LLŶR FLOATING OFFSHORE WIND PROJECT

Llŷr 1 Floating Offshore Wind Farm

Environmental Statement

Volume 6: Appendix 22E – Marine Ornithology Project Alone and Cumulative Impact Scenarios

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Prepared by: Llŷr Floating Wind Ltd

FLOVENTIS ENERGY

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Acronyms and abbreviations

Acronym or Abbreviation	Definition	Acronym or Abbreviation	Definition
EIA	Environmental Impact Assessment	PVA	Population Viability Analysis
HRA	Habitats Regulation Assessment	SPA	Special Area of Protection
JNCC	Joint Nature Conservation Committee	SSSI	Special Site of Scientific Interest
NRW (A)	Natural Resources Wales Advisory	SSSP	Skomer, Skokholm and Seas off Pembrokeshire

Glossary of project terms

Term	Definition
The Applicant	The developer of the Project, Llŷr Floating Wind Limited
Array	All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s).
Array Area	The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located
Floventis Energy	A joint venture company between Cierco Limited and SBM Offshore Limited of which Llyr Floating Wind Limited is wholly owned by.
Landfall	The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays
Llŷr 1	The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases.
Marine Licence	A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team (MLT) on behalf of the Welsh Ministers.
Offshore Development Area	The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application
Offshore Export Cable	The cable(s) that transmit electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OfECC)	The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall.
Onshore Development Area	The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as

Term	Definition
	defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application.
Onshore Export Cable(s)	The cable(s) that transmit electricity from the landfall to the onshore substation
Onshore Export Cable Corridor (OnECC)	The area within which the onshore export cable circuit(s) will be located.
proposed Project	All aspects of the Llŷr 1 development (i.e. the onshore and offshore components).
Onshore Substation	Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption.
Section 36 consent	Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works.
Barrier effects	Barrier effects may occur when birds that would have previously flown through an area (e.g., on the way to feeding, resting or nesting areas) either have to cease flying, or alter their flight paths due to the presence of an offshore wind farm which may affect energetic costs.
Collision risk	Risk that a bird entering the 'risk window', the sweep of the turbine blades, could be struck.
Displacement	Displacement is considered to be a reduction in the number of birds using / visiting the Array Area or its surroundings. Birds that would normally utilise the Array Area and surrounding sea may be disturbed or displaced from the area due to the presence of the wind turbine generators, resulting in an effective loss of available habitat for sensitive species.

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22E. MARINE ORNITHOLOGY PROJECT ALONE AND CUMULATIVE IMPACT SCENARIOS

22.1 Introduction

1. This **Technical Appendix 22E: Marine Ornithology Project Alone and Cumulative Impact Scenarios** determines the requirements for population modelling in respect of the focal seabird species in the assessments for the Llŷr Floating Offshore Wind Farm Project (hereafter referred to as the proposed Project) i.e., the Environmental Impact Assessment ('EIA') as reported in the **Environmental Statement (ES) Volume 3, Chapter 22 Marine Ornithology** and the Habitats Regulations Assessment (HRA) as reported in **Appendix 8E: HRA RIAA (Report to Inform Appropriate Assessment)**.
2. The impact scenarios determined in this report – for quantified impacts arising from the proposed Project, both project-alone and in combination with other relevant developments - feed directly into **Appendix 22F: Marine Ornithology Population Modelling.**
3. This process (the collation of impact scenarios and determination of population modelling requirements) is informed by the advice from Natural Resources Wales Advisory (NRW (A)) and the Joint Nature Conservation Committee (JNCC), received during pre-application consultation for the proposed Project (**Table 22-5** of **Chapter 22: Marine Ornithology**).
4. Of particular relevance is the advice received on the EIA and HRA reference populations for assessment as well as the direction to use 1% of baseline mortality (in relation to these populations) as the 'threshold' for determining whether the population consequences of quantified impacts require further investigation (which, if so, are addressed in **Appendix 22F: Marine Ornithology Population Modelling**).
5. This current **Appendix 22E** refers to the proposed Project-alone impact quantification presented in **Appendix 22C: Marine Ornithology Collision Risk Modelling** and **Appendix 22D: Marine Ornithology Displacement Assessment**. Collision risk and displacement / barrier effects are the two types of long-term impact arising from offshore wind farms where semi-quantitative methods have been developed to estimate potential seabird mortalities.
6. Although there will be some long-term loss[1] of foraging habitat arising from the proposed Project, this will be relatively minor compared to the extent of supporting habitat available to foraging seabirds, both within their breeding season foraging ranges (as defined in Woodward *et al.,* 2019) and within the full extent of their non-breeding BDMPS[2] (Furness, 2015). As such, there is no risk of any population consequence from this impact pathway requiring inclusion in **Appendix 22F: Marine Ornithology Population Modelling**.
7. Short-term disturbance / displacement impacts to seabirds and their prey species may also arise during wind farm construction and decommissioning and are considered in the assessment process (EIA and HRA). NRW(A) have suggested in their advice notes of 17 February 2023 and 05 April 2023 (**Table 22-5 in Chapter 22: Marine Ornithology**) that these disturbance/displacement impacts could be quantified by halving the range of displacement mortality matrix estimates presented in **Appendix 22D: Marine Ornithology Displacement Assessment**.

[1] The extent of potential habitat loss relates to the foundation choice for the floating turbines and to the placement of any rock protection for the export cable, plus any associated scouring potentially arising.

[2] BDMPS: Biologically Defined Minimum Population Scale

8. While it is possible to obtain such estimates, they cannot currently be carried forward into quantitative population modelling using the population viability analysis (PVA) tool commissioned by Natural England. This is because the NE PVA tool is not yet able to account for differential annual mortalities[3]. There would also be some complexity around deriving and combining measures of uncertainty for such estimates.

22.2 Methods

22.2.1. EIA Thresholds

9. **Table 22E-1** presents the calculation of the 1% thresholds of baseline mortality for EIA using the reference populations advised by NRW (A) and JNCC in their advice note dated 15 June 2023. Note that the adult survival rate has been used to derive this threshold.

10. Basing the 1% of baseline mortality on the adult survival rate creates a more stringent (or precautionary) threshold compared to adopting a mean survival rate across age classes. Therefore, it allows species to be readily screened against quantified impacts to identify if these are at a level of concern requiring further investigation (i.e., population modelling).

Table 22E-1. Calculation of 1% of EIA baseline mortalities

Species	Adult survival rate[1]	EIA (BDMPS) population[2] (individuals)	BDMPS date range	Baseline mortality	1% of baseline mortality
Gannet	0.919	661,888	2004 - 2013	53,613	**536**
Kittiwake	0.854	911,586	1998 - 2013	133,092	**1,331**
Guillemot	0.939	1,145,528	1998 - 2013	69,877	**699**
Puffin	0.906	1,482,791	1998 - 2013	139,382	**1,394**
Razorbill	0.895	606,914	1990s - 2013	63,726	**637**
Manx shearwater	0.87	1,821,544	1990s - 2012	236,801	**2,368**
Lesser black-backed gull	0.885	240,750	1990s - 2013	27,686	**277**
Great black-backed gull[3]	*0.93*	*44,753*	*1999 - 2012*	*3,133*	***31***

[1]Adult survival rate from Horswill and Robinson (2015). As noted, these EIA thresholds are based on adult survival only and hence are 'worst case' (or precautionary) for EIA populations which are 'whole' populations comprised of all age-classes (immatures, juveniles and chicks as well as adults).
[2]This is the relevant BDMPS population for assessment of total annual impacts under EIA, as advised by NRW (A) / JNCC in their note dated 15 June 2023 which uses the data available from Furness (2015). In this regard, the age of the data introduces uncertainty into the assessment, however, this is a recognised limitation which the SNCBs are aware of.
[3]The threshold for great black-backed gull is included for information only.

[3] That is, it is not currently possible to model 50% construction / decommissioning mortality estimates in addition to the 30-year (100%) operational mortality estimates.

22.2.2. SPA / SSSI Thresholds

11. **Table 22E-2** presents the calculation of the 1% thresholds of baseline mortality for SPA and SSSI qualifying interests, using colony count data that is most closely contemporaneous with the dates of the digital aerial survey programme undertaken for the proposed Project. Digital aerial surveys for the proposed Project were conducted monthly between March 2020 and March 2022 (24 surveys), and the closest available counts to this 'time stamp' have been used for quantification of impacts resulting from the proposed Project (see **Appendix 22B: Marine Ornithology Colony Apportioning** for further detail on the collation of colony count information).

Table 22E-2. Calculation of 1% of SPA and SSSI baseline mortalities

Species	Adult survival rate[1]	SPA breeding population[2] (individuals)	Year of census	Baseline mortality	1% of Baseline mortality
Grassholm SPA					
Gannet	0.919	72,022	2015	5,834	**58**
Skomer, Skokholm and Seas off Pembrokeshire (SSSP) SPA					
Kittiwake	0.854	2,878	2021	420	**4**
Guillemot	0.939	44,099[3]	2021-2022	2,690	**27**
Puffin	0.906	33,619	2021-2022	3,160	**32**
Razorbill	0.895	16,900[3]	2021-2022	1,775	**18**
Manx shearwater	0.870	910,312[4]	2018	118,341	**1,183**
Lesser black-backed gull	0.885	16,704	2021-2022	1,921	**19**
Castlemartin SSSI[5]					
Guillemot	0.939	22,591[2]	2021-2022	1,378	**14**

[1] Adult survival rate from Horswill and Robinson, 2015. This is the correct metric for SPA / SSSI populations given that their designation specifically relates to the population of breeding adults (as given on the citations).

[2] These are the colony counts most closely contemporaneous with the Llŷr survey programme.

*[3]A correction factor (based on Harris, 1989) has been applied to the total site count from the SMP for guillemot and razorbill to derive the number of breeding adults (see **Appendix 22B: Marine Ornithology Colony Apportioning** for detailed calculations).*

[4] Manx shearwater data from Perrins et al. (2020).

*[5]Assessment of guillemot at Castlemartin SSSI is the only colony-specific assessment required under EIA. Note that Lundy SSSI was also screened in for assessment at an early stage, however, once the colony-specific apportioning weightings were calculated, these showed that any estimated mortalities would be negligible against this SSSI (**Appendix 22B: Marine Ornithology Colony Apportioning**).*

22.2.3. Comparison Between Proposed Project-Alone Impacts and Thresholds for EIA

12. **Table 22E-3** presents the comparison between impacts and thresholds undertaken for EIA. As demonstrated, the project-alone impacts are fall well below thresholds for all species being assessed quantitatively under EIA, with the exception of guillemot.

13. For guillemot, the risk of population consequence from displacement impacts is investigated through PVA at the key breeding colonies in proximity to the proposed Project: SSSP SPA and Castlemartin SSSI (**Section 22.2.4** below, as taken forward into **Appendix 22F: Marine Ornithology Population Modelling**).

14. If there is no significant population consequence from total annual displacement impacts (project-alone and cumulative) against the key Pembrokeshire guillemot colonies, then it follows that there will not be significant effects at the wider (EIA) scale, assessing against a larger-sized population.

Table 22E-3. Comparison between project-alone impacts and 1% baseline mortality thresholds for EIA

Species	1% of Baseline mortality	Project-alone annual mortality estimates (for EIA)		
		Collision[1]	Displacement [2]	Total
Gannet	**536**	3.7	82.08	85.78
Kittiwake[3]	**1,331**	23.9		
Guillemot	**699**		1,052.45	
Puffin	**1,394**		52.08	
Razorbill	**637**		186.13	
Manx shearwater	**2,368**		236.4	
Lesser black-backed gull	**277**	1.9		

*[1] The collision mortality estimates presented are those for the 'worst case' ten turbine scenario for the proposed Project (**Appendix 22C: Marine Ornithology Collision Risk Modelling**).*
*[2] The figures quoted in this table are the maximum estimates obtained from the displacement matrix for each species, i.e., the upper end of the range advised by NRW (A) and JNCC; maximum displacement rates / mortality rates of 80%/10% for gannet, 70%/10% for the auks, 50%/10% for Manx shearwater (**Appendix 22D: Marine Ornithology Displacement Assessment**).*
*[3] Information on kittiwake displacement has been presented in **Appendix 22D: Marine Ornithology Displacement Assessment** at the request of JNCC.*

22.2.4. Comparison Between Project-Alone Impacts and Thresholds for SPA / SSSI Populations

15. **Table 22E-4** presents the comparison between impacts and thresholds undertaken for HRA (SPA) and EIA (SSSI) colony-specific assessments. From this work, it is determined that PVA is necessary for the following species:

- guillemot - to investigate the population consequences of displacement impacts at both SSSP SPA and Castlemartin SSSI;
- puffin - due to the higher predicted energetic consequences of displacement and barrier effects to this species, as modelled by SeabORD at SSSP SPA (see **Appendix 22D: Annex C – SeabORD Displacement Modelling**); and
- gannet – to investigate the population consequences in relation to cumulative impacts at Grassholm SPA (see **Section 22.2.5**).

Table 22E-4. Comparison between project-alone impacts and 1% baseline mortality thresholds for SPA / SSSI populations

Species	1% of Baseline mortality	Project-alone apportioned annual mortalities			
		Collision[1]	Displacement [2]	SeabORD[3]	Total
Grassholm SPA					
Gannet	**58**	3.0	27.93		30.93
Skomer, Skokholm and Seas off Pembrokeshire SPA					
Kittiwake[4]	**4**	0.7			
Guillemot	**27**		92.74	16.33	
Puffin	**32**		11.63	37.17	
Razorbill	**18**		4.17	7.5	
Manx shearwater	**1,183**		198.43		
Lesser black-backed gull	**19**	1.1			
Castlemartin SSSI[5]					
Guillemot	**14**		67.45	10.00	

*[1]The collision mortality estimates presented are those for the 'worst case' ten turbine scenario as apportioned to Grassholm SPA (**Appendix 22C: Marine Ornithology Collision Risk Modelling**).*
*[2]The figures quoted in this table are the maximum estimates obtained from the colony-apportioned displacement matrices for each species, i.e., the upper end of the range advised by NRW (A) and JNCC; maximum displacement rates/mortality rates of 80%/10% for gannet, 70%/10% for the auks, 50%/10% for Manx shearwater (**Appendix 22D: Marine Ornithology Displacement Assessment**).*
*[3]These figures are the (annual) adult mortalities predicted by SeabORD modelling, based on the energetic costs arising from displacement during the chick-rearing period, when these costs are predicted to be most significant in terms of seabird ecology. Displacement or barrier effects that occur during chick-rearing are predicted to impact directly on productivity (i.e., the chick mortalities predicted by SeabORD) as well as reduced fitness of adults entering the non-breeding season. See **Appendix 22D: Annex C - SeabORD Displacement Modelling**).*
*[4]Information on kittiwake displacement has been presented in **Appendix 22D: Marine Ornithology Displacement Assessment** at the request of JNCC.*

22.2.5. Consideration of Cumulative / In Combination Assessment Requirements

16. **Appendix 22E: Annex A – Other Plans and Projects included in Cumulative Effects Assessment for Marine Ornithology** sets out the consideration of the development long list, identifying those projects which are relevant to consider and providing a summary of how they are addressed in assessment, whether this is qualitatively or quantitively.

17. Where there is data available for other projects, with certainty in the mortality estimates quantified and with apportioning undertaken to allow for colony-specific assessment, the impacts can be taken forward for cumulative PVA, as reported in **Appendix 22F: Marine Ornithology Population Modelling**. In this regard, it is determined that PVA is required for:

- guillemot at SSSP SPA and Castlemartin SSSI (see **Table 22E-6** and **Table 22E-7**);
- puffin at SSSP SPA (**Table 22E-9** and **Table 22E-10**); and
- gannet at Grassholm SPA (**Table 22E-15**).

Guillemot

18. As set out in **Section 22.2.4** above, **Table 22E-6** (displacement matrix mortality estimates) and **Table 22E-7** (SeabORD displacement modelling) presents the cumulative impact scenarios to be addressed for assessment in relation to the guillemot populations at SSSP SPA and Castlemartin SSSI.

19. As advised by NRW(A) and JNCC, all estimated mortalities (derived from displacement matrices, as based on digital aerial survey data) are assumed to be adult and no allowance is made for sabbatical birds. From review of the developments in **Appendix 22E: Annex A – Other Plans and Projects included in Cumulative Effects Assessment for Marine Ornithology**, it is only Erebus (located in close proximity to the proposed Project) which has confirmed displacement (matrix) mortality estimates for inclusion in assessment.

20. The submitted applications (ES/EIA reports and RIAAs) for the consented Awel y Mor and Twin Hub offshore wind farms and for the Morlais tidal project, have each been checked to confirm that there are zero guillemot mortalities to assign from these projects against either the SSSP SPA or Castlemartin SSSI populations (**Appendix 22E: Annex A**). The White Cross application has also been reviewed and is discussed in paragraphs 26 to 27 below (as well as in **Appendix 22E: Annex A**).

21. The Erebus Supplementary Environmental Information (SEI), as submitted on 30 August 2022 presents the correct auk figures to take forward in this cumulative assessment (those which were updated to include the non-ID birds[4]). For context and comparison, **Table 22E-5** presents the mean seasonal peaks (MSPs) for the guillemot breeding and non-breeding seasons for the proposed Project and Erebus (the Array Areas plus 2 km buffers as per SNCB 2022 guidance).

22. For the proposed Project these MSPs are taken from **Appendix 22D: Annex B – SPA Seasonal Displacement Matrices**. For Erebus, the MSPs are taken from the SEI, with the SSSP SPA figures calculated in Table 7.3.4 of the SEI and those for Castlemartin SSSI derived by applying the relevant apportioning weightings[5] to the total MSP estimates in this table of 7,001 and 28,338 for breeding season and non-breeding seasons respectively[6].

[4] 'Non-ID birds' is the term used to describe those observed individuals which could not be identified fully to species, only to species group.

[5] The colony apportioning weightings in the breeding season are project-specific as there is a distance element (between each project and the designated site) included in the calculation. However, for the non-breeding season the weightings are the same as they're based on the same population information in Furness (2015).

[6] All the Erebus MSP estimates being referenced from this table are the ones calculated for the SEI which include the non-ID birds.

Table 22E-5. Guillemot MSPs for the proposed Project alongside Erebus, apportioned by colony, as used for displacement matrix assessments

Proposed Project		Erebus	
Breeding MSP	Non-breeding MSP	Breeding MSP	Non-breeding MSP
Skomer, Skokholm and Seas off Pembrokeshire SPA			
986.66	338.23	5,279	737
Castlemartin SSSI			
729.36	234.16	1,225.18	510.08

24. **Table 22E-6** presents the displacement matrix mortality estimates being modelled for guillemot under PVA in **Appendix 22F – Marine Ornithology Population Modelling.** For the proposed Project, both SSSP SPA and Castlemartin SSSI apportioned estimates are taken from **Appendix 22D: Annex B - SPA Seasonal Displacement Matrices.,** while for Erebus the SSSP SPA are taken from **Table 7.3.8** (breeding season) and **Table 7.3.9** (non-breeding) in the SEI. The Erebus estimates are rounded up to the nearest whole bird, as presented in the SEI.

25. The apportioned estimates for Erebus, as assigned to Castlemartin SSSI, have been calculated by applying the relevant displacement and mortality rates to the apportioned MSPs for the SSSI, as presented in **Table 22E-5**. HiDef have completed this work to input into the current assessment for the proposed Project, and therefore the figures are presented to two decimal points (as for the proposed Project).

Table 22E-6. Guillemot: estimated displacement mortalities to input into PVA (from the matrix approach)

Matrix displacement and mortality rates	Proposed Project	Erebus	Cumulative (proposed Project + Erebus)
Skomer, Skokholm and Seas off Pembrokeshire SPA			
Matrix 30%/1%	3.97	19 *16 breeding, 3 non-breeding*	22.97
Matrix 60%/3%	31.80	110 *96 breeding, 14 non-breeding*	141.80
Matrix 70%/10%	92.75	422 *370 breeding, 52 non-breeding*	514.75
Castlemartin SSSI			
Matrix 30%/1%	2.89	5.21	8.10
Matrix 60%/3%	17.34	31.23	48.57
Matrix 70%/10%	67.45	41.65	109.10

26. While the White Cross application was submitted in autumn 2023, determination is currently on hold pending the submission of supplementary environmental information. There are

currently no agreed mortality estimates (derived from displacement matrices) that can be input into cumulative assessment with any confidence or certainty.

27. However, it has been possible to take account of this project through the SeabORD displacement modelling (which only requires the Array Area boundary for each wind farm modelled); please see **Appendix 22D: Annex C - SeabORD Displacement Modelling**.

28. **Table 22E-7** presents the SeabORD outputs taken forward for modelling under PVA, including the cumulative scenario of the proposed Project in combination with Erebus and White Cross.

Table 22E-7. Guillemot: estimated displacement mortalities to input into PVA (from SeabORD modellling)

Proposed Project alone SeabORD model outputs		Cumulative SeabORD model outputs (proposed Project + Erebus + White Cross)	
Adult mortality	**Chick mortality**	**Adult mortality**	**Chick mortality**
Skomer, Skokholm and Seas off Pembrokeshire SPA			
16.333	5.400	27.000	15.400
Castlemartin SSSI			
10.000	3.000	11.667	5.900

Puffin

29. As for guillemot, it is only the Erebus project which has confirmed displacement (matrix) mortality estimates for puffin for inclusion in cumulative assessment (**Appendix 22E: Annex A – Other Plans and Projects included in Cumulative Effects Assessment for Marine Ornithology**). There are negligible puffin mortalities to be assigned against the SSSP SPA population from either Awel y Mor or Twin Hub offshore wind projects or from the Morlais tidal project. The application for White Cross offshore wind floating demonstrator project has also been checked (paragraphs 26 to 27, as referenced for puffin in paragraph 32 below).

30. **Table 22E-8** presents the MSPs for the puffin breeding and non-breeding seasons for Proposed Project and Erebus, as apportioned to the SSSP SPA. The proposed Project apportioned MSP estimates are from **Appendix 22D: Annex B – SPA Seasonal Displacement Matrices** and those for Erebus are from Table 7.3.6 in the submitted SEI.

Table 22E-8. Puffin MSPs for the proposed Project alongside Erebus; apportioned by colony, as used for displacement matrix assessments

Proposed Project		Erebus	
Breeding MSP	**Non-breeding MSP**	**Breeding MSP**	**Non-breeding MSP**
Skomer, Skokholm and Seas off Pembrokeshire SPA			
148.96	17.17	1,412	5

31. **Table 22E-9** presents the displacement matrix mortality estimates modelled for puffin under PVA in **Appendix 22F – Marine Ornithology Population Modelling.** For the proposed Project, the estimates are taken from **Appendix 22D: Annex B – SPA Seasonal Displacement Matrices** while for Erebus they're from Table 7.3.14 (breeding season) and 7.3.15 (non-breeding) in the

SEI. The Erebus estimates are rounded up to the nearest whole bird, as presented in the SEI. All puffins are assumed to be adult, and no allowance is made for sabbatical birds.

Table 22E-9. Puffin: estimated displacement mortalities to input into PVA (from the matrix approach)

Matrix displacement and mortality rates	Proposed Project	Erebus	Cumulative (proposed Project + Erebus)
Skomer, Skokholm and Seas off Pembrokeshire SPA			
Matrix 30%/1%	0.50	6 *5 breeding, 1 non-breeding*	6.50
Matrix 60%/3%	2.99	27 26 *breeding, 1 non-breeding*	29.99
Matrix 70%/10%	11.63	100 *99 breeding, 1 non-breeding*	111.63

32. As for guillemot, **Table 22E-10** presents the puffin SeabORD outputs taken forward for modelling under PVA, including the cumulative scenario for the proposed Project in combination with Erebus and White Cross. Only the cumulative impacts exceed the stated threshold, however, project-alone impacts have also been included for context in **Appendix 22F: Marine Ornithology Population Modelling**.

Table 22E-10. Puffin estimated displacement mortalities to input into PVA (from SeabORD modellling)

Proposed Project alone SeabORD model outputs		Cumulative SeabORD model outputs (proposed Project + Erebus + White Cross)	
Adult mortality	Chick mortality	Adult mortality	Chick mortality
Skomer, Skokholm and Seas off Pembrokeshire SPA			
20.333	9.300	37.167	17.400

Gannet

33. Gannet are considered to be potentially affected by both collision risk and displacement impacts from offshore wind (as quantified for the proposed Project in **Appendix 22C: Marine Ornithology Collision Risk Modelling** and **Appendix 22D: Marine Ornithology Displacement Assessment**). In the absence of alternatives, the estimated mortalities from each of these impact pathways are simply summed for consideration in assessment (NRW (A) advice note, 05 April 2023).

34. **Table 22E-11** and **Table 22E-13** set out the colony apportioning and age-class apportioning calculations used to derive the project alone element of the cumulative impact scenarios for gannet, as taken forward into PVA modelling (**Appendix 22F: Marine Ornithology Population Modelling**).

35. Full breeding seasons (from Furness, 2015) have been agreed for use in marine ornithological assessment for the proposed Project, with the migration seasons slightly adjusted to avoid overlap (or double counting) in assessment as agreed with NRW (A) and JNCC. The calculation of colony apportioning weightings for gannet in **Table 22E-11**, are set out in Appendix **22B: Marine Ornithology Colony Apportioning**.

Table 22E-11. Colony apportioning of gannet mortality estimates from proposed Project, as assigned to Grassholm SPA

Gannet mortalities apportioned to Grassholm SPA	Full breeding season Mar - Sep	Autumn migration Oct - Nov	Spring migration Dec - Feb
Collision risk; 10 turbine 'worst case' scenario			
Seasonal mortality	3.0	0.5	0.3
Apportioning weighting	*0.969*	*0.144*	*0.119*
SPA apportioned mortality	2.907	0.072	0.036
Displacement matrix outputs 60% / 1%			
Seasonal mortality	1.476	4.29	0.39
Apportioning weighting	*0.969*	*0.144*	*0.119*
SPA apportioned mortality	1.430	0.618	0.046
Displacement matrix outputs 70% / 1%			
Seasonal mortality	1.72	5.01	0.46
Apportioning weighting	*0.969*	*0.144*	*0.119*
SPA apportioned mortality	1.670	0.721	0.055
Displacement matrix outputs 70% / 3%			
Seasonal mortality	5.17	15.02	1.37
Apportioning weighting	*0.969*	*0.144*	*0.119*
SPA apportioned mortality	5.010	2.162	0.162
Displacement matrix outputs 80% / 10%			
Seasonal mortality	19.98	57.20	5.20
Apportioning weighting	*0.969*	*0.144*	*0.119*
SPA apportioned mortality	19.070	8.237	0.619

36. The age-class proportions (adults/immatures) that are used in the age-class apportioning are those recorded during the digital aerial survey programme as presented in **Table 22-35** of **Appendix 22A: Marine Ornithology Baseline.** The apportioning is done seasonally (as requested in the NRW(A) advice note of 05 April 2023), based on the gannet observations recorded in each season. **Table 22E-12** presents these proportions (with juveniles included in the immature age-class category) which are then used in the calculations given in **Table 22E-13**.

Table 22E-12. Percentage of aged gannets in each age class averaged across all surveys in each season in the marine ornithology survey area for the proposed Project

Season	Adults (%)	Immatures[1] (%)
Breeding season	95.99	4.01
Autumn migration	93.04	6.96
Spring migration	100	0.00

[1]*Immature age-class including juveniles.*

Table 22E-13. Seasonal age-class apportioning of proposed Project gannet mortality estimates

Gannet apportioned mortalities	Full breeding season Mar - Sep	Autumn migration Oct - Nov	Spring migration Dec - Feb	Annual totals
Collision risk and displacement (60% / 1%)				
Seasonal mortality	4.337	0.690	0.082	5.109
Apportioning weightings	*0.9599/0.0401*	*0.9304/0.0696*	*1/0*	-
Adult apportioned mortality	4.163	0.642	0.082	4.887
Immature apportioned mortality	0.174	0.048	0	0.222
Collision risk and displacement (70% / 1%)				
Seasonal mortality	4.577	0.793	0.091	5.461
Apportioning weightings	*0.9599/0.0401*	*0.9304/0.0696*	*1/0*	-
Adult apportioned mortality	4.393	0.738	0.091	5.222
Immature apportioned mortality	0.184	0.055	0	0.239
Collision risk and displacement (70% / 3%)				
Seasonal mortality	7.917	2.234	0.198	10.349
Apportioning weightings	*0.9599/0.0401*	*0.9304/0.0696*	*1/0*	-
Adult apportioned mortality	7.600	2.079	0.198	9.877
Immature apportioned mortality	0.317	0.155	0	0.472
Collision risk and displacement (80% / 10%)				
Seasonal mortality	21.977	8.309	0.655	30.941
Apportioning weightings	*0.9599/0.0401*	*0.9304/0.0696*	*1/0*	-
Adult apportioned mortality	21.096	7.731	0.655	29.482
Immature apportioned mortality	0.881	0.578	0	1.459

37. As set out in **Appendix 22E: Annex A – Other Plans and Projects included in Cumulative Effects Assessment for Marine Ornithology** it is only the following projects where there are predicted gannet mortalities to be assigned against Grassholm SPA:

- **Erebus**: as presented in **Table 22E-14** below, the total annual collision mortality estimate of 5.36 gannet is taken from paragraph 7.4.4.1 of the Erebus SEI (from the CRM calculations presented in Section 7.4.2). All birds are assumed to be adult as the 'worst case' and while the figures presented adopt the 30% input densities now recommended by NRW(A), they will be slightly precautionary as sCRM has not been rerun using the higher gannet avoidance rate now being recommended. Displacement mortality estimates are taken from Table 7.4.5 (breeding), Table 7.4.6 (autumn migration) and Table 7.4.7 (spring migration) of the SEI.
- **Awel y Mor:** in the submitted (now consented) application, this project assigned four annual gannet mortalities (assumed to be adult as 'worst case') against Grassholm SPA.

This is the figure referenced in the Erebus SEI (project also now consented) and so is included here for the proposed Project.

- **Morlais:** based on review of the information available for Morlais, a single gannet mortality is estimated to arise from this tidal project against Grassholm SPA (as was also assumed for the Erebus SEI).

38. Of the other projects considered in **Table 22-16**, it is confirmed that **Twin Hub** (offshore wind) will not give rise to any gannet mortalities at Grassholm SPA, and while it is possible that there will be a level of mortality to assign from **White Cross** (offshore wind), this project is in the process of submitting further information, so as yet, there are no figures available agreed for reference (i.e., gannet mortality estimates which are confirmed to be correct).

Table 22E-14. Erebus gannet seasonal mortalities each year as apportioned to Grassholm SPA

Gannet mortalities apportioned to Grassholm SPA	Migration-free breeding[1] Apr - Aug	Autumn migration Sep - Nov	Spring migration Dec - Mar	Annual total
Collision risk; seven 14MW turbines 'worst case' scenario				
SPA apportioned mortality	-	-	-	5.36
Displacement matrix outputs 60% / 1%				
SPA apportioned mortality	2	1	1	4
Displacement matrix outputs 70% / 1%				
SPA apportioned mortality	2	1	1	4
Displacement matrix outputs 70% / 3%				
SPA apportioned mortality	5	2	1	8
Displacement matrix outputs 80% / 10%				
SPA apportioned mortality	18	4	1	23

[1] *For the Erebus assessment, the migration-free breeding season was used in accordance with NRW(A) advice on that project.*

39. **Table 22E-15** sums the mortality estimates (adults/immatures) across projects to give the cumulative totals modelled under PVA (taken forward in **Table 22-6** of **Appendix 22F: Marine Ornithology Population Modelling**).

Table 22E-15. Cumulative impact scenarios[1] modelled under PVA for the Grassholm SPA gannet population

Adult mortalities[1] Proposed Project + Erebus + Awel y Mor + Morlais	Immature mortalities[1] (proposed Project only; assumed to be all adult for the other projects)	Total cumulative (annual) mortalities[1] to model under PVA	
		Adults	Immatures
1. Cumulative - CRM + matrix 60% / 1%			
4.85 + 9.36 + 4 + 1 = 19.21	0.22	**19.21**	**0.22**
2. Cumulative - CRM + matrix 70% / 1%			
5.18 + 9.36 + 4 + 1 = 19.54	0.23	**19.54**	**0.23**
3. Cumulative - CRM + matrix 70% / 3%			
9.83 + 13.36 + 4 + 1 = 28.19	0.45	**28.19**	**0.45**
4. Cumulative - CRM + matrix 80% / 10%			
30.78 + 28.36 + 4 + 1 = 64.14	1.39	**64.14**	**1.39**

[1]*All figures in the table are numbers of birds.*

22.3 References

Blue Gem Wind., 2022. Project Erebus: Supplementary Environmental Information Addendum Report.

Furness, R.W., 2015. Non-breeding season populations of seabirds in UK waters. Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Report 164.

Horswill, C. and Robinson, R.A., 2015. *Review of seabird demographic rates and density dependence*. JNCC Report No. 522.

Perrins, C., Padget, O., O'Connell, M., Brown, R., Büche, B., Eagle, G., Roden, J., Stubbings, E. and Wood, M. J. 2020. A census of breeding Manx Shearwaters Puffinus puffinus on the Pembrokeshire islands of Skomer, Skokholm and Midland in 2018. Seabird. 32, pp 106-118.

SNCB., 2022. Joint SNCB Interim displacement advice notice, Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments. SNCB.

Woodward, I., Thaxter, C. B., Owen, E., and Cook, A.S.C.P., 2019. Desk-based revision of seabird foraging ranges used for HRA screening. BTO research report, Number 724.

22.4 Appendix 22E: Annex A – other PLANS AND PROJECTS included in cumulative effects assessment FOR MARINE ORNITHOLOGY

40. This **Annex A** presents other plans and projects considered in the cumulative effects assessment for marine ornithological interests (Error! Reference source not found.**6**). The location of this development is illustrated in **Figure 22E-1.**

Table 22E-16. List of projects considered for the marine ornithology cumulative effects assessment

Project Name	Project Type	Tier	Status	Distance to Array Area	Consideration in Marine Ornithological Cumulative Impact Assessment (EIA / HRA)	Assessment Approach
Operational Projects						
Arklow Bank	Offshore Wind	1	Operational	159 km NW	Irish project. No available data for quantified assessment (as for Liverpool Bay projects, see next row).	Qualitative
Barrow	Offshore Wind	1	Operational	321 km NE	There is very limited data for these operational wind farms in Liverpool Bay for EIA and no data available for HRA against the focal Pembrokeshire SPA (and SSSI) breeding seabird colonies. However, if these existing projects were causing a significant impact, or population consequence, against Pembrokeshire SPA (and SSSI) seabird colonies then this would have been picked up in changes to population trends (reductions in population growth, accelerated declines, or switches from an increasing to a decreasing trend). No such impacts have been recorded through the colony monitoring, and therefore it can be concluded that these projects have had no demonstrable effect on the Pembrokeshire SPAs or SSSIs assessed for the proposed Project, and therefore, by implication, for any wider EIA regional populations defined in NRW (A) and JNCC advice. In line with the above, the projects in Liverpool Bay have been considered qualitatively which aligns with the approach undertaken for the consented projects Awel y Mor (also Liverpool Bay) and Erebus (Pembrokeshire) wind farms; as per the relevant entries below.	Qualitative
Burbo Bank	Offshore Wind	1	Operational	276 km NE		Qualitative
Burbo Bank Extension	Offshore Wind	1	Operational	271 km NE		Qualitative
Gwynt y Mor	Offshore Wind	1	Operational	257 km NE		Qualitative
North Hoyle	Offshore Wind	1	Operational	260 km NE		Qualitative
Ormonde	Offshore Wind	1	Operational	327 km NE		Qualitative
Rhyl Flats	Offshore Wind	1	Operational	251 km NE		Qualitative
Walney Phase 1	Offshore Wind	1	Operational	319 km NE		Qualitative
Walney Phase 2	Offshore Wind	1	Operational	320 km NE		Qualitative
Walney Extension	Offshore Wind	1	Operational	317 km NE		Qualitative
West of Duddon Sands	Offshore Wind	1	Operational	313 km NE		Qualitative

Project Name	Project Type	Tier	Status	Distance to Array Area	Consideration in Marine Ornithological Cumulative Impact Assessment (EIA / HRA)	Assessment Approach
Rampion	Offshore Wind	1	Operational	361 km SE	English project. Only relevant to consider in respect of kittiwake (in terms of BDMPS regions), however, there is no available data for the same reasons as for the Liverpool Bay projects.	Qualitative
Robin Rigg	Offshore Wind	1	Operational	390 km NE	Scottish project. No available data for the same reasons as for the Liverpool Bay projects.	Qualitative
Ramsey Sound (TIGER)	Tidal	1	Operational	55 km N	Ramsey Sound TIGER project has a marine licence for 1.4 MW capacity tidal turbine. Previously, the Tidal Energy Ltd (TEL) Deltastream device was deployed at the site; however, TEL went into administration. The TIGER project has now taken over the lease area and seeks to remove the Deltastream device, to replace it with their own turbine. At present, there is no further information that would allow any quantitative assessment, so this project is considered qualitatively.	Qualitative
Consented Projects and / or Under Construction						
Greenlink Interconnector	Interconnector	1	Construction	29 km N	Subsea electricity connection between Pembrokeshire and Ireland. Construction is due for completion by end of 2024, so there will be no temporal overlap of construction impacts with the proposed Project and no significant long-term seabird population consequences.	Qualitative
Celtic Interconnector	Interconnector	1	Construction	143 km E	Subsea electricity connection between Ireland and France with construction underway and due to finish by 2027. The key marine ornithological impact pathways associated with this project (i.e., construction disturbance and habitat loss) will not result in any significant, long-term population consequences to seabirds that require further consideration here.	Qualitative

Project Name	Project Type	Tier	Status	Distance to Array Area	Consideration in Marine Ornithological Cumulative Impact Assessment (EIA / HRA)	Assessment Approach
Erebus	Offshore Wind	2	Consented	4.8 km NW	Erebus is the closest consented project to the proposed Project. It has good data availability to input into a quantified HRA for the focal species being assessed: guillemot, puffin and gannet. It has also been included in the cumulative scenario for SeabORD displacement modelling, as undertaken for the proposed Project.	**Quantitative and also included in cumulative SeabORD modelling**
Awel y Mor	Offshore Wind	2	Consented	251 km NE	Awel y Mor is the most recently consented project in Welsh waters (decision issued 20 September 2023) located in Liverpool Bay, so at distance from the proposed Project. Four gannet mortalities are assigned against Grassholm SPA on a precautionary basis. There are negligible puffin mortalities to consider and zero guillemot.	**Quantitative**
Twin Hub	Offshore Wind	2	Consented	102 km SW	Twin Hub is located in waters off the Cornish coast. Gannet is the only focal species assessed of relevance to this cumulative assessment for the proposed Project. NE advise minimal impacts against the gannet population at Flatholm SSSI and no advised impacts against Grassholm (NE letter of 14 December 2018).	**Quantitative**
Morlais	Tidal	2	Consented	218 km NE	Morlais is located in waters off Holy Island, Anglesey. A single gannet mortality is assigned against Grassholm SPA on a precautionary basis. There are zero guillemot or puffin mortalities to consider.	**Quantitative**
Projects at Application						
White Cross	Offshore Wind	3	Application	19 km SE	White Cross is located in English waters in the Bristol Channel but in relative proximity to the proposed Project. It has been submitted for determination but is currently on hold pending the submission of supplementary environmental information (SEI).	Qualitative but included in **SeabORD modelling**

Project Name	Project Type	Tier	Status	Distance to Array Area	Consideration in Marine Ornithological Cumulative Impact Assessment (EIA / HRA)	Assessment Approach
					NE have raised queries around the project alone data analysis and impact modelling, and therefore, the available auk and gannet mortality estimates (from displacement matrices and CRM) presented for this project cannot be used with any confidence. In respect of potential cumulative impacts for White Cross, NE provided a 'gap-filling' paper as part of their response to the MMO. While the paper does not specify the projects for which NE have concerns, they are assumed to be the operational offshore wind farms for the *Western waters* BDMPS as listed and discussed in this table, i.e., Liverpool Bay projects, Rampion and Robin Rigg.	
South Irish Sea Array	Offshore wind	3	Application	132 km NW	Fixed foundation project, between 40-60 turbines, proposed off the southeast Irish coast between Arklow and Wexford. Although believed to be at application stage, no EIA/HRA assessment details available online.	Qualitative
Pre-application Projects, yet to be submitted						
Llŷr 2	Offshore Wind	4	Pre-App	N/A	The Applicant still hopes to progress a Llŷr 2 project depending on the outcome of negotiations with the Crown Estate. Analysis of survey data cannot be further progressed until there is a confirmed project area, although it is still intended for this to be located within the original development area surveyed.	Qualitative
Valorous	Offshore Wind	4	Pre-App	13 km W	Valorous is proposed off the Pembrokeshire coast, however, there is no data for it currently available, so that it can only be acknowledged at the present time.	Qualitative
Gwynt Glas	Offshore Wind	4	Pre-App	23 km SW	Early stage floating offshore wind project under development by EDF Renewables UK and DP Energy, located in the waters off the Pembrokeshire coast.	Qualitative

Project Name	Project Type	Tier	Status	Distance to Array Area	Consideration in Marine Ornithological Cumulative Impact Assessment (EIA / HRA)	Assessment Approach
					Although it was raised by RSPB for consideration, there is no data yet available and so it can only be acknowledged and considered qualitatively at present.	
Llywelyn	Offshore Wind	4	Pre-App	25 km SW	Early stage floating offshore wind project under development by BlueFloat Energy and Renantis. located in waters off the Pembrokeshire coast. Although it was raised by RSPB for consideration, there is no data yet available and so it can only be acknowledged at present.	Qualitative
Petroc	Offshore Wind	4	Pre-App	39 km S	Early stage floating offshore wind project under development by BlueFloat Energy and Renantis. located in Cornish waters. Although it was raised by RSPB for consideration, there is no data currently available and so it can only be acknowledged and considered qualitatively at the present time.	Qualitative
Mona	Offshore Wind	4	Pre-App	289 km NE	Mona is proposed to be located in Liverpool Bay. Preliminary environmental information report (PEIR) submitted early in 2023; however, it has been announced that the project boundary is being revised and therefore no confirmed impact estimates are available. Also, the PEIR only presents EIA information and does not include the colony apportioning calculations necessary for HRA.	Qualitative
Morgan	Offshore Wind	4	Pre-App	314 km NE	Morgan is proposed to be located in Liverpool Bay. Status as above for Mona.	Qualitative
Morecambe	Offshore Wind	4	Pre-App	305 km NE	Morecambe is also proposed to be located in Liverpool Bay with a community consultation launched in April 2023. However, no data is currently available due to its pre-application status.	Qualitative

Project Name	Project Type	Tier	Status	Distance to Array Area	Consideration in Marine Ornithological Cumulative Impact Assessment (EIA / HRA)	Assessment Approach
Mooir Vannan (Isle of Man)	Offshore Wind	4	Pre-App	320 km NE	Mooir Vannan is proposed to be located in waters around the Isle of Man, in proximity to the offshore wind farms in Liverpool Bay. No data currently available.	Qualitative
Rampion 2	Offshore Wind	4	Pre-App	342 km SE	Proposed extension to the Rampion wind farm (listed above); only relevant to consider in respect of kittiwake. No data currently available.	Qualitative
Irish Pre-App Projects	Offshore Wind	4	Pre-App	N/A	There are a number of pre-application projects located in the Celtic Sea, in Irish waters including Arklow Bank 2, NISA, Clogherhead, Codling Wind Park, Dublin Array, Inis Ealga and the North Celtic Sea. These projects are acknowledged and considered qualitatively for cumulative assessment pending agreement on a transboundary approach between UK (Welsh) and Irish governments.	Qualitative

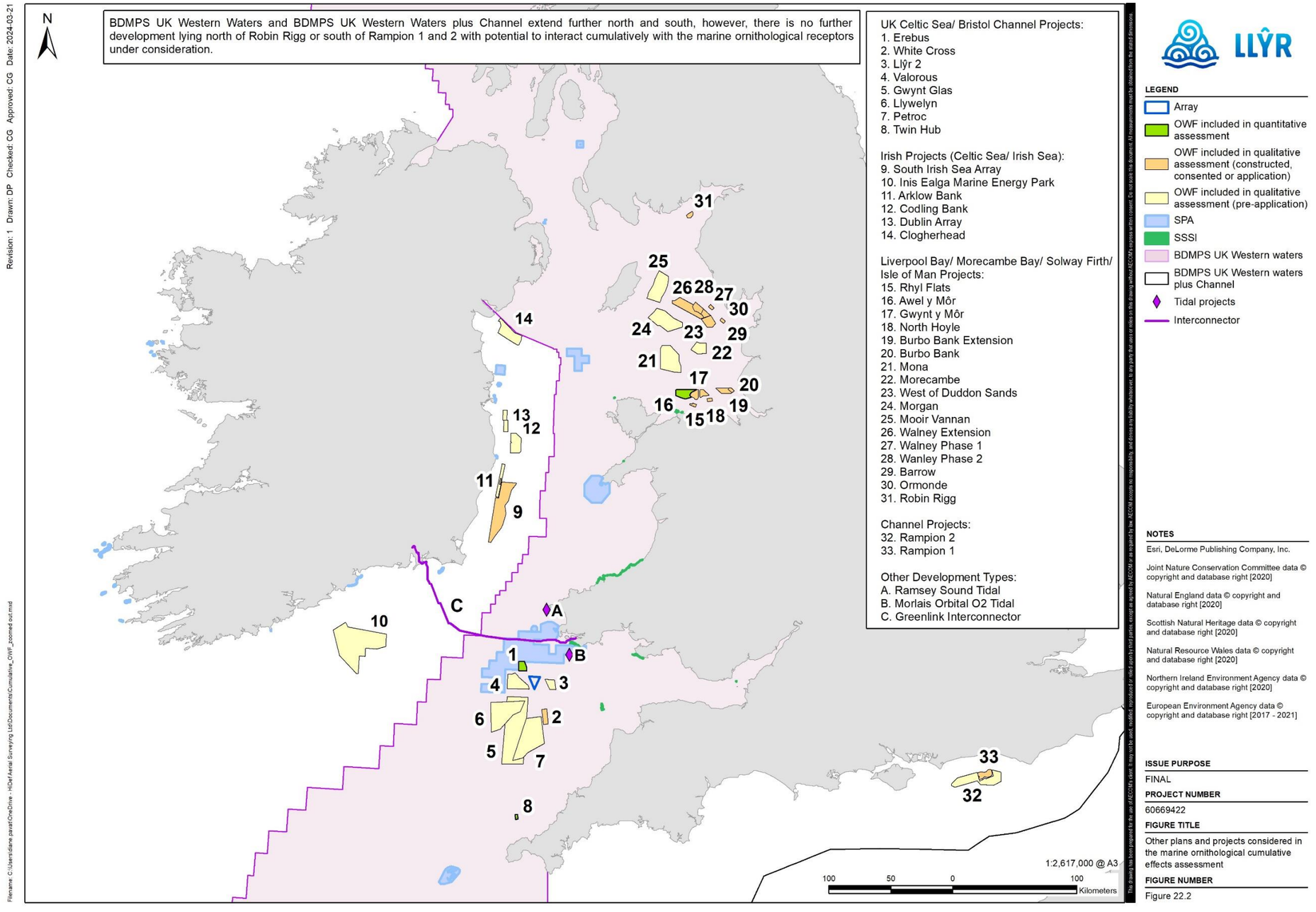

Figure 22E-1. Long-list offshore developments considered for marine ornithological impact assessment