪ Marking on Admiralty Charts ▪ Allowable weather limits on work activities	Commercial fishing vessels displaced due to adverse weather, no safety consequences	4	1	1	1	1	1.0	**Broadly Acceptable**	Commercial fishing vessels displaced from routine resulting in potential safety impacts i.e., vessel grounding, vessel damage	1	4	2	3	3	3.0	**Broadly Acceptable**	Noted that impacts on commercial fishing are covered in the Commercial Fisheries Assessment.

				■ Buoyed construction area																	
Recreational Vessels																					
Displacement (adverse weather transit)	Recreational vessels may be displaced from their existing adverse weather transits due to the buoyed construction area and construction / decommissioning vessels	C/D	■ Adverse weather ■ Buoyed construction area ■ Presence of project vessels during construction/ decommissioning	■ Promulgation of information ■ Marking on Admiralty Charts ■ Allowable weather limits on work activities ■ Buoyed construction area	Recreational vessels displaced due to adverse weather, no safety consequences.	1	1	1	1	1	1.0	**Broadly Acceptable**	Recreational vessels displaced from transit resulting in potential safety impacts i.e., vessel grounding, vessel damage	1	4	1	2	2	3.0	**Broadly Acceptable**	
Displacement (adverse weather transit)	Recreational vessels may be displaced from their existing adverse weather transits due to the presence of structures and associated work vessels	O	■ Presence of structures associated with the project ■ Presence of project vessels during operations and maintenance ■ Adverse weather	■ Promulgation of information ■ Marking on Admiralty Charts ■ Allowable weather limits on operations and maintenance activities	Recreational vessels displaced due to adverse weather, no safety consequences.	1	1	1	1	1	1.0	**Broadly Acceptable**	Recreational vessels displaced from transit resulting in potential safety impacts i.e., vessel grounding, vessel damage	1	4	1	2	2	3.0	**Broadly Acceptable**	
Displacement leading to increased Collision risk	Displaced recreational vessels may lead to increased traffic densities in certain areas and subsequently increase the collision risk with other vessels	C/D	■ Presence of project vessels during construction/ decommissioning ■ Buoyed construction area ■ Adverse weather ■ Non-adherence to COLREGS	■ Promulgation of information ■ Marking on Admiralty Charts	Recreational vessels displaced from existing transits, no safety consequences.	4	1	1	1	1	1.0	**Broadly Acceptable**	Recreational vessels displaced from existing transits, creating increased encounters leading to increased collision risk and possible safety consequences	2	4	1	4	4	4.0	**Tolerable**	

Displacement leading to increased Collision risk	Displaced recreational vessels may lead to increased traffic densities in certain areas and subsequently increase the collision risk with other vessels	O	▪ Presence of structures associated with the project ▪ Presence of project vessels during maintenance ▪ Adverse weather ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Marking on Admiralty Charts	Recreational vessels displaced from existing transits, no safety consequences.	3	1	1	1	1	1.0	Broadly Acceptable	Recreational vessels displaced from existing transits, creating increased encounters leading to increased collision risk and possible safety consequences	1	4	1	4	4	3.3	Broadly Acceptable	
Collision Risk with project vessels	The presence of project vessels during construction may increase the likelihood of vessel-to-vessel encounters and subsequently increase the collision risk between recreational vessels and project vessels	C/D	▪ Presence of project vessels during construction / decommissioning. ▪ Lack of familiarity of 3rd party vessels with the project. ▪ Vessels restricted in manoeuvrability at times. ▪ Non-adherence to COLREGS.	▪ Promulgation of information ▪ Navigational Safety and Vessel Management Plan ▪ Marine coordination ▪ Compliance of project vessels with international marine regulations ▪ Application for safety zones	Increased encounters involving recreational vessels and project vessels that do not have safety consequences	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters involving recreational vessels and project vessels that result in safety consequences	2	4	1	2	2	2.3	Broadly Acceptable	
Collision Risk with project vessels	The presence of project vessels during operation may increase the likelihood of vessel-to-vessel encounters and subsequently increase the collision risk between	O	▪ Presence of project vessels during maintenance ▪ Unfamiliarity with project ▪ Non-adherence to COLREGS	▪ Promulgation of information ▪ Navigational Safety and Vessel Management Plan ▪ Marine coordination	Increased encounters involving recreational vessels and project vessels that do not have safety consequences	3	1	1	1	1	1.0	Broadly Acceptable	Increased encounters involving recreational vessels and project vessels that result in safety consequences	1	4	1	2	2	2.3	Broadly Acceptable	

	recreational vessels and project vessels			▪ Compliance of project vessels with international marine regulations ▪ Application for safety zones																	
Allision risk	Structures within the array could create an allision risk to a recreational vessel under power or drifting	C/D	▪ Presence of new structures associated with the project ▪ Watchkeeper failure ▪ Bad visibility and ineffective radar use ▪ Unfamiliarity with project ▪ Failure of aid to navigation	▪ Marking on Admiralty Charts ▪ DSLP ▪ Promulgation of information ▪ Application for safety zones ▪ Lighting and marking ▪ Guard vessel(s) where required ▪ Buoyed construction area	Recreational vessel has to make late alteration to course resulting in near miss	3	1	1	1	1	1.0	Broadly Acceptable	Recreational vessel allides with or drifts into structure resulting in vessel damage, injury / fatality and/or pollution	1	4	1	2	2	2.3	Broadly Acceptable	Hazards with construction specific stage allision risk (i.e., partial structures, components) are managed via construction stage specific mitigation (e.g., buoyed construction area, temporary lighting of all structures). Lighting and marking including temporary construction lighting will be agreed via LMP process.
Allision risk	Structures within the array could create an allision risk to a recreational vessel under power or drifting	O	▪ Presence of structures associated with the project ▪ Watchkeeper failure ▪ Bad visibility and ineffective radar use	▪ Marking on Admiralty Charts ▪ DSLP ▪ Promulgation of information ▪ Lighting and marking	Recreational vessel has to make late alteration resulting in near miss	4	1	1	1	1	1.0	Broadly Acceptable	Recreational vessel allides with or drifts into structure resulting in vessel damage, injury / fatality and/or pollution	2	4	1	2	2	2.3	Broadly Acceptable	

			▪ Unfamiliarity with project ▪ Failure of aid to navigation	▪ Guard vessel(s) where required																	
All Vessels																					
Reduced under keel clearance due to cable protection	The implementation of cable protection may reduce water depths and under-keel clearance	C/O/D	▪ Reduction of water depth due to the installation of cable protection	▪ MGN 654 compliance ▪ Marking on Admiralty Charts ▪ Promulgation of information ▪ Cable burial risk assessment	Vessel transits over an area of slightly reduced clearance but does not make contact	5	1	1	1	1	1.0	**Tolerable**	Vessel transits over and contacts the cable protection resulting in vessel damage, injury/fatality and/or pollution	1	2	5	3	2	3.0	**Broadly Acceptable**	
Impacts on Port Operations	Port operations may be impacted due to construction, decommissioning and/or maintenance activities associated with the project	C/O/D	▪ Presence of project vessels during construction/ decommissioning	▪ Marine coordination ▪ Navigational Safety and Vessel Management Plan ▪ Compliance of project vessels with international marine regulations ▪ Liaison with port and updated port procedures	No impact on routine operations	5	1	1	1	1	1.0	**Tolerable**	Impact on routine operations (e.g., schedules) but no safety consequences	1	1	1	1	4	1.8	**Broadly Acceptable**	Marine coordination will need to consider project vessel movements should a local port be selected as a base.
Anchor interaction	The presence of subsea cables associated with the project may increase the likelihood of anchor	C/O/D	▪ Presence of subsea cables and cable protection ▪ Human error	▪ Marking on Admiralty Charts ▪ Promulgation of information	Vessels do not anchor in OAA due to water depth. Commercial vessel could drop or drag anchor in	3	1	1	1	1	1.0	**Broadly Acceptable**	Vessel anchors on or drags anchor over an installed cable/protection resulting in damage to the cable/protection and/or anchor	1	2	4	3	2	2.8	**Broadly Acceptable**	Noted that impacts associated with gear snagging are covered in the Commercial

	interaction for all vessels		▪ Mechanical or technical failure ▪ Adverse weather leading to anchor drag	▪ Cable burial risk assessment ▪ Guard vessel(s) where required (e.g., if exposed cables represented a hazard)	vicinity of an installed cable but interaction is unlikely																Fisheries Assessment
Interference with navigational equipment	Communication and position-fixing equipment may be affected by the presence of structures within the site, or proposed ECC	C/O/D	▪ Presence of structures ▪ Human error relating to use of radar controls	▪ Marking on Admiralty Charts ▪ Promulgation of information ▪ MGN 654 compliance	Minor but manageable effects upon vessel equipment such as radar effects / EMF	5	1	1	1	1	1.0	**Tolerable**	Interference with marine equipment affecting efficiency of navigation and/or collision avoidance	2	2	2	2	2	2.0	**Broadly Acceptable**	
Emergency Responders																					
Emergency response capability	The presence of the project may result in an increased number of incidents requiring emergency response associated with project vessels and/or third-party vessels. The presence of the structures may reduce access for SAR responders, e.g., SAR or surface craft such as lifeboats	C/O/D	▪ Presence of array reduces emergency response access compared with open sea location Adverse weather	▪ MGN 654 Compliance ▪ DSLP ▪ Promulgation of information ▪ Emergency Response Coordination Plan ▪ Marine Coordination ▪ Compliance of project vessels with international marine regulations ▪ MPCP ▪ Marking on charts	Minimal impact on emergency response	4	1	1	1	1	1.0	**Broadly Acceptable**	Reduced probability of detection of a casualty leading to delay in rescue	2	4	2	2	4	3.0	**Broadly Acceptable**	Through life safety management was raised post workshop. Approach will be set out in NRA.

				▪ Lighting and marking																	
Cumulative – All Vessel Types																					
Cumulative displacement leading to increased encounters and collision risk	Vessels may be displaced from their existing routes due to construction activities associated with the project and other offshore developments	C/O/D	▪ Presence of project vessels during construction, maintenance and decommissioning ▪ Presence of other offshore developments in the area and associated project vessels	▪ Promulgation of information ▪ Marking on Admiralty Charts	Increased displacement that does not impact on safety, but minor increases in voyage distance / time without impacting on schedules	5	1	1	1	1	1.0	**Tolerable**	Increased displacement that does impact on safety	2	3	3	3	3	3.0	**Broadly Acceptable**	

Appendix C Consequences Assessment

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 wind farm structures.

The significance of risk of the hazards due to the presence of the OAA are also assessed based upon risk evaluation criteria and comparison with historical accident data in UK waters[10].

C.1 Risk Evaluation Criteria

C.1.1 Risk to People

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

Individual risk considers whether the risk from an incident to a particular individual changes significantly due to the presence of the offshore 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.

The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of the offshore 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 offshore Project relative to the background individual risk levels.

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.

[10] For the purposes of this assessment, UK waters is defined as the UK Exclusive Economic Zone (EEZ) and UK territorial waters refers to the 12 nm limit from the British Isles, excluding the Republic of Ireland.

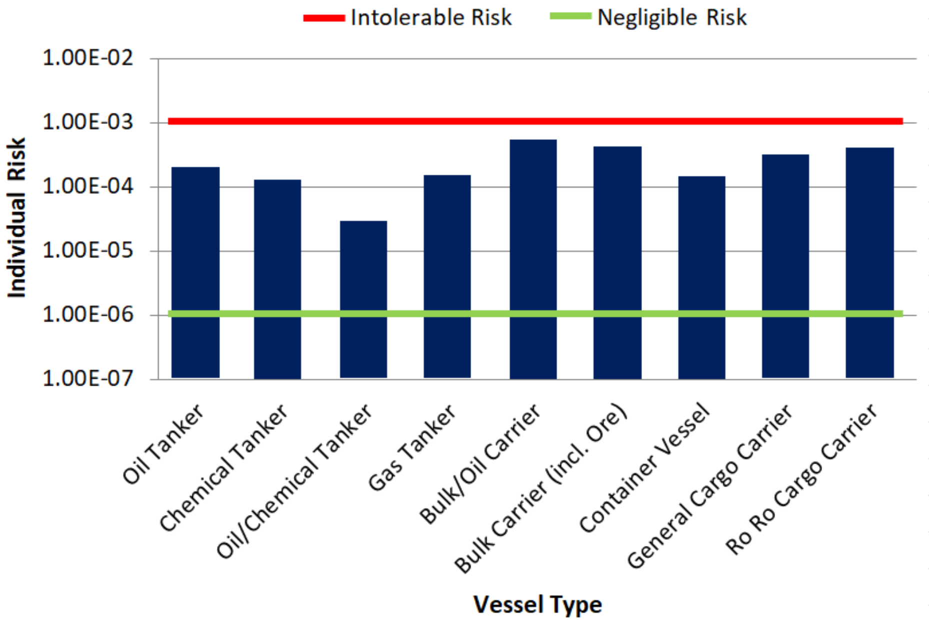

Figure C.1 Individual Risk Levels and Acceptance Criteria per Vessel Type

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

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.

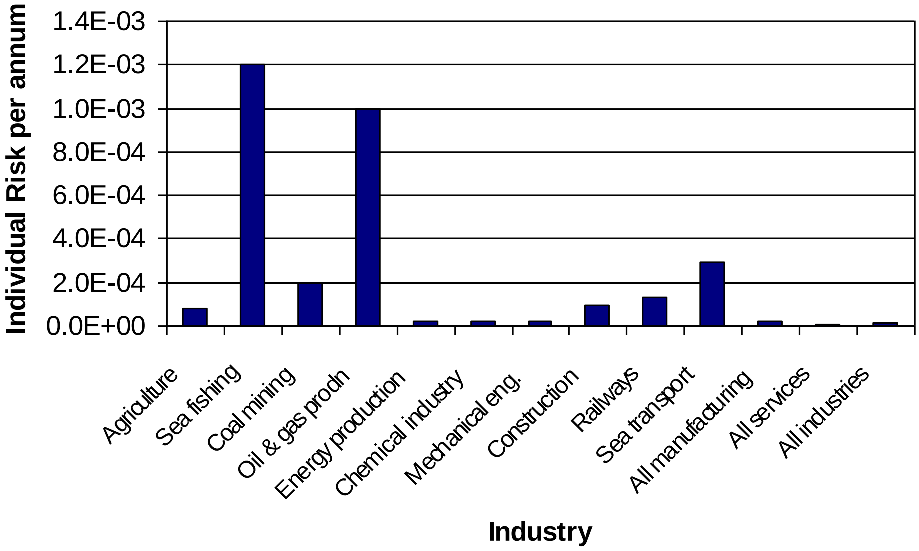

Figure C.2 Individual Risk per Year for Various UK Industries

The individual risk for sea transport of 2.9×10^{-4} per year is consistent with the worldwide data presented in Figure C.1, whilst the individual risk for sea fishing of 1.2×10^{-3} per year is the highest across all of the industries included.

C.1.2.2 Societal Risk

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.

Within this assessment, societal (navigation-based) risk can be assessed within the OAA, giving account to the change in risk associated with each accident scenario caused by the introduction of the wind farm 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 Potential Loss of Life (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.

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.1.3 Risk to Environment

For risk to the environment the key criteria considered in terms of the risk due to the offshore Project is the potential quantity of oil spilled from a vessel involved in an incident.

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 offshore Project to background pollution risk levels for the UK.

C.2 Marine Accident Investigation Branch Incident Analysis

C.2.1 All UK Waters Incidents

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.

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 offshore Project.

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 (some incidents, such as collisions, involved more than one vessel).

The locations of all incidents reported in proximity to the UK are presented in Figure C.3, colour-coded by incident type. It is noted that the MAIB aim for 97% accuracy in reporting the location of incidents.

The distribution of unique incidents by year in UK waters is presented in Figure C.4.

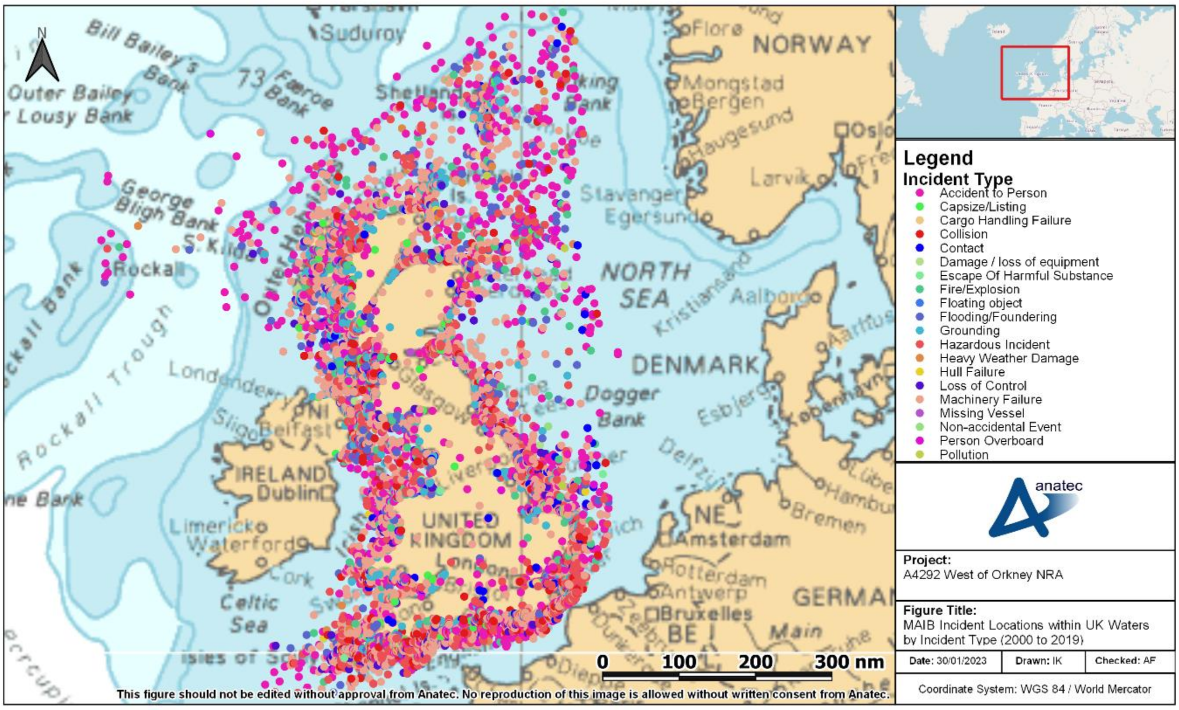

Figure C.3 MAIB Incident Locations by Incident Type within UK Waters (2000 to 2019)

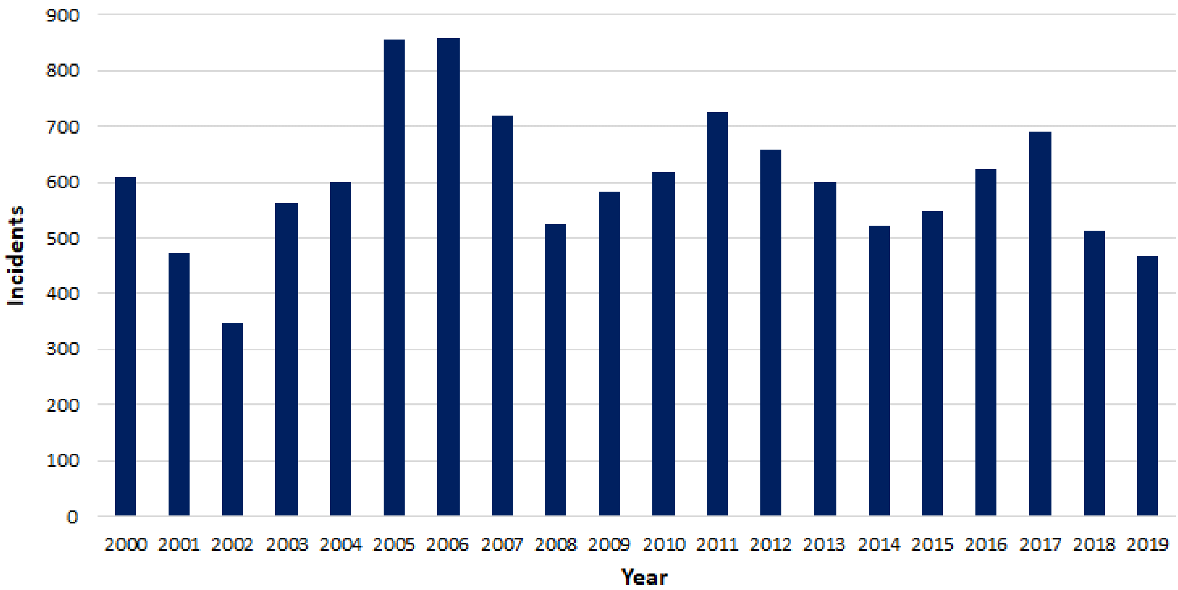

Figure C.4 MAIB Unique Incidents per Year within UK Waters (2000 to 2019)

The average number of unique incidents per year was 605. There has generally been a fluctuating trend in incidents over the 20-year period.

The distribution of incidents in UK waters by incident type is presented in Figure C.5.

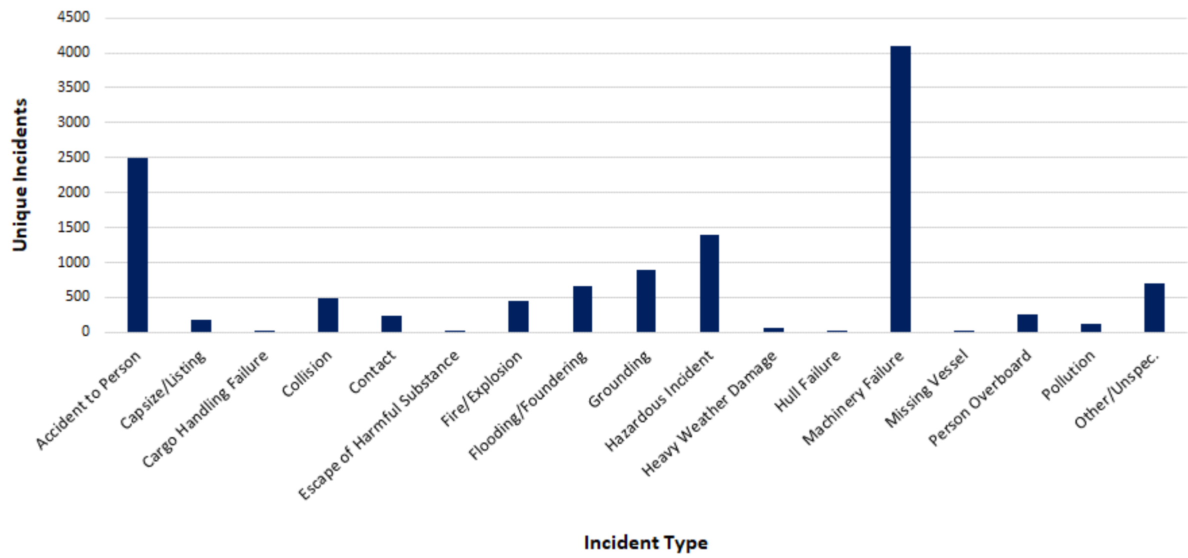

Figure C.5 MAIB Incident Types Breakdown within UK Waters (2000 to 2019)

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.

The distribution of incidents in UK waters by vessel type is presented in Figure C.6.

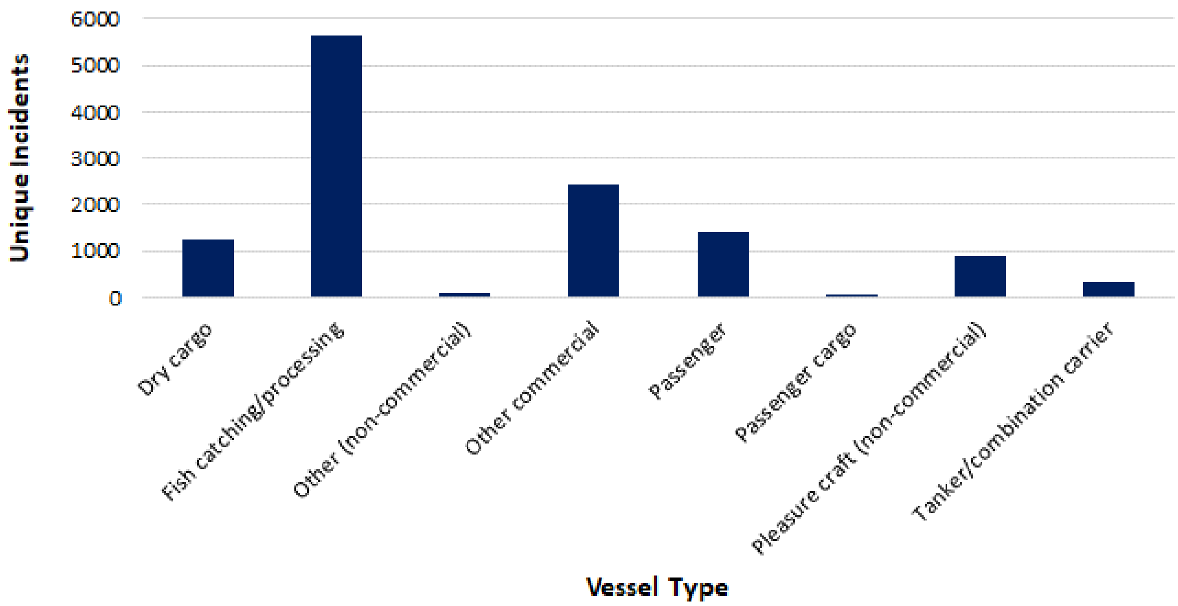

Figure C.6 MAIB Incident Vessel Type Breakdown within UK Waters (2000 to 2019)

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%).

The total of 373 fatalities were reported in the MAIB incidents within UK waters from 2000 to 2019, averaging 19 fatalities per year.

The distribution of fatalities in UK waters by vessel type and person category (namely crew, passenger and other) is presented in Figure C.7.

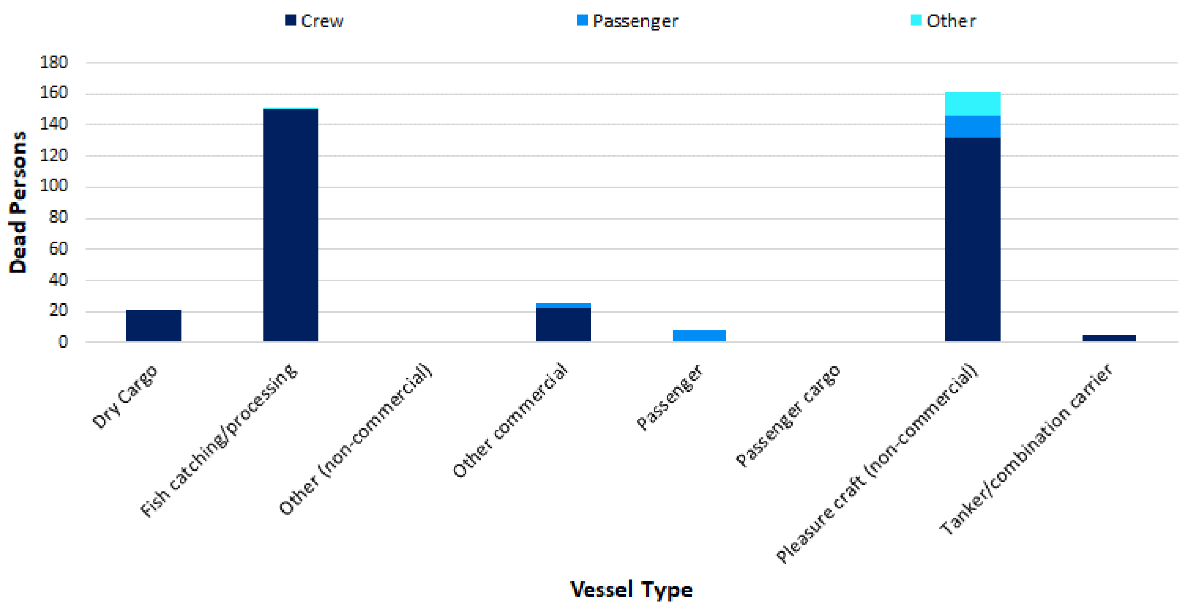

Figure C.7 MAIB Fatalities by Vessel Type within UK Waters (2000 to 2019)

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

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).

A total of 481 collision incidents were reported to the MAIB in UK waters between 2000 and 2019 involving 1,090 vessels (in a small number of cases the other vessel involved was not logged).

The locations of collision incidents reported in proximity to the UK are presented in Figure C.8, followed by the distribution of collision incidents per year presented in Figure C.9.

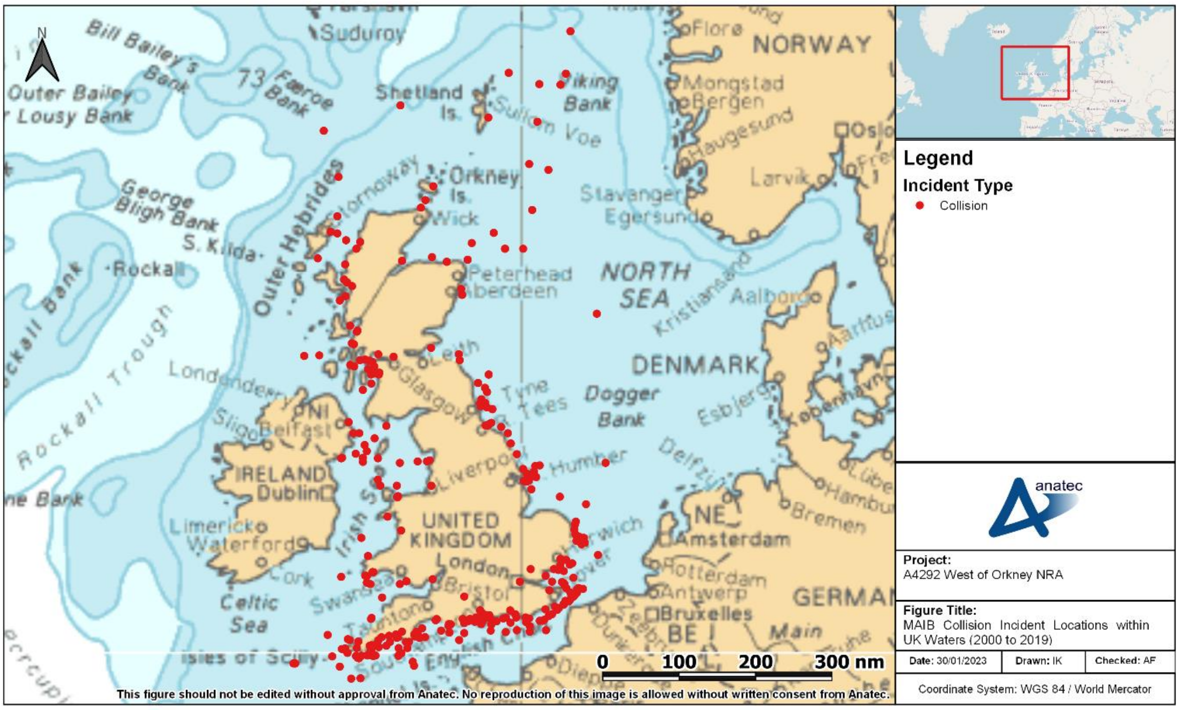

Figure C.8 MAIB Collision Incident Locations within UK Waters (2000 to 2019)

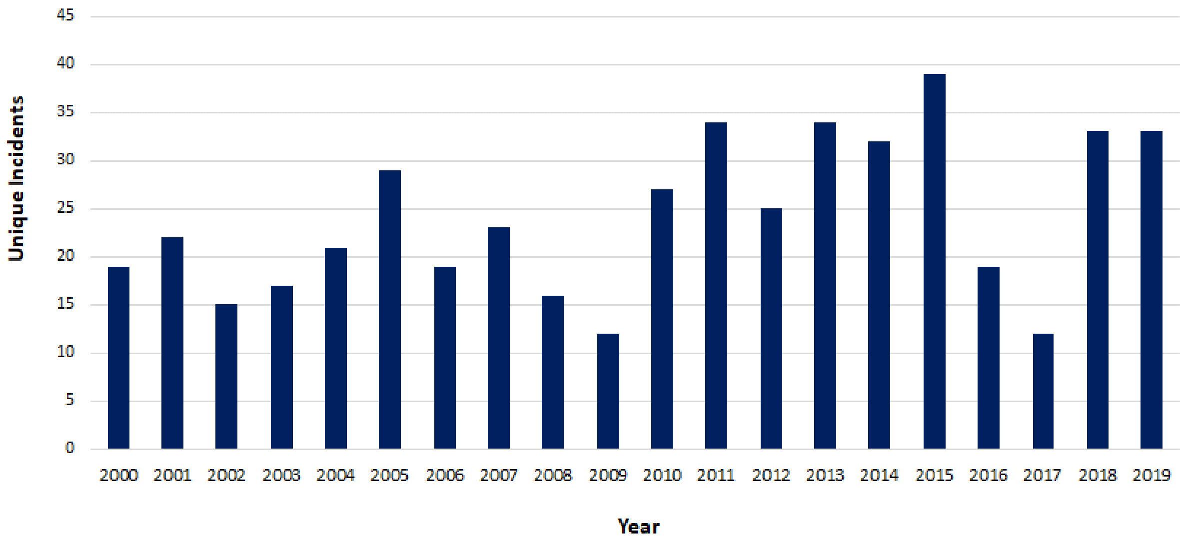

Figure C.9 MAIB Annual Collision Incidents within UK Waters (2000 to 2019)

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.

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%).

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

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).

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).

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.

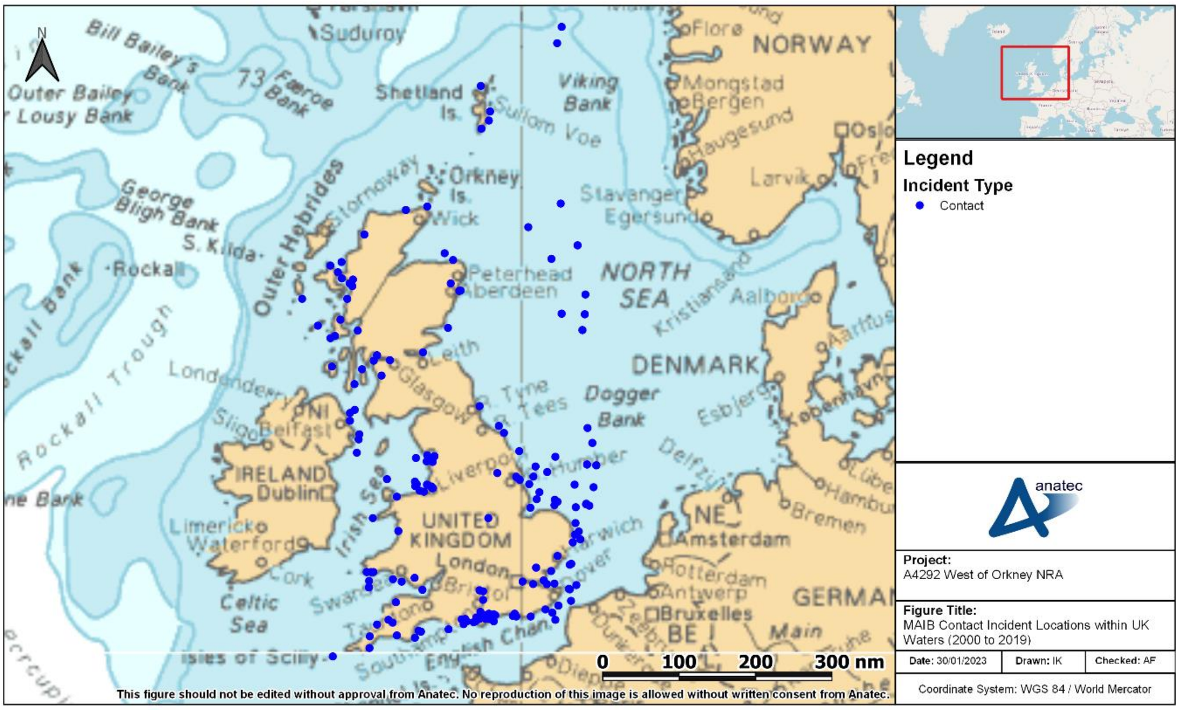

Figure C.10 MAIB Contact Incident Locations within UK Waters (2000 to 2019)

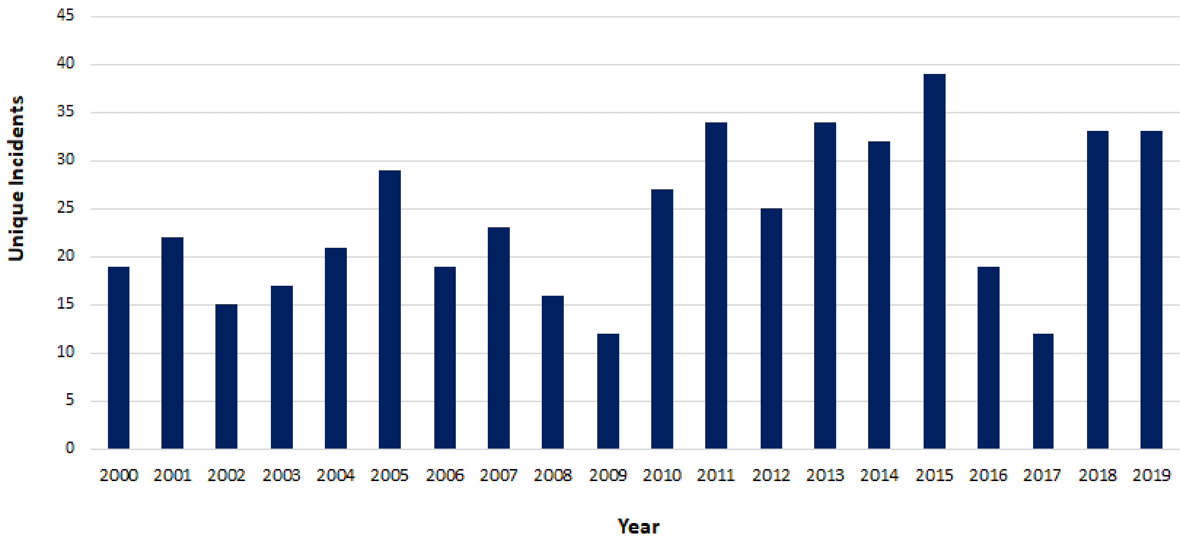

Figure C.11 MAIB Contact Incidents per Year within UK Waters (2000 to 2019)

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.

The distribution of vessel types involved in contact incidents is presented in Figure C.12.

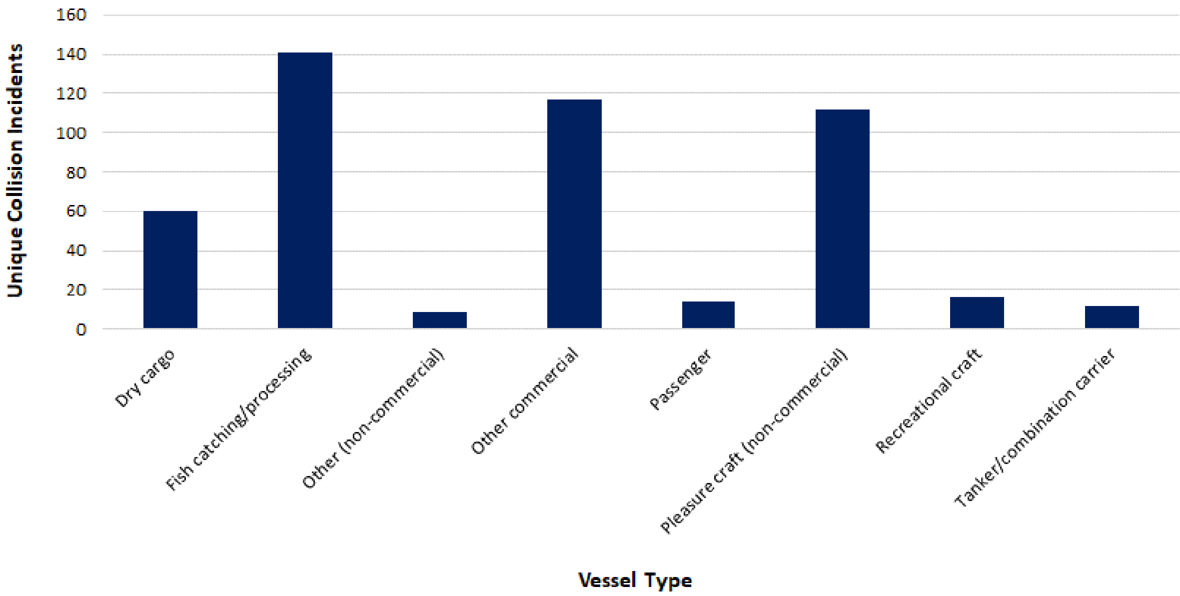

Figure C.12 MAIB Contact Incidents by Vessel Type within UK Waters (2000 to 2019)

The most commonly involved vessel types in contact incidents were other commercial vessels (43%), fishing vessels (15%), and non-commercial pleasure craft (13%).

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 Collision 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

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 offshore Project.

The wind farm 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.

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.

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 OSP. 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.

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

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.

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
Passenger	RoPax, cruise liner, etc.	Vessel traffic survey data / online information	2,263
Fishing	Trawler, potter, dredger, etc.	MAIB incident data	3.3
Recreational	Yacht, small commercial motor yacht, etc.	MAIB incident data	3.3

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.

Using the average number of POB, along with the vessel type information involved in collision incidents reported by the MAIB (see Figure C.8), there were an estimated 10,533 POB the vessels involved in the collision incidents.

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.

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}

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 offshore Project

The base case and future case annual collision and allision frequency levels pre and post wind farm for the OAA are summarised in Table C.6, where change refers to the increase in collision and allision frequency due to the presence of the offshore Project (estimated at overall 1.02×10^{-1}, equating to an additional collision or allision every 9.8 years) for the base case.

Table C.6 Summary of Annual Collision and Allision Risk Results

Risk	Scenario	Annual Frequency (Return Period)		
		Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	Base case	1.52×10^{-3} (1 in 658 years)	2.04×10^{-3} (1 in 491 years)	5.14×10^{-4} (1 in 1,945 years)
	Future case (10%)	1.96×10^{-3} (1 in 511 years)	2.61×10^{-3} (1 in 383 years)	6.55×10^{-4} (1 in 1,525 years)
	Future case (20%)	2.32×10^{-3} (1 in 431 years)	3.10×10^{-3} (1 in 322 years)	7.79×10^{-4} (1 in 1,284 years)

Risk	Scenario	Annual Frequency (Return Period)		
		Pre Wind Farm	Post Wind Farm	Change
Powered vessel to structure allision	Base case	-	7.79×10^{-4} (1 in 1,283 years)	7.79×10^{-4} (1 in 1,283 years)
	Future case (10%)	-	8.57×10^{-4} (1 in 1,167 years)	8.57×10^{-4} (1 in 1,167 years)
	Future case (20%)	-	9.35×10^{-4} (1 in 1,069 years)	9.35×10^{-4} (1 in 1,069 years)
Drifting vessel to structure allision	Base case	-	1.51×10^{-4} (1 in 6,640 years)	1.51×10^{-4} (1 in 6,640 years)
	Future case (10%)	-	1.66×10^{-4} (1 in 6,036 years)	1.66×10^{-4} (1 in 6,036 years)
	Future case (20%)	-	1.81×10^{-4} (1 in 5,533 years)	1.81×10^{-4} (1 in 5,533 years)
Fishing vessel to structure allision	Base case	-	1.01×10^{-1} (1 in 9.9 years)	1.01×10^{-1} (1 in 9.9 years)
	Future case (10%)	-	1.09×10^{-1} (1 in 9.2 years)	1.09×10^{-1} (1 in 9.2 years)
	Future case (20%)	-	1.18×10^{-1} (1 in 8.5 years)	1.18×10^{-1} (1 in 8.5 years)
Total	**Base case**	**1.52×10^{-3} (1 in 658 years)**	**1.04×10^{-1} (1 in 9.6 years)**	**1.02×10^{-1} (1 in 9.8 years)**
	Future case (10%)	**1.96×10^{-3} (1 in 511 years)**	**1.13×10^{-1} (1 in 8.9 years)**	**1.11×10^{-1} (1 in 9.0 years)**
	Future case (20%)	**2.32×10^{-3} (1 in 431 years)**	**1.22×10^{-1} (1 in 8.2 years)**	**1.20×10^{-1} (1 in 8.4 years)**

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 offshore Project for the base case and future cases are presented in Figure C.13.

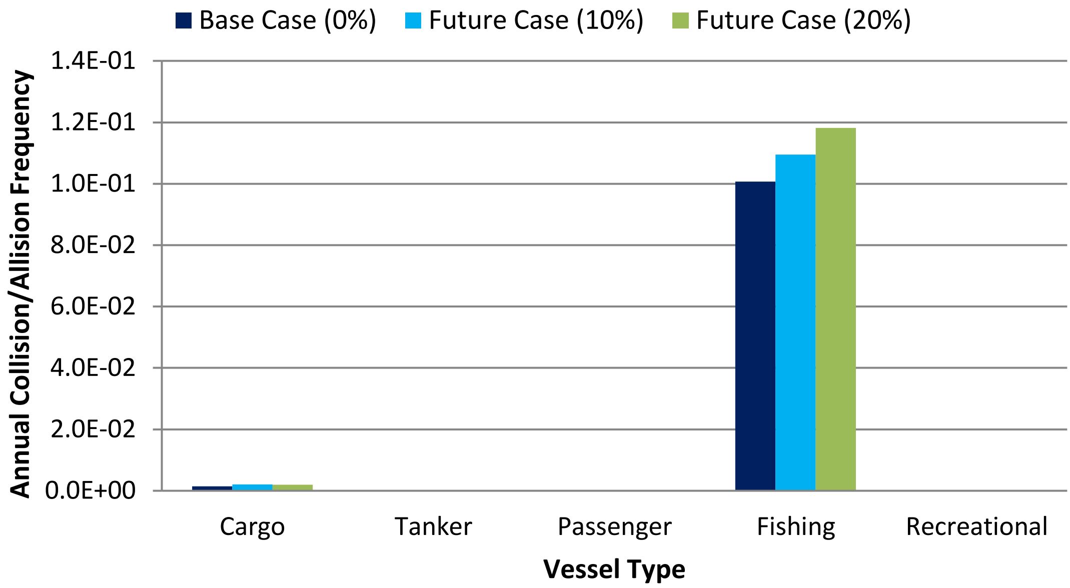

Figure C.13 Change in Annual Collision and Allision Frequency by Vessel Type

It can be seen that the majority of change in collision and allision frequency is associated with fishing vessels, owing to the greater duration spent in proximity to OAA by fishing vessels engaged in fishing activities and the possibility of fishing occurring internally within the OAA itself.

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 offshore Project for the base case is estimated to be 6.84×10^{-4}, equating to one additional fatality every 1,462 years.

The estimated incremental increases in PLL due to the offshore Project, distributed by vessel type for the base and future cases, are presented in Figure C.14.

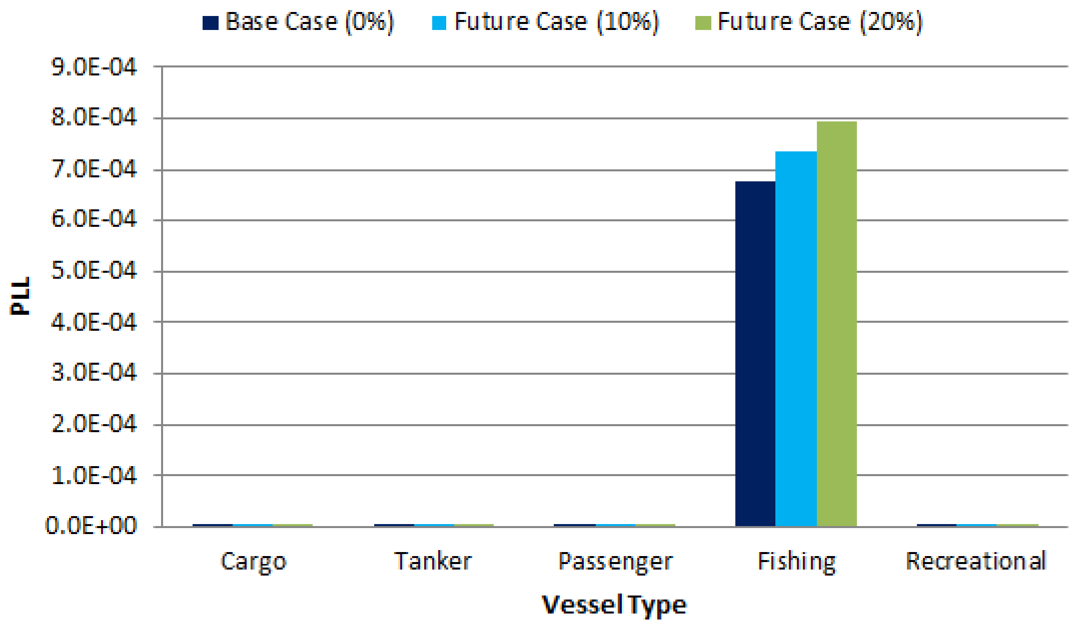

Figure C.14 Estimated Change in Annual PLL by Vessel Type

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.

Converting the PLL to individual risk based upon the average number of people exposed by vessel type, the results are presented in Figure C.15.

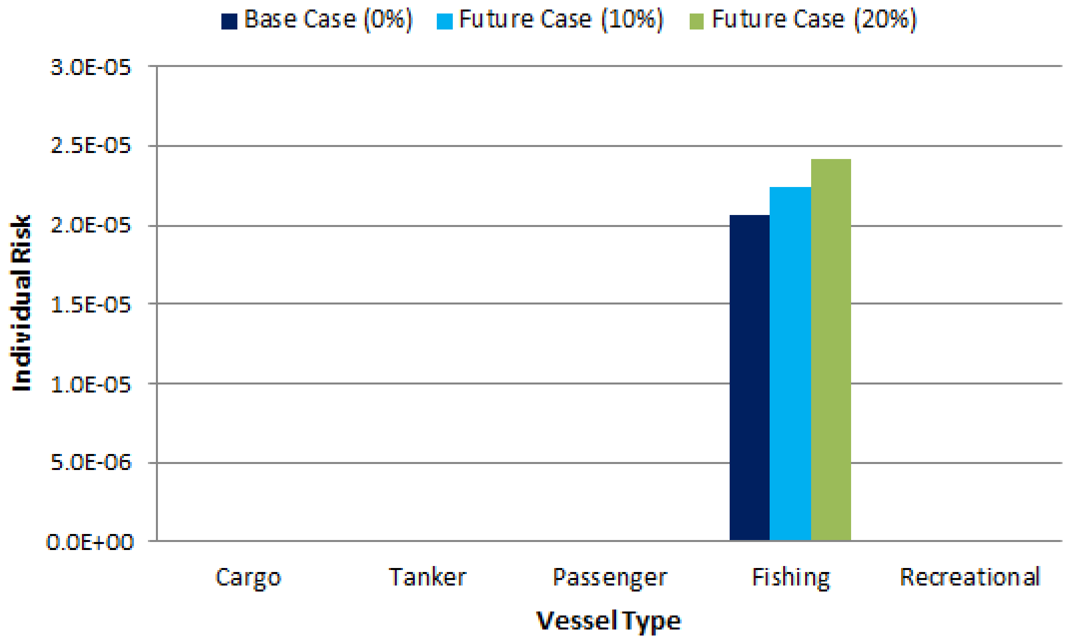

Figure C.15 Estimated Change in Individual Risk by Vessel Type

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.

C.3.4 Significance of Increase in Fatality Risk

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 1,703 years represents a small change.

In terms of individual risk to people, the change for commercial vessels attributed to the offshore Project (approximately 1.21×10^{-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.

For fishing vessels, the change in individual risk attributed to the offshore Project (approximately 2.06×10^{-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

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).

Two types of oil spill are considered within this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

Research undertaken as part of the UK's DfT MEHRAs 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.

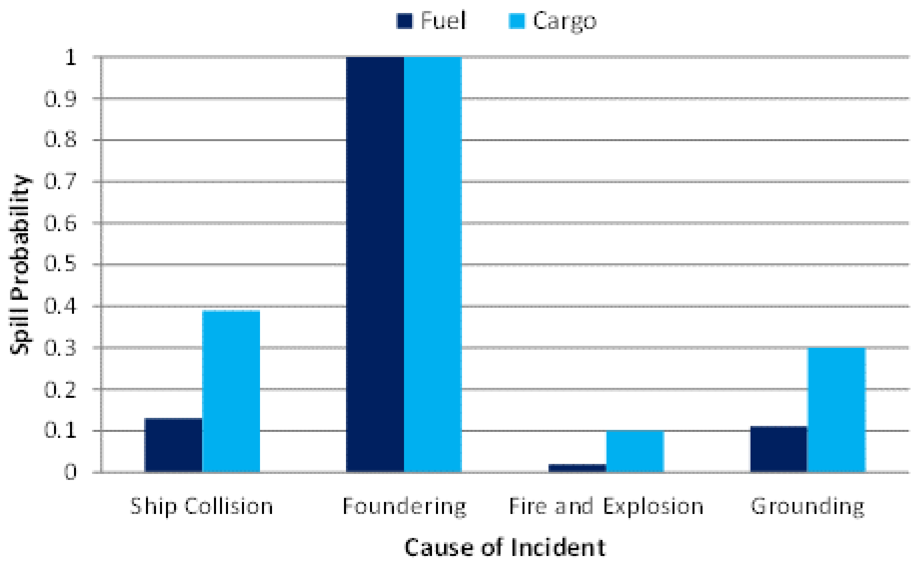

Figure C.16 Probability of an Oil Spill resulting from an Incident

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.

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.

For the types and sizes of vessels exposed to the offshore Project, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

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.

Based upon this data and the tankers transiting in proximity to the OAA, an average spill size of 400 tonnes is considered conservative.

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 Offshore Project

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 offshore Project would equate to 0.29 tonnes of oil per year for the base case. For the future case scenarios, this estimate increases to 0.32 tonnes and 0.34 tonnes for traffic increases of 10% and 20%, respectively.

The estimated increase in tonnes of oil spilled, distributed by vessel type, for the base and future cases are presented in Figure C.17.

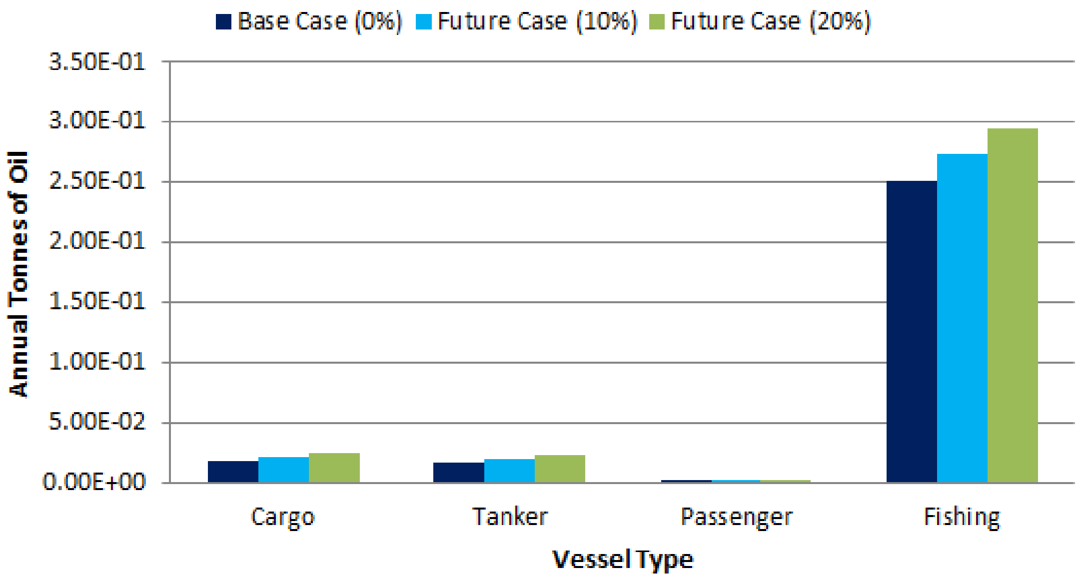

Figure C.17 Estimated Change in Pollution by Vessel Type

The majority of annual oil spill results are associated with fishing vessels due to the high annual allision frequency associated with fishing vessels. Tankers and cargo vessels also contribute to the annual oil spill estimate, which reflects the greater spillage size anticipated in associated incidents.

C.4.3 Significance of Increase in Pollution Risk

To assess the significance of the increased pollution risk from vessels caused by the offshore Project, historical oil spill data for the UK has been used as a benchmark.

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%.

The overall increase in pollution estimated due to the offshore Project of 0.29 tonnes for the base case represents a 0.002% increase compared to the historical average pollution quantities from marine incidents in UK waters.

C.5 Conclusion

This appendix has quantitatively assessed the fatality and pollution risk associated with the offshore 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 offshore Project on people and the environments is very low compared to the existing background risk levels.

Appendix D Regular Operator Consultation

As part of the consultation process for the offshore Project, Regular Operators identified (from the vessel traffic surveys and long-term vessel traffic data) that would be required to deviate their routes due to the presence of the OAA were consulted via email. An example of the correspondence sent to the Regular Operators (which shows the extent of the OAA and ECC at that time) 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: 15/09/2022
Ref: A4292-WOW-RO-1

Opportunity to Participate in Consultation Relating to Shipping and Navigation for the Proposed West of Orkney Offshore Wind Farm

Dear Stakeholder,

As you may be aware, Offshore Wind Power Limited (OWPL) is the developer of the West of Orkney Offshore Wind Farm ('the Project') which was awarded in the recent ScotWind offshore wind leasing round. The Project is to be located approximately 16 nautical miles (nm) off the west coast of Orkney and around 13nm from the north Sutherland coast. The project is currently considering both fixed-bottom foundations and floating substructures for the wind turbines which when constructed will generate an approximate capacity of 2GW (capable of powering the equivalent of more than two million homes). Further information relating to the Project is available on the Project website here.

Following a Scoping Report for the Project submitted to Scottish Ministers, in March 2022 (see here), West of Orkney Windfarm are proceeding to create the associated Navigational Risk Assessment (NRA) which will inform the shipping and navigation assessment undertaken for the application.

As part of the NRA process, the Project would like to ensure that comprehensive consultation is undertaken to identify any potential impacts that the Project may have upon shipping and navigation users. To analyse shipping movements within and in the vicinity of the site, 12 months Automatic Identification System (AIS) data covering the entirety of 2021 has been collected and assessed and will feed into the NRA. According to the assessment of the available datasets, your company's vessel(s) have been recorded navigating within and/or in the vicinity of the site. Consequently, your company has been identified as a potential marine stakeholder for the Project. We therefore invite your feedback on the potential development including any impact it may have upon the navigation of vessels.

An overview of the site for the Project is provided in Figure 1 for your reference.

We would be grateful if you could provide us with any comments or feedback that you may have, including any impact it may have upon the navigation of vessels, by the 28th September. This will allow us to assess your feedback as part of the NRA which is currently being undertaken. We would also be grateful if you could forward a copy of this information to any other vessel operators/owners you feel may be interested in commenting. For reference, the operators we are reaching out to directly are listed out in Appendix A to this letter.

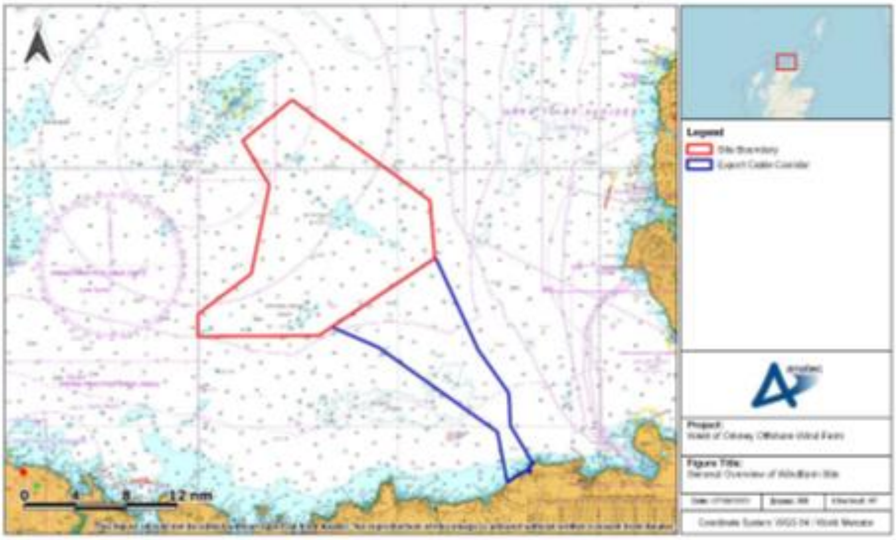

Figure 1 General Overview of the Project Site

Whilst we welcome all feedback we are particularly interested in any comments or feedback on the following:

1. Whether the proposal to construct the Project is likely to impact the routeing of any specific vessels, including the nature of any change in regular passage;
2. Whether any aspect of the Project poses any safety concerns to your vessels, including any adverse weather routeing;
3. Whether you would choose to make passage internally through the array;
4. Whether you would view floating turbines any differently from fixed turbines from a passing vessel perspective; and
5. Whether you wish to be retained on our list of marine stakeholders and consulted throughout the NRA process.

Additionally, we would like to invite you to attend a Hazard Workshop scheduled to take place in late October 2022. Details are to be confirmed imminently.

We would appreciate any responses are provided via email to [redacted] as well as an indication of whether you are interested in attending the Hazard Workshop noted above.

Yours sincerely,

[redacted]
Risk Analyst
Anatec Ltd.

Appendix A – List of Operators

- AquaShip
- Arklow Shipping
- Astrol LLC
- Biofeeder
- Cargow
- DFDS
- Eimskip
- Exmar
- Hav Shipping
- James Fisher
- Longship
- Marnavi
- Migdale Transport Ltd
- Serco Northlink
- Nordic Chartering
- NTS Shipping
- Ocean Farm Services
- Samskip
- Scotline
- SMT Shipping
- Smyril Line
- Solvatrans
- Stenersen
- Tarbit Tankers
- Thun Tankers

Appendix E Long-Term Vessel Traffic Movements

E.1 Introduction

This appendix assessed the additional long-term vessel traffic data for the offshore Project.

As required under MGN 654 (MCA, 2021), the NRA and Offshore EIA Report, chapter 15 (of the EIAR): Shipping and navigation 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. Therefore, in line with good practice assessment procedures, this NRA will also consider a long-term dataset covering the entirety of 2021 to ensure comprehensive characterisation of vessel traffic movements can be established, including the capture of any seasonal variation.

This approach (i.e., the use of both short- and long-term data) have been agreed with the MCA and NLB.

E.1.1 Aims and Objectives

The key aims and objectives of this appendix are as follows:

- Identify seasonal variations in vessel traffic via assessment of the long-term vessel traffic data;
- Determine which variations are not reflected within the short-term vessel traffic survey data (and therefore should be fed into the NRA baseline); and
- Assess which dataset (long-term, survey, or a combination of both) should be utilised for each key NRA element that requires vessel traffic data input.

E.2 Methodology

E.2.1 Study Area

This appendix has assessed the long-term vessel traffic data within a custom offshore study area surrounding the OAA. The offshore study area was defined in order to capture relevant routeing within the vicinity of the OAA and so a 10 nm buffer was considered for the eastern extents of the OAA boundary. However, this radius has been extended to 15 nm to the northwest to ensure vessels passing offshore of the Skerry Rocks are captured. This follows feedback from the Chamber of Shipping received during Scoping which stated that vessels currently transiting through the OAA may be displaced into the area offshore of the Skerry rocks (Section 4).

E.2.2 Data Period and Temporary Vessel Traffic

The long-term vessel traffic data was collected from coastal AIS receivers for the entirety of 2021 (i.e., 1 January to 31 December 2021) and so data assessed in the long-term analysis was AIS only. The percentage uptime per month for the AIS receivers for the AIS data that has used within this report was analysed. On average across the entire study period, the uptime for the receivers was estimated at >99%.

Any traffic deemed to be temporary and / or non-routine in nature have been excluded from the analysis, as per the vessel traffic surveys. Traffic that was excluded included vessels engaged in active survey or guard work within, or in transit to areas out with, the offshore study area. Temporary traffic that have been filtered out of the rest of the analysis is presented below in Figure E.1.

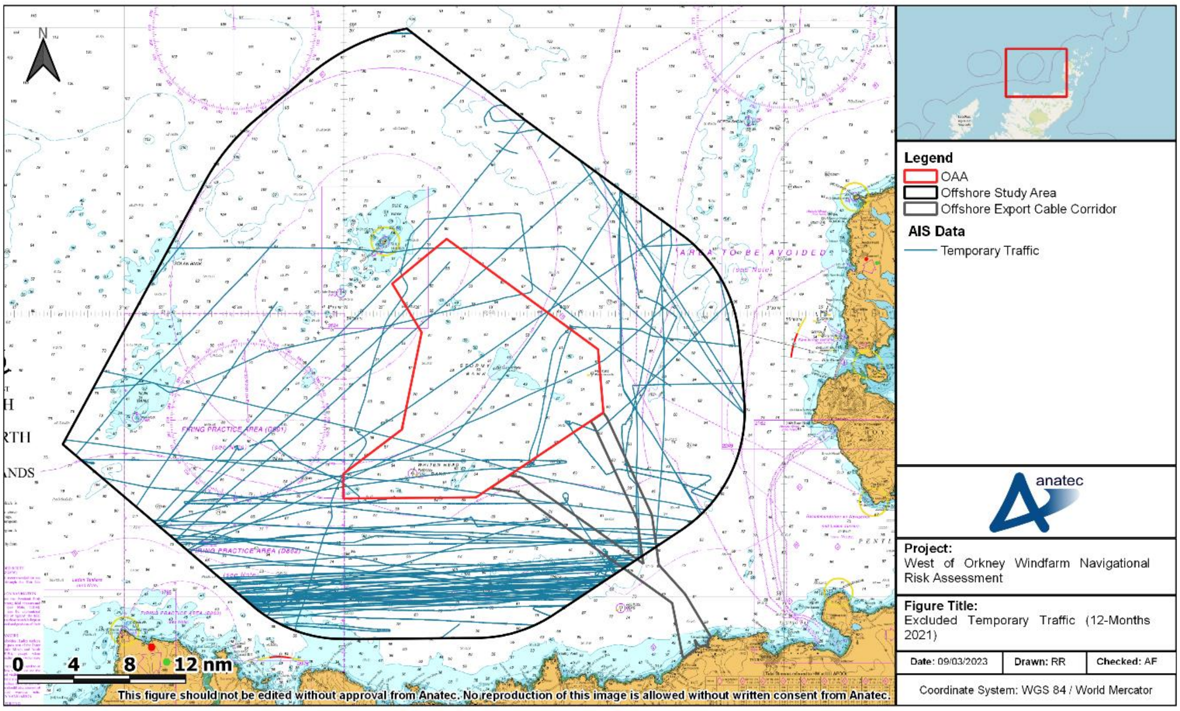

Figure E.1 Long-Term AIS Data -Excluded Temporary Traffic (12-Months, 2021)

E.2.3 AIS Carriage

General limitations associated with the use of AIS data (for example, carriage requirements) are discussed within Section 5.4.

E.3 Long-Term Vessel Traffic Movements

A plot of the vessel tracks recorded within the offshore study area during the data period, colour-coded by vessel type and excluding temporary traffic is presented in Figure E.2. The vessel density within the offshore study area is then presented in Figure E.3.

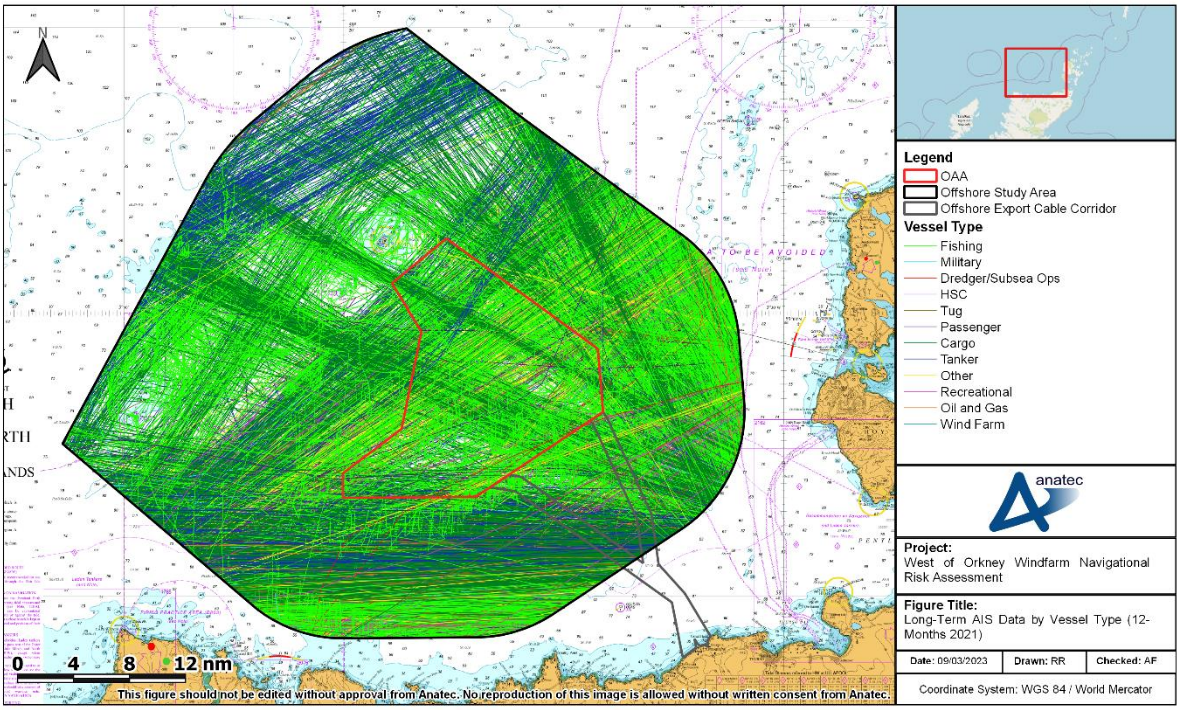

Figure E.2 Long-Term AIS Data by Vessel Type (12-Months, 2019)

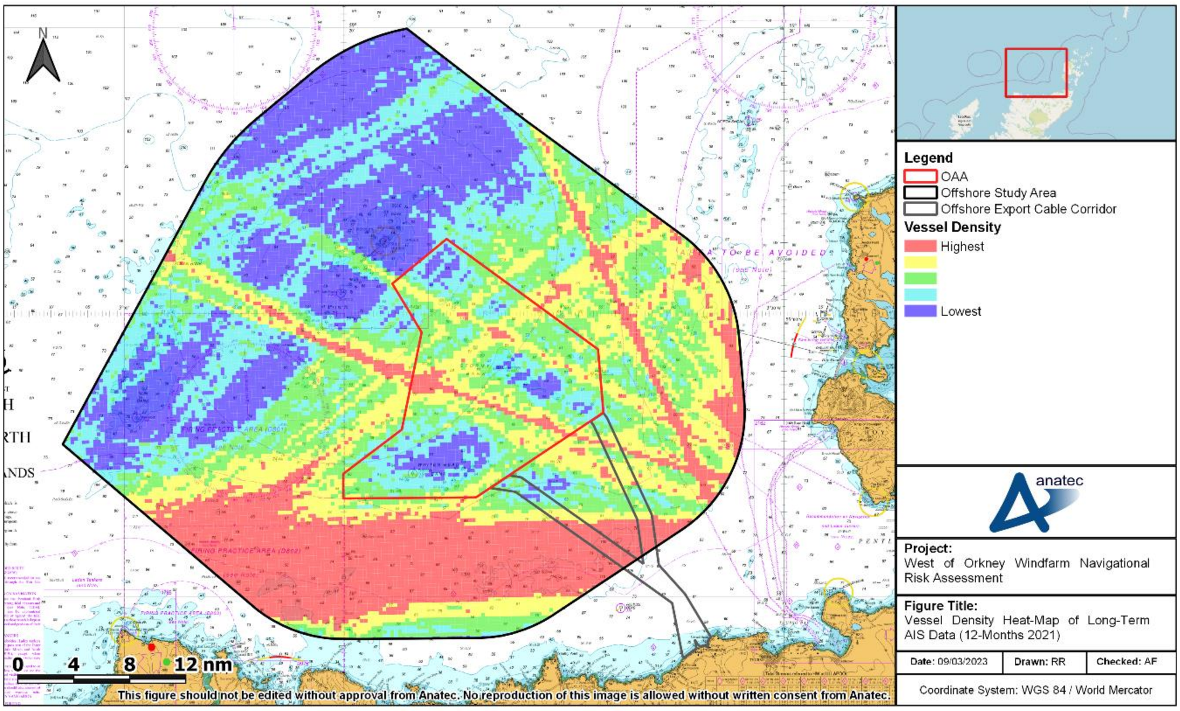

Figure E.3 Vessel Density Heat-Map of Long-Term AIS Data (12-Months, 2021)

E.3.2 Vessel Count

The average daily number of vessels within the offshore study area and the OAA are presented in Figure E.4.

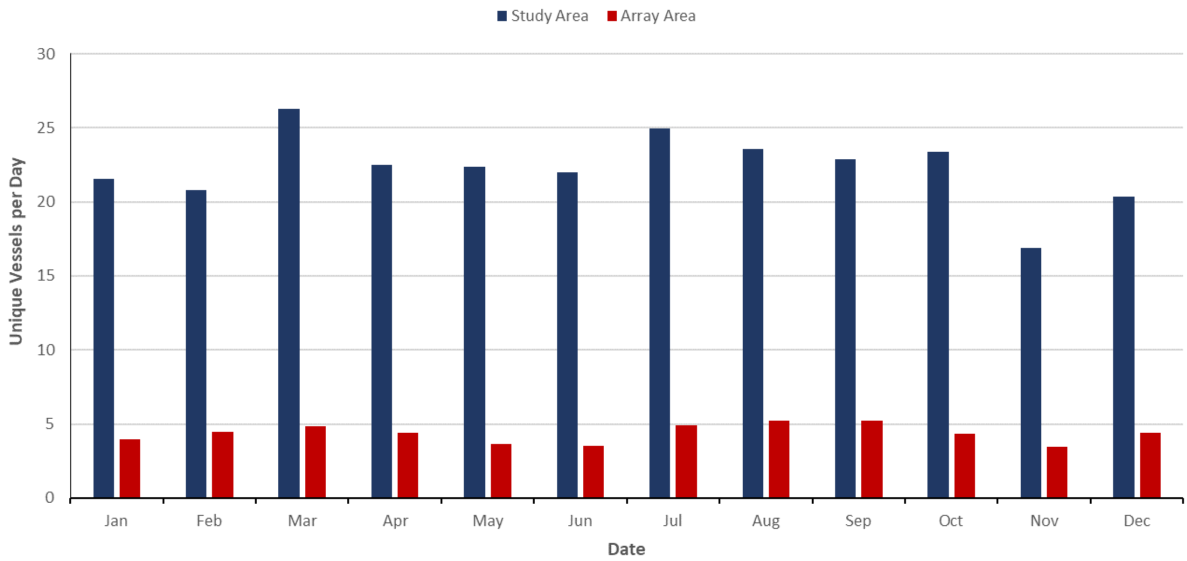

Figure E.4 Long-Term Daily Vessel Counts by Month within the OAA and Offshore Study Area (12-Months, 2021)

The busiest month recorded within the offshore study area was March with an average of 26 unique vessels per day, while the quietest month was November with an average of 17 unique vessels per day. These months were also the busiest and quietest months for vessels intersecting the OAA.

E.3.3 Vessel Type

The distribution of the main vessel types recorded during the data period are presented in Figure E.5.

It is noted that the vessel types recorded that made up less than 1% of all data were included in the 'All Other' Category[11].

[11] Vessel types included in All Other category are: Military, Dredger / Subsea, HSC, windfarm, and other.

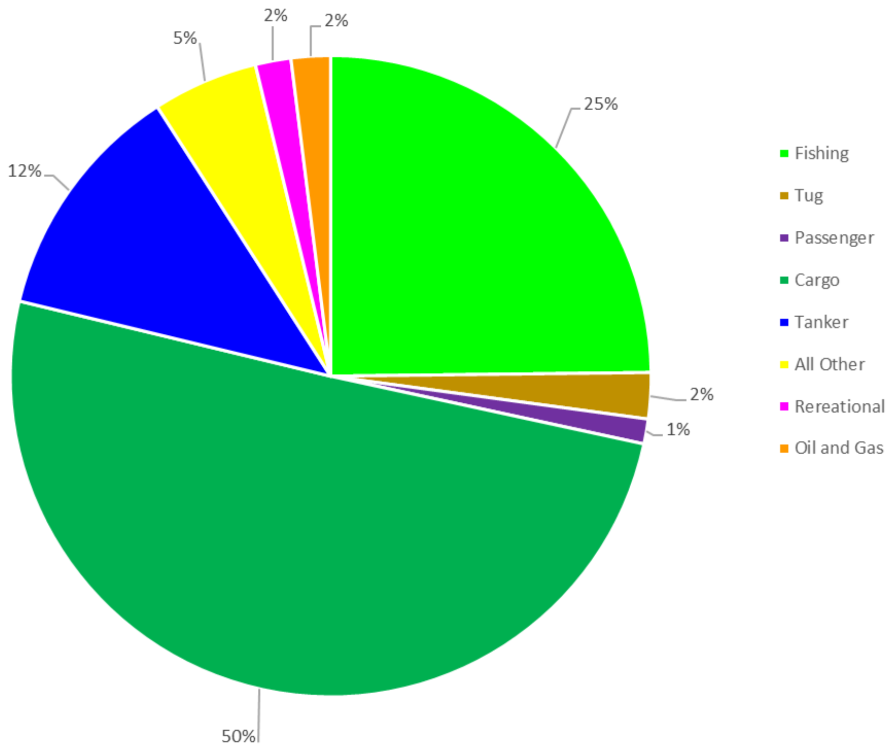

Figure E.5 Main Vessel Type Distribution (12-Months, 2021)

The most common vessel types recorded were cargo vessels which accounted for half of all traffic recorded (50%). Other common vessel types included commercial fishing vessels (25%), and tankers (12%).

E.3.4 Commercial Vessels

Figure E.6 presents the commercial vessels recorded within the offshore study area during the data period, colour-coded by vessel type. Commercial traffic in this scenario includes cargo vessels, passenger vessels, and tankers.

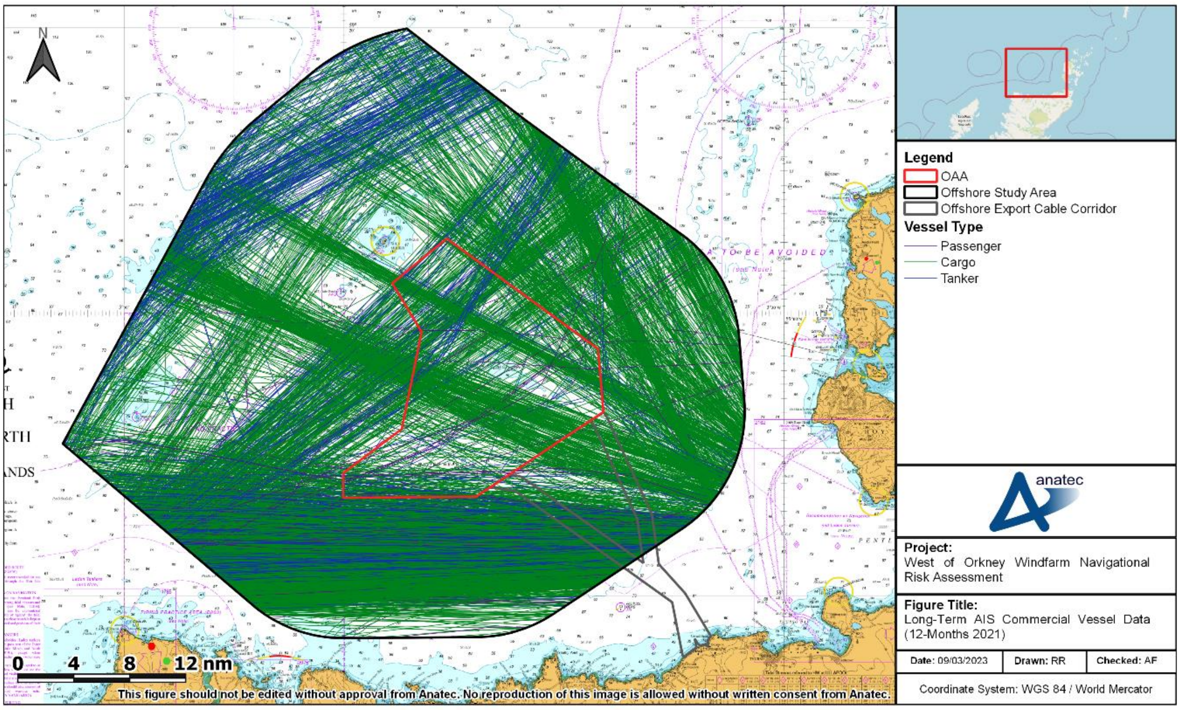

Figure E.6 Commercial Vessels by Vessel Type (12-Months, 2021)

A high density of commercial traffic was noted within the offshore study area, accounting for approximately 64% of all activity within the offshore study area. The majority of commercial traffic area on well-defined shipping routes. Routing was predominantly in east-west and northwest-southeast direction to / from the Pentland Firth. Regular RoRo routeing included the Smyril Line-operated route between Scrabster and Tórshavn, with approximately one transit per week recorded, as well as the DFDS Seaways-operated RoRo route between Belfast and Skogn approximately two to three times per month. A higher volume of tanker traffic was noted to the northwest of the site, offshore from Skerry Rocks, when compared with other commercial vessels.

Figure E.7 presents the average number of unique commercial vessels for each vessel type detected per month within the offshore study area.

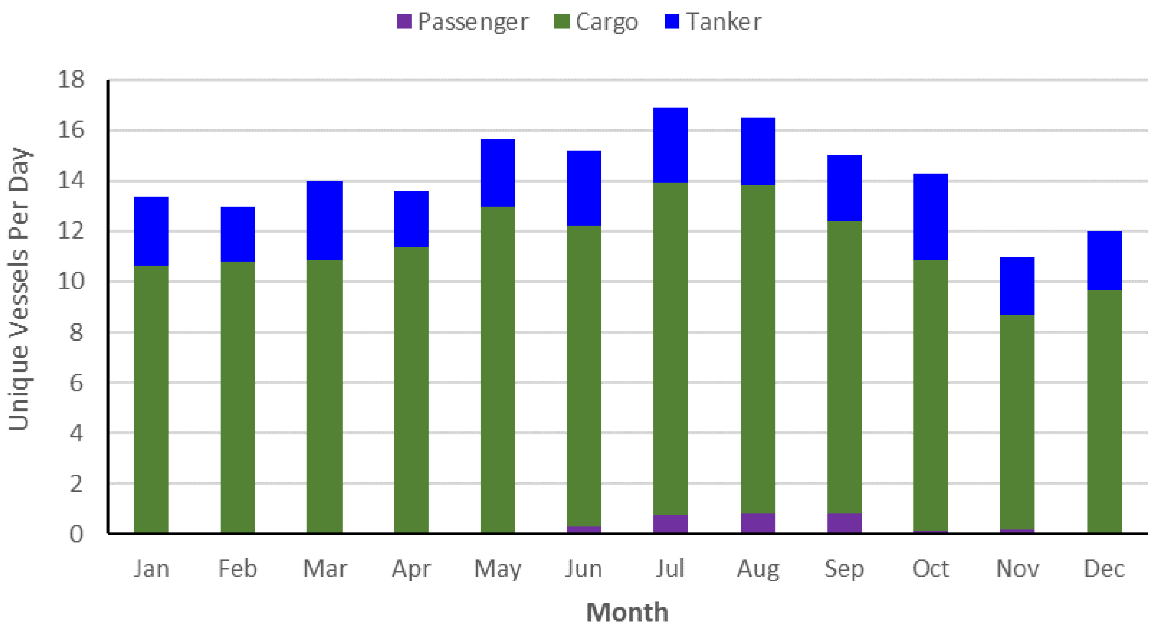

Figure E.7 Average Number of Daily Commercial Vessels per Month within the Offshore Study Area (12-Months, 2021)

Passenger vessels highlighted the seasonal variation within the offshore study area, as higher counts of vessel presence was recorded between June and September when compared with the winter months.

Cargo vessels showed minimal seasonal variation with vessel numbers peaking in July with 409 vessels recorded. The quietest month was December with 299 vessels recorded.

Tankers, similar to cargo, showed minimal seasonal variation. The busiest month for tankers were October when 106 vessels were recorded, and the quietest month was February when 61 vessels were recorded.

Table E.1 presents a summary of the average number of commercial vessels within the offshore study area during the busiest month, quietest month, and the average throughout the full data period.

Table E.1 Quietest, Busiest, and Average Daily Unique Vessel Counts for Commercial Vessels (12-Months, 2021)

Vessel Type	Quietest Month (Unique vessels per day)	Busiest Month (Unique vessels per day)	Average (Unique vessels per day)
Cargo vessels	9-10	13	11
Tankers	2	5-6	2-3
Passenger vessels	0	1	0-1

In summary the most common type of commercial vessels recorded within the offshore study area was cargo vessels. Cargo vessels and tankers showed minimal seasonal variation while passenger vessel activity was greater in the summer months.

E.3.5 Other Commercial Users

Other commercial vessel types recorded within the offshore study area are presented in Figure E.8. These vessels are not deemed to be on distinct commercial routes and timetables but more involved in commercial operations.

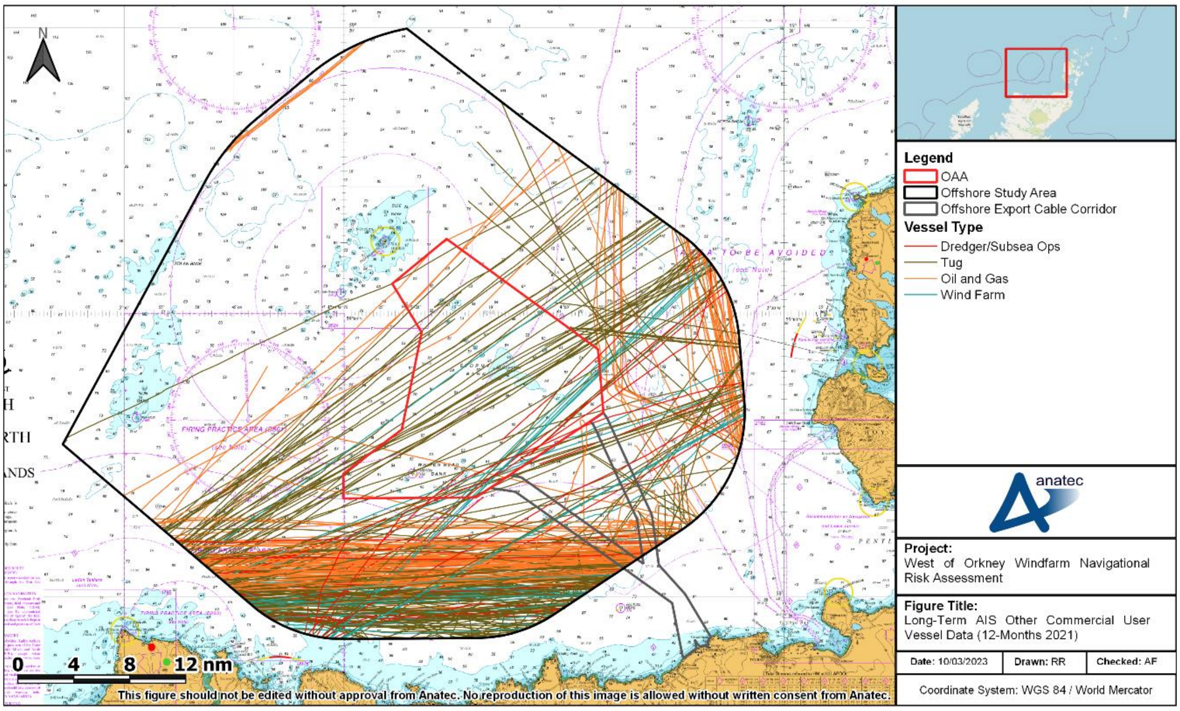

Figure E.8 Other Commercial Vessels by Vessel Type (12-Months, 2021)

Other commercial traffic including oil and gas support vessels, windfarm vessels, tugs, and marine aggregate dredgers and sub-sea operation vessels were recorded within the offshore study area. These vessels were noted heavily to the south of the offshore study area on an east-west transit. Other vessels were recorded transiting northeast-southwest across the offshore study area as well as north-south to the eastern extent.

On average, one oil and gas support vessel and tug was recorded within the offshore study area every two days. June was the busiest month for both of these vessel types with 25 oil and gas support vessels and 20 tugs. Windfarm vessels and marine aggregate dredgers / subsea operation vessels were less common with one unique vessel recorded on average every 14 days for each vessel type within the offshore study area.

E.3.6 Commercial Fishing Vessels

Commercial fishing vessels made up a quarter (25%) of all vessels recorded on AIS during the data period. Figure E.9 presents all fishing vessels recorded within the offshore study area during the data period colour-coded by likely fishing activity. Fishing activity was determined by vessel speed, destination, track behaviour, and navigational status information transmitted via AIS. It is considered that a proportion of vessels were recorded on transit before and after being identified in active fishing activity.

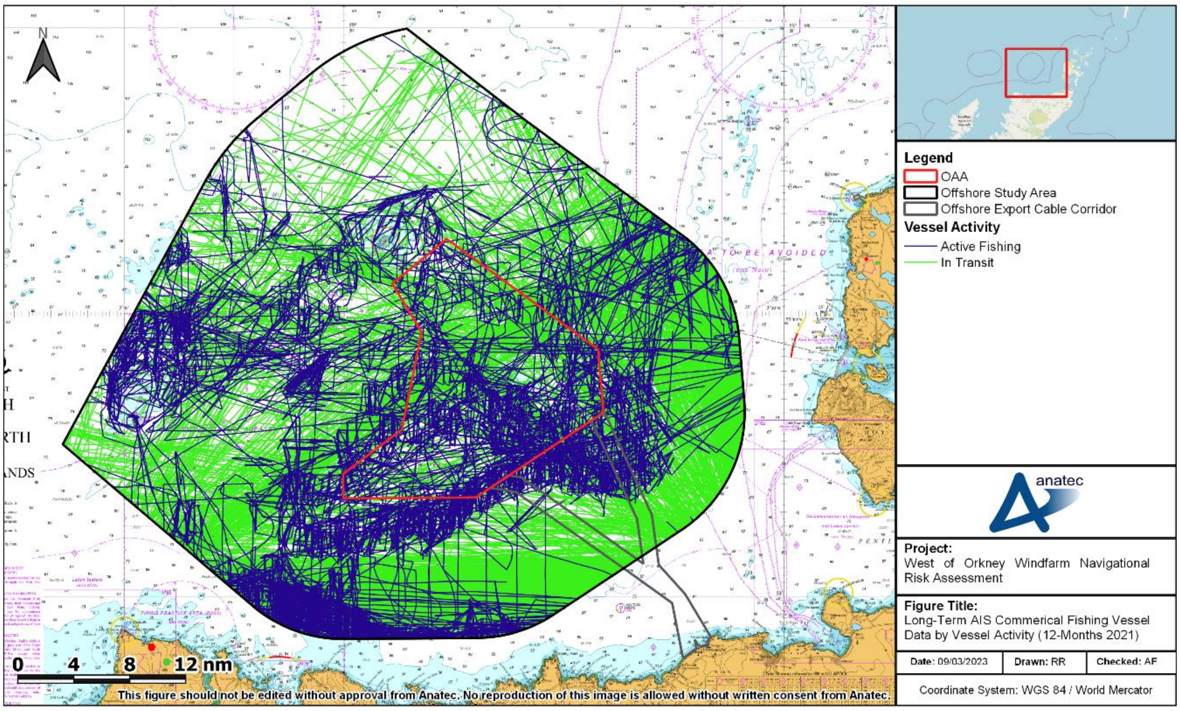

Figure E.9 Commercial Fishing Vessels by Vessel Activity (12-Months, 2021)

Commercial fishing vessels were seen both in transit (77%) and engaged in likely fishing activity (23%) within the offshore study area. Of those vessels engaged in fishing, activity was presents across the offshore study area with a heavy presence at the south and west boundaries as well as within and surrounding the OAA. Fish gear was identified for all vessels engaged in likely fishing with potters / whelkers being the most common (94%). Dredgers, pelagic and demersal trawlers, and demersal pair trawlers were also recorded.

The distribution of daily unique commercial fishing vessels recorded per month within the offshore study area is presented in Figure E.10.

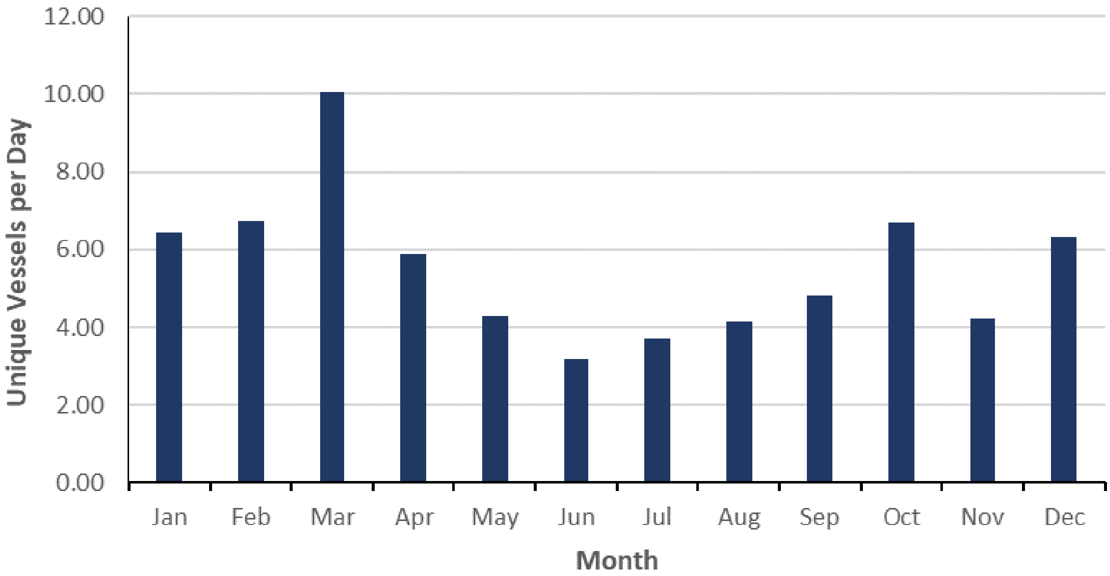

Figure E.10 Average Daily Commercial Fishing Vessel Count per Month within the Offshore Study Area (12-Months, 2021)

Fishing in the area showed slight seasonality with a higher number of vessels recorded in the winter and spring months. The busiest month was March with 312 unique vessels recorded. The quietest month was June with 96 vessels recorded. On average, across the data period, an average of five to six unique vessels were present within the offshores study area per day, or 169 unique vessels per month.

E.3.7 Recreational Vessels

Figure E.11 presents the commercial vessels recorded within the offshore study area during the data period.

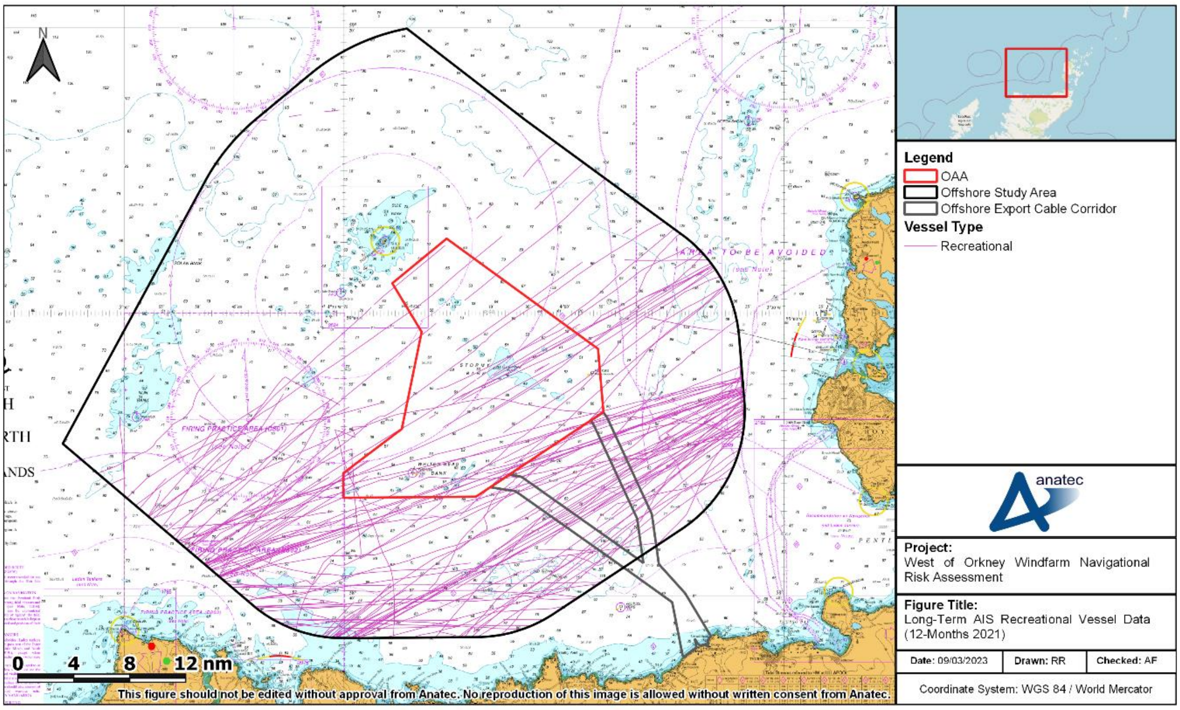

Figure E.11 Recreational Vessels (12-Months, 2021)

Recreational vessel activity was typically observed within the southwest of the offshore study area with most vessels on a northeast-southwest transit. These vessels remain coastal with less vessels recorded further offshore. Based on the behaviour of recorded AIS vessel tracks, there is a potential that a large proportion of recreational vessels were going to/and from Stromness, East of study area, and Loch Eriboll, South of study area. Vessels can also be seen passing to the West of Cape Wrath.

The distribution of daily unique recreational vessels recorded per month within the offshore study area is presented in Figure E.12.

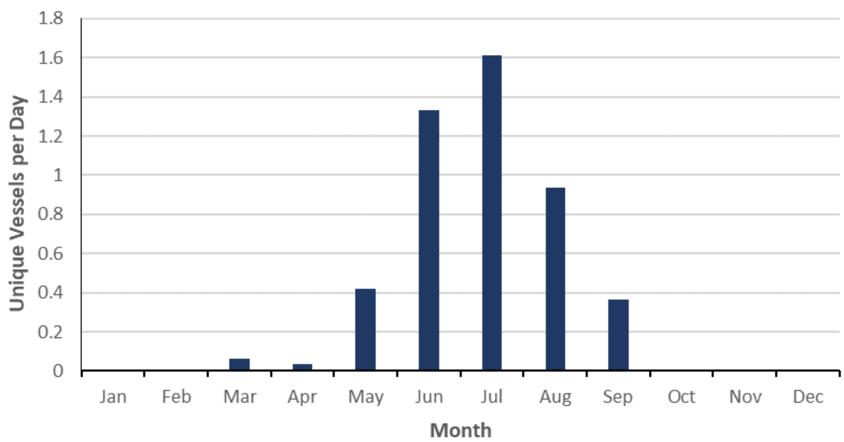

Figure E.12 Average Daily Recreational Vessel Count per Month within the Offshore Study Area (12-Months, 2021)

Recreational vessels showed great seasonal variation with higher numbers of vessels recorded during the summer months when compared to winter. July was the busiest month with a recorded 50 vessels. No recreational vessels were recorded January-February and October-December. An average of 12 unique recreational vessels were recorded per month or an average of one vessel every two to three days within the offshore study area.

E.4 Site Specific Analysis

The vessel tracks intersecting the OAA during the data period are presented in Figure E.13.

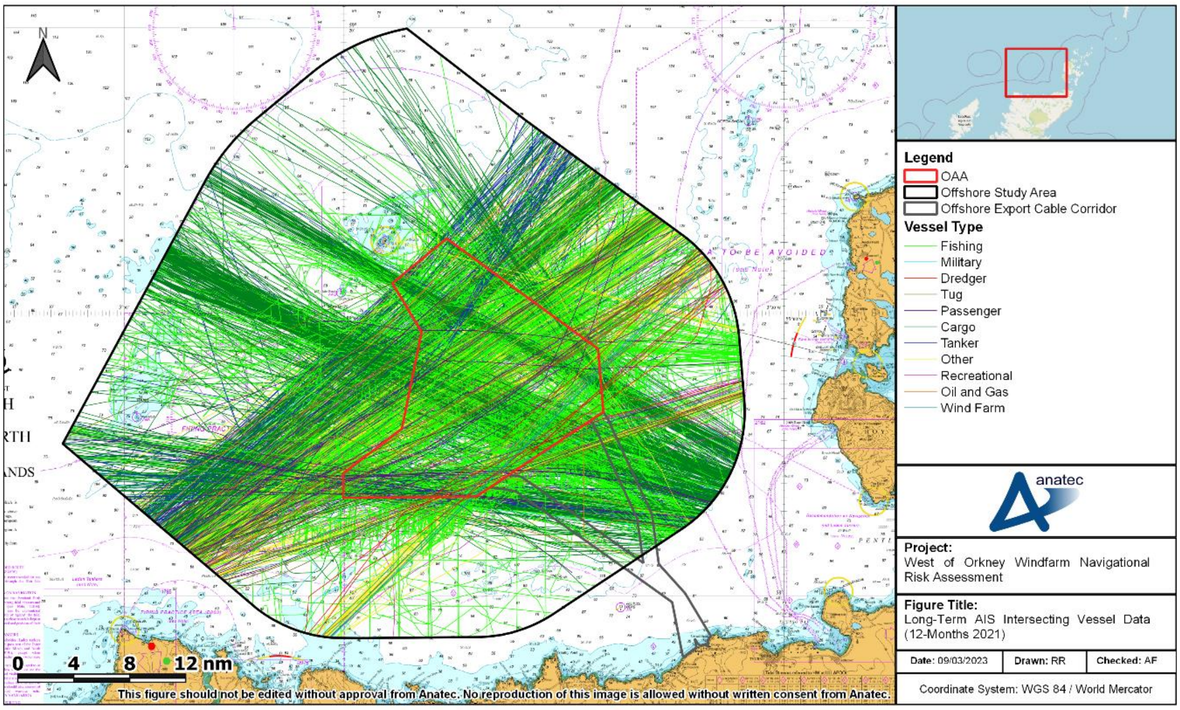

Figure E.13 Vessels Intersecting the OAA by Vessel-Type (12-Months, 2021)

On average, four unique vessels per day were recorded intersecting the OAA. The busiest month was March with 150 unique vessels, with the busiest days recorded being 6 March 2021, 4 September 2021, and 9 October 2021 when 11 unique vessels were recorded intersecting the OAA. The quietest month was November with 103 unique vessels recorded.

The vessel type distribution of vessels intersecting the OAA during the data period is presented in Figure E.14.

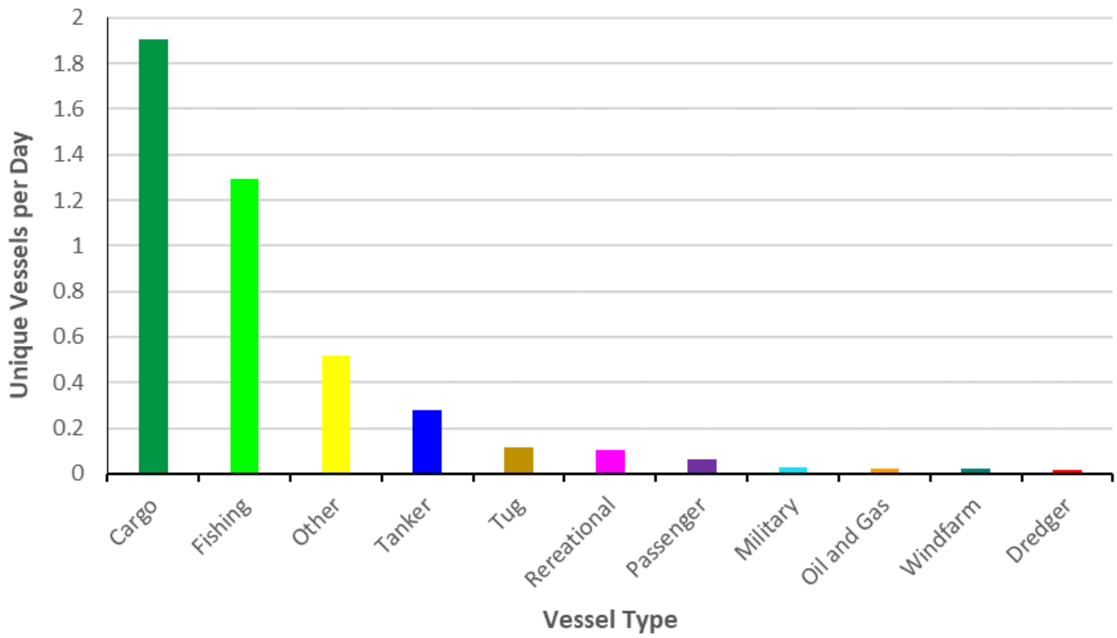

Figure E.14 Distribution of Vessels Intersecting the OAA by Vessel Type (12-Months, 2021)

The most common vessel types recorded within the OAA were cargo vessels (comprising 44% of all vessels), followed by fishing vessels (30%), and vessels classed as 'other' (the majority of these vessels were fish carriers).

It can be seen from Figure E.13 that considerable levels of commercial vessel activity was observed within the OAA. On average two cargo vessels passed through the OAA per day, while an average of one tanker every three to four days, and one passenger vessel every two weeks was also recorded.

E.5 Survey Data Comparison

Survey data recorded during the 14-day periods in August and November 2022 were collected using a combination of AIS, Radar, and visual observation. This subsection provides comparison of the 28-Day survey data (summer and winter combined) against the long-term 2021 AIS data.

A comparison of the average number of each main vessel type recorded during the long -term 2021 data and the two 14-day survey periods area presented in Table E.2.

Table E.2 Average Daily Vessel Counts by Vessel Type for Survey and Long-Term Data

Vessel Type	Long-term 2021 AIS Data (Vessels per Day)			Summer Survey (August 2022)	Winter Survey (November 2022)
	Quietest Month	Busiest Month	Average Vessels per Day	Average Vessels per Day	Average Vessels per Day
Cargo Vessels	8-9	13	11	13	8-9
Commercial fishing vessels	3	10	5-6	3	5
Tankers	2	3-4	2-3	1-2	1-2
Recreational vessels	0	1-2	0-1	1	0
Passenger vessels	0	1	0-1	1-2	0
Oil and gas Vessels	0-1	1	0-1	0	0-1

The average daily vessel count within the long-term data was mostly consistent with the survey data for the majority of vessel types. Tankers and commercial fishing vessels were recorded at a higher level (albeit a minor increase) during the long-term data analysis than that of the survey data. Passenger vessel traffic levels were higher in the summer survey than the long term AIS.

E.6 Conclusion

A year of AIS data during 2021 has been analysed to validate the summer and winter 2022 vessel traffic survey data recorded within the offshore study area.

The main vessel types detected within the offshore study area during 2021 were cargo vessels (50%), commercial fishing vessels (25%), and tankers (12%). Similarly, the main vessel types detected during the summer 2022 vessel traffic survey were cargo vessels (54%), commercial fishing vessels (15%), and passenger vessels (7%), with tankers (6%) following. Passenger vessels were noted to be higher during the summer survey period due to seasonal variation in passenger cruise liners. The winter 2022 vessel traffic survey showed the same trend as the long-term data with the main vessel types recorded being cargo vessels (47%), commercial fishing vessels (29%), and tankers (10%). Overall, the vessel types detected within the offshore study area were similar between the long-term data and the vessel traffic surveys with tankers and commercial fishing vessels showing slightly higher average numbers during the long-term data than that of the survey data. Passenger vessel traffic levels were higher in the summer survey than the long term AIS.