VATTENFALL

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Technical Appendix 7.1

Ornithology

Contents

Glossary

Term	Definition
Baseline	The existing conditions that prevail against which the effects of the Proposed Development are compared.
UK Birds of Conservation Concern (BoCC)	A five-yearly assessment of ornithological conservation priorities, provided by a review of the population status of birds regularly found in the UK, Channel Islands and the Isle of Man conducted by the UK's leading bird conservation organisations.
Collision Risk Zone	The area derived by applying a buffer around each turbine with a radius equal to the length of the turbine blades, plus an additional precautionary 200 m.
Infrastructure	This is used to describe all parts of South Kyle II Wind Farm development that require construction activities, both temporary and permanent; including turbines, hard standings, borrow pits and tracks (where new or widened).
South Kyle II Proposed Development Area	The proposed application boundary for the Proposed Development.
South Kyle II Wind Farm	The turbines and all associated infrastructure required for South Kyle II Wind Farm (also referred to as the 'Proposed Development').
Schedule 1 species	A list of species of 'principal importance' for maintaining and enhancing biodiversity, as named under the Wildlife and Country Act 1981.
Survey Area	The area within which ornithological baseline surveys were carried out. This refers to the Proposed Development Area plus a surrounding buffer, the size of which is determined by the specific survey being described.

List of Abbreviations

Abbreviation	Description
BoCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CRM	Collision Risk Modelling
CRZ	Collision Risk Zone
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
GIS	Geographic Information Systems
HMA	Habitat Management Area
EMMP	Ecological Management and Monitoring Plan
MBBS	Moorland Breeding Bird Survey
Natural Power	Natural Power Consultants Ltd Limited, the lead EIA Co- Ordinator
OS NGR	Ordnance Survey National Grid Reference
PCH	Potential Collision Height
RSPB	Royal Society for the Protection of Birds
SBL	Scottish Biodiversity List
Sch1	Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)
SNH	Scottish Natural Heritage (now NatureScot)
SWS	South West Scotland Interconnector
SWSEIC	South West Scotland Environmental Information Centre
VP	Vantage Point
WCA	Wildlife and Countryside Act 1981 (as amended)

7.1.1 Introduction

7.1.1.1 This Technical Appendix presents the following information in support of Chapter 7: Ornithology, of the Environmental Impact Assessment (EIA) for South Kyle II Wind Farm (the 'Proposed Development'):

- A list of scientific (Latin) and English names of all ornithological features that are referred to in the main chapter;
- Details of historic ornithological records from baseline ornithology surveys undertaken between 1993 and 2021 for developments surrounding the Proposed Development: South Kyle Wind Farm, South West Scotland Interconnector Project (SWS), Windy Standard Complex, and Afton Wind Farm.
- Existing non-confidential ornithological records within a 5 km radius of Proposed Development Area (10 km for eagle species, and 25 km for goose and gull species), held by the Royal Society for the Protection of Birds (RSPB), and the South West Scotland Environmental Information Centre (SWSEIC);
- The methods employed by Natural Power Consultants Ltd (Natural Power) to provide baseline information on target bird species present within the site. Timings, surveyors and duration of survey work are provided for each survey type. Details of weather conditions during survey can be provided on request;
- Details of target and non-target species flights recorded during Vantage Point (VP) surveys undertaken between April 2021 and February 2023;
- Details of target raptor species recorded during breeding raptor surveys in 2022;
- Details of ornithological species recorded during Moorland Breeding Bird Surveys (MBBS) undertaken in 2021 and 2022; and
- Calculations of the theoretical collision risk to target species (where a sufficient number of flights was recorded) using the Band Model[1] as advocated by NatureScot[2].

7.1.2 Latin names

7.1.2.1 Latin names of all species referred to in Volume 1 Chapter 7: Ornithology and within this Technical Appendix are given in Table A7.1

Table A7.1: Latin names of species referred to in Chapter 7: Ornithology, and this technical appendix

Common name	Scientific Name
Brent Goose	*Branta bernicla*
'Dark-bellied Brent Goose'	*Branta bernicla bernicla*
'Pale-bellied Brent Goose'	*Branta bernicla hrota*
Canada Goose	*Branta canadensis*
Barnacle Goose	*Branta leucopsis*
Ross's Goose	*Anser rossi*
Snow Goose	*Anser caerulescens*
Greylag Goose	*Anser anser*
Taiga Bean Goose	*Anser fabalis*
Pink-footed Goose	*Anser brachyrhynchus*
Tundra Bean Goose	*Anser serrirostris*
White-fronted Goose	*Anser albifrons*
Greenland White-fronted Goose	*Anser albifrons flavirostris*
European White-fronted Goose	*Anser albifrons albifrons*
Lesser White-fronted Goose	*Anser erythropus*
Whooper Swan	*Cygnus cygnus*
Mallard	*Anas platyrhynchos*
Teal	*Anas crecca*
Red Grouse	*Lagopus lagopus scotica*
Black Grouse	*Lyrurus tetrix*
Nightjar	*Caprimulgus europaeus*
Swift	*Apus apus*
Oystercatcher	*Haematopus ostralegus*
Lapwing	*Vanellus vanellus*
Golden Plover	*Pluvialis apricaria*
Whimbrel	*Numenius phaeopus*
Curlew	*Numenius arquata*
Black-tailed Godwit	*Limosa limosa*
Woodcock	*Scolopax rusticola*
Snipe	*Gallinago gallinago*
Common Sandpiper	*Actitis hypoleucos*
Black-headed Gull	*Chroicocephalus ridibundus*
Herring Gull	*Larus argentatus*
Lesser Black-backed Gull	*Larus fuscus*
Cormorant	*Phalacrocorax carbo*
Grey Heron	*Ardea cinerea*
Osprey	*Pandion haliaetus*
Golden Eagle	*Aquila chrysaetos*
Sparrowhawk	*Accipiter nisus*
Goshawk	*Accipiter gentilis*
Hen Harrier	*Circus cyaneus*
Red Kite	*Milvus milvus*
White-tailed Eagle	*Haliaeetus albicilla*
Buzzard	*Buteo buteo*

[1] Band, W. (2024*). Using a collision risk model to assess bird collision risks for onshore wind farms.* NatureScot Research Report 909.

[2] NatureScot (2024). *Guidance on using an updated collision risk model to assess bird collision risk at onshore wind farms.* Available at: https://www.nature.scot/doc/guidance-using-updated-collision-risk-model-assess-bird-collision-risk-onshore-wind-farms

Common name	Scientific Name
Barn Owl	*Tyto alba*
Short-eared Owl	*Asio flammeus*
Tawny Owl	*Strix aluco*
Kestrel	*Falco tinnunculus*
Merlin	*Falco columbarius*
Peregrine	*Falco peregrinus*
Raven	*Corvus corax*
Willow Tit	*Poecile montanus*
Skylark	*Alauda arvensis*
Willow Warbler	*Phylloscopus trochilus*
Sedge Warbler	*Acrocephalus schoenobaenus*
Grasshopper Warbler	*Locustella naevia*
Wren	*Troglodytes troglodytes*
Song Thrush	*Turdus philomelos*
Spotted Flycatcher	*Muscicapa striata*
Meadow Pipit	*Anthus pratensis*
Crossbill	*Loxia curvirostra*
Snow Bunting	*Plectrophenax nivalis*
Reed Bunting	*Emberiza schoeniclus*

7.1.3 Desk Study Results

Existing Historic Records

7.1.3.1 A number of historic baseline ornithology surveys have been conducted for developments immediately adjacent or surrounding the Proposed Development Area between 1993 and 2021 (South Kyle Wind Farm, South West Scotland Interconnector Project (SWS), Windy Standard Complex, and Afton Wind Farm). Table A7.2 shows a summary of the known ornithological surveys undertaken at these developments during this period, and Table A7.3 shows a summary of the bird species recorded during these surveys.

Table A7.2: Ornithological surveys undertaken between 1993-2021 at developments immediately adjacent to and surrounding the Proposed Development Area

Survey Type	South Kyle	South Kyle Habitat Management Area (HMA)	SWS	Windy Standard Complex	Afton Wind Farm
Baseline Development Phase (EIA)					
Vantage point	2009-2012		2006-2008	2009, 2010	2003-2004
Raptor	2009-2012				
MBBS		2021	2006-2008	2009, 2012, 2013, 2020	
Woodland breeding bird	2009-2012				
Black grouse			2006-2008	1993-1994, 1994-2001, 2013	2003-2004
Forest owl, woodcock and nightjar	2009-2012				
Non-breeding/wintering bird			2006-2008		
Pre-construction Phase					
Breeding raptor	2018- 2019				
Construction Phase					
Breeding raptor	2020-2021				
Breeding bird	2020-2021				

Source: Natural Power[3]

Table A7.3: Summary of target bird species presence between 1993 – 2021 at developments immediately adjacent to and surrounding the Proposed Development Area

	Development									
	South Kyle			SWS			Windy Standard Complex			
Species	EIA	Pre-construction	Habitat Management Plan (HMP)	A	B	C	Windy Standard	Windy Standard II	Windy Standard III	Afton Wind Farm
Barnacle goose				Passage						
Greylag goose	Passage			Passage	Passage	Passage		Passage	Passage	
Pink-footed goose	Passage			Passage						
Bean goose (unidentified)				Passage	Passage					
White-fronted goose				Passage		Passage				
Goose sp. (unidentified)				Passage					Passage	
Whooper swan				Passage						
Black grouse	Breeding			Breeding	Breeding	Breeding	Breeding (in wider area)		Breeding	Wintering
Oystercatcher									Present	
Lapwing	Breeding			Breeding						
Golden plover	Wintering / Passage			Passage	Passage				Passage	

[3] Natural Power (2021). *South Kyle II Wind Farm Scoping Report.* The Natural Power Consultants on behalf of Vattenfall Wind Power Ltd.

Species	Development South Kyle EIA	Pre-construction	Habitat Management Plan (HMP)	SWS A	SWS B	SWS C	Windy Standard Complex Windy Standard	Windy Standard II	Windy Standard III	Afton Wind Farm
Whimbrel	Passage (One flight of three birds passing through site.)			Passage						
Curlew	Breeding			Breeding		Breeding			Present	Breeding
Black tailed godwit				Passage						
Snipe									Present	Breeding
Common sandpiper									Breeding	Breeding
Osprey	Passage								Passage	
Goshawk	Present (Breeding not confirmed)	Present		Wintering					Present	
Hen harrier	Present			Wintering	Wintering	Wintering		Passage	Present	
Red Kite	Passage								Passage	
Barn owl	Breeding in wider area (>3 km from site)			Breeding	Breeding	Present		Present		
Short-eared owl							Present	Passage	Present	Present
Merlin	Breeding			Present; Wintering	Breeding	Breeding			Present	Present
Peregrine	Breeding			Breeding	Wintering	Breeding	Present	Present	Present	Breeding
Common crossbill	Breeding	Present		Present	Present	Present	Present	Present	Present	
Snow bunting										Passage

Source: Natural Power[3]

Data Search Results

7.1.3.2 RSPB and SWSEIC records can be found in Table A7.4, which lists all protected bird species and/or Birds of Conservation Concern (UK BoCC Red or Amber-listed[4]) for which there were records for in the data provided. Additionally, the RSPB provided information regarding breeding black grouse last recorded in 2016 within 5 km of the Proposed Development Area for which further details are provided in Confidential Technical Appendix 7.2: Ornithology. SWSEIC data consisted of a single record of golden eagle which was last recorded in 2015. Further details of this record are provided in Confidential Technical Appendix 7.2: Ornithology.

[4] Stanbury, A., Eaton, M., Aebischer, N., Balmer, D., Brown, A., Douse, A., Lindley, P., McCulloch, N., Noble, D., and Win I. (2021). *Birds of Conservation Concern 5: the population status of birds in the United Kingdom, Channel Islands and Isle of Man.* British Birds 114, 723–747.

Table A7.4 Results of the data search from RSPB and SWSEIC within a 5 km buffer (10 km for eagles and 25 km for geese and gulls) of Proposed Development Area between 2013 – 2023.

Common name	Last record	No. records RSPB	No. records SWSEIC	Nest recorded	Legal protection*	UK BoCC*	Scottish Biodiversity List*
Brent Goose	2018	1	0	No		Amber	
Pale-bellied Brent Goose	2018	0	4	No		Amber	
Barnacle Goose	2021	0	41	No	Annex I	Amber	SBL
Ross's Goose	2021	0	3	No		-	
Snow Goose	2020	0	20	No		-	
Greylag Goose	2022	29	747	No		Amber	
Pink-footed Goose	2021	0	178	No		Amber	
White-fronted Goose	2021	1	11	No		Red	SBL
Greenland White-fronted Goose	2019	0	20	No	Annex I	Red	SBL
Lesser White-fronted Goose	2015	0	1	No		-	
Mallard	2016	2	0	No		Amber	
Teal	2016	1	0	-		Amber	
Swift	2019	2	0	No		Red	SBL
Curlew	2016	5	0	No		Red	SBL
Snipe	2016	9	0	-		Amber	
Kestrel	2016	1	0	No		Amber	SBL
Skylark	2016	3	0	-		Red	SBL
Willow Warbler	2016	2	0	No		Amber	
Sedge Warbler	2016	2	0	-		Amber	
Wren	2016	4	0	No		Amber	
Song Thrush	2016	3	0	No		Amber	SBL
Meadow Pipit	2016	19	0	No		Amber	
Reed Bunting	2016	1	0	-		Amber	SBL

Annex I: listed on Annex I of the Birds Directive 2009[5]; Schedule 1: listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)[6], Red/Amber: listed on the UK BoCC Red or Amber List[4], SBL: Scottish Biodiveristy List[7].

Source: RSPB, and SWSEIC

5 UK. Directive 2009/147/EC of the European Parliament and of the Council (2009). Available from - https://www.legislation.gov.uk/eudr/2009/147/contents [Accessed: 03/10/2023]

6 UK. Wildlife and Countryside Act (1981). Available from - https://www.legislation.gov.uk/ukpga/1981/69 [Accessed: 03/10/2023]

7 Scottish Government (2020). *Scottish Biodiversity List.* Available from - https://www.nature.scot/doc/scottish-biodiversity-list [Accessed: 03/10/2023]

7.1.4 Survey Methods

7.1.4.1 Baseline ornithology surveys commenced in April 2021 and were completed in February 2023[8] to quantify the use of the Proposed Development Area by breeding and non-breeding birds, and to determine an estimate of the theoretical risk of bird collision with the turbine rotors.

7.1.4.2 Baseline ornithological surveys comprised:

- VP flight activity surveys (April 2021 – February 2023);
- MBBS (April– July 2021 and 2022);
- Breeding raptor surveys (April– July 2021 and March – July 2022); and
- Black grouse reconnaissance and lek surveys (April – May 2021 and 2022).

7.1.4.3 The survey methods are described in detail below.

7.1.4.4 Areas where access was not permitted for surveying is shown in Figure 7.2: Ornithology Survey Areas, Volume 2a of the EIAR.

Vantage Point (VP) Surveys

7.1.4.5 VP surveys were undertaken using the standard method published in NatureScot guidance[9]. This method focuses on identifying flight-paths and flight heights of target species, such as waterfowl and raptors, and allows any regular patterns of flight lines to be identified, allowing turbine locations to be designed to minimise collision risk to birds. The data generated can also be used to estimate the theoretical collision risk of a particular species.

7.1.4.6 NatureScot guidance states that VP locations are chosen in order to achieve maximum visibility with the minimum number of points; all of the survey area should be covered such that no point is greater than 2 km from a VP. VPs and viewsheds are shown in Figure 7.1: Vantage Points and Viewsheds, Volume 2a of the EIAR.

7.1.4.7 Six VP locations were carefully selected based on viewshed analysis and a ground-truthing visit prior to surveys commencing. VPs were located at the following Ordnance Survey National Grid References (OS NGR):

- VP1 was located at grid reference NS 52762 05439 looking north east;
- VP2 was located at grid reference NS 54392 05461 looking north west;
- VP3 was located at grid reference NS 52989 07474 looking south;
- VP4 was located at grid reference NS 53423 08379 looking west;
- VP5 was located at grid reference NS 54182 08562 looking south west; and
- VP6 was located at grid reference NS 55348 09756 looking south west.

7.1.4.8 The weather conditions during each survey were recorded every hour, full details of survey dates, times and weather conditions during VP surveys will be provided upon request. As recommended in NatureScot guidance[9], a minimum of 36 hours per VP were ideally carried out in conditions of moderate or better visibility (1-2 km or above).

7.1.4.9 Surveys were carried out at various times of day, ensuring that a representative sample of times between dawn and dusk were surveyed. All VP surveys were three hours in duration, with a minimum resting period of 30 minutes between surveys, in line with the most recent NatureScot guidance[9].

7.1.4.10 A summary of VP survey effort for each VP is shown in Table A7.5.

7.1.4.11 Focal sampling was carried out for target species. The area in view was scanned until a target species was observed, at which point it was followed until it had ceased flying or had flown out of sight. The flight lines of target bird species observed were recorded onto 1:10,000 scale maps. Following NatureScot guidance[9] the time and duration of the flight were recorded, and the altitude of the target bird(s) was recorded at the start of the observation and at 15 second intervals thereafter into one of three height bands, (1) < 10 m, (2) 10 m - 210 m, and (3) > 210 m.

7.1.4.12 A map showing the flight lines for each target species was compiled in a Geographic Information Systems (GIS), with each flight line linked to its associated flight duration and height information held in an Excel spreadsheet.

7.1.4.13 The information collected on key target species flying over the Proposed Development Area and the adjacent airspace was used to estimate the number of individuals per species predicted to collide with the turbine rotors. The collision risk modelling (CRM) methods are described in Section 7.4 of Chapter 7: Ornithology

7.1.4.14 All secondary species were recorded using five-minute summaries. Each VP survey was sub-divided into five-minute periods. At the end of each five-minute period, the number and activity of all secondary species observed was recorded. If a target species was being tracked during a five-minute period, then the activity summary for that period was abandoned and a new one started once observations of the target species had ended. Thus, observation of target species took priority over the recording of secondary species. The number of birds recorded in a five-minute period was the minimum number of individuals that could account for the activity observed.

[8] Ornithology surveys were carried out by MBEC between April and August 2021 (inclusive).

[9] SNH. 2017. Recommended bird survey methods to inform impact assessment of onshore wind farms. SNH, Battleby.

Table A7.5: VP survey hours 2021-2023 breeding and non-breeding seasons

Month	VP1	VP2	VP3	VP4	VP5	VP6*
Breeding Season 2021						
March 2021	0	0	0	0	0	0
April 2021**	9	9	9	9	6	6
May 2021**	9	6	12	9	12	12
June 2021**	9	9	6	9	9	9
July 2021	6	9	6	6	6	6
August 2021	3	3	3	3	3	3
Total	**36**	**36**	**36**	**36**	**36**	**36**
Non-breeding Season 2021-2022						
September 2021	0	0	0	0	0	0
October 2021***	12	12	12	12	12	12
November 2021	6	6	6	6	6	6
December 2021	3	6	6	6	6	6
January 2022	9	6	6	6	6	6
February 2022	6	6	6	6	6	6
Total	**36**	**36**	**36**	**36**	**36**	**36**
Breeding Season 2021						
March 2022	6	6	6	6	6	6
April 2022	6	6	6	6	6	6
May 2022	6	6	6	6	6	6
June 2022	6	6	6	6	6	6
July 2022	6	6	6	6	6	6
August 2022	6	6	6	6	6	6
Total	**36**	**36**	**36**	**36**	**36**	**36**
Non-breeding Season 2022-2023						
September 2022	6	6	6	6	6	6
October 2022	6	6	6	6	6	6
November 2022	6	6	6	6	6	6
December 2022	6	6	6	6	6	6
January 2023	6	6	6	6	6	6
February 2023	6	6	6	6	6	6
Total	**36**	**36**	**36**	**36**	**36**	**36**

**VP 6 did not overlap with the CRZ, **An extra three hours of VP survey was undertaken to account for no surveys undertaken in March 2021 and only three hours of survey conducted in August 2021 at each VP, ***Six additional hours of survey was undertaken at each VP in October to account for no surveys undertaken in September*

Source: Natural Power

Moorland Breeding Bird Surveys

7.1.4.15 MBBS were undertaken between April and July in 2021 and 2022 covering all areas of open habitat within the previous Proposed Development Area and a 500 m buffer, access permitting, on the dates presented in Table A7.6. The site was surveyed using the standard methodology for assessing upland wader populations, as described by Brown and Shepherd (1993)[10]. This standard upland bird methodology, as advocated by NatureScot, is used to survey breeding upland wading birds to assess the presence and map the distribution of breeding birds within a surveyed area. Four survey visits were carried out between April and July. Full details of weather conditions during the MBBS can be provided upon request.

Table A7.6: MBBS dates

Year	Month	Date
2021*	April	20
	May	22
	June	14
	July	15
2022**	April	13
	May	17 and 19
	June	15 and 22
	July	13 and 15

*Source: *MBEC; **Natural Power*

7.1.4.16 A single surveyor walked a pre-determined route ensuring that all parts of the survey area were approached to within 100 m. A handheld GPS unit was used to ensure that the survey route was maintained. The location and behaviour of all birds encountered during the survey visits were recorded in the field on 1:25,000 scale maps. Standard British Trust for Ornithology (BTO) behaviour and species codes were used on field forms.

7.1.4.17 Following completion of the survey season, territory analysis was carried out for all species that were a target of this survey: waterfowl, wader, grouse and gull species. Other species were not mapped, but a species list of passerines encountered was taken during the survey visits. Territories were identified using a cluster analysis method, as outlined in Bibby *et al*.[11]. This method used the following principles:

- For resident bird species and summer migrants alike, a minimum of two registrations from two separate visits were required to generate a 'cluster'. This cluster was considered to represent a territory;
- Where a nest with eggs or young chicks was recorded, this record on its own constituted a cluster and hence a breeding territory;
- Species were considered to be breeding if any of the following behaviour was observed during a single visit:
  - Song, courtship or territorial display;
  - Territorial dispute;
  - Nest building and nest-hole excavation;
  - Agitated behaviour by adult bird(s) indicating the presence of a nearby nest or young (e.g. repetitive alarm calling, distraction display);
  - Adult(s) carrying food; and
  - Juveniles with parents in attendance;

[10] Brown, A.F. & Shepherd, K.B. (1993). A Method for Censusing Upland Breeding Waders. *Bird Study* **40**, 189-195.

[11] Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe, S., 2000. *Bird census techniques*. Elsevier.

- Where there were too few records to generate a cluster, with no evidence of any breeding behaviour, the individuals were not included in estimates for number of territories.

7.1.4.18 The field data for each visit was combined to produce overarching species maps, showing locations of registrations and behaviour indicative of breeding for each individual species of high and moderate conservation concern. These locations and behaviour were then assessed to produce an estimate of the overall breeding population for each species recorded in the survey area.

7.1.4.19 All surveys were carried out by experienced surveyors in suitable weather conditions.

Breeding Raptor Surveys

7.1.4.20 Breeding raptor surveys were undertaken within the Proposed Development Area between April and July 2021 and March and July 2022 on dates presented in Table A7.7. Dedicated breeding raptor surveys were undertaken within the previous Proposed Development Area plus a 2 km buffer, access permitting.

Table A7.7: Breeding raptor survey dates

Year	Month	Date
2021*	April	10, 12 and 30
	May	14, 24 and 31
	June	18
	July	30
2022**	March	18, 21 and 29
	April	1, 19, 21 and 26
	May	23, 24 and 25
	June	21, 23 and 24
	July	19, 25 and 27

*Source: *MBEC; **Natural Power*

7.1.4.21 A combination of ad-hoc VP surveys, and walkover surveys over suitable breeding habitat was undertaken. Ad-hoc VP surveys were carried out with the aim of identifying courtship displays and territorial behaviour and walkover surveys to check for signs of breeding raptors and, where relevant, to locate nest sites. Although searches focussed on areas identified during the VP surveys (both ad-hoc VPs and flight activity survey VPs) as potentially occupied by breeding raptors, all areas identified as providing suitable nesting habitat were surveyed, regardless of whether VP surveys indicated raptor occupancy. Methods are described in Hardey *et al*., 2013[12].

7.1.4.22 Due to access restrictions outside the Proposed Development Area, this was not possible for the whole buffer. Therefore, during the course of walkover surveys when the surveyor was near the Proposed Development Area, they scanned the visible habitat outside the site for signs of breeding, such as display behaviour.

7.1.4.23 All raptor and owl species encountered were recorded. This included all observations of secondary raptor species such as buzzard and sparrowhawk.

[12] Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. & Thompson, D. 2013. Raptors: a field guide to survey and monitoring. 3rd Edition. The Stationery Office, Edinburgh.

Black Grouse Surveys

7.1.4.24 Black grouse surveys were undertaken in April and May in 2021 and 2022 on the dates presented in Table A7.8, within all suitable habitat within the previous Proposed Development Area plus a 1.5km buffer. In the areas outside of the Proposed Development Area where access was not permitted, surveyors spent time at the edge of the Proposed Development Area looking and listening for birds lekking on the surrounding ground.

Table A7.8: Black grouse survey dates and times

Year	Month	Date	Survey times
2021*	April	13	05:20-08:20
			05:50-08:20
	May	10	04:10-07:10
			04:15-07:15
		14	04:10-07:10
2022**	April	14	05:30-08:50
			05:35-08:10
	May	5	04:30-07:50
			05:15-07:40

*Source: *MBEC; **Natural Power*

7.1.4.25 Surveys for black grouse were carried out following the method specified in the National Black Grouse Survey Instructions (Etheridge and Baines, 1995[13]; summarised in Gilbert *et al.* 1998[14]).

7.1.5 Survey Results

7.1.5.1 A summary of the ornithology results is presented in Chapter 7: Ornithology, Volume 1 of the EIAR. Further details of these results are provided below. Full non-confidential survey data can be provided on request.

Vantage Point Surveys

7.1.5.2 A summary of all baseline flights of target species recorded during the breeding season surveys in 2021 and 2022 are presented in Table A7.9. Target species flights recorded during the non-breeding seasons in 2021/2022 and 2022/2023 are presented in Table A7.10.

7.1.5.3 Incidental observations of target species (i.e species that were recorded either outside the survey period or area, as being heard only, or observed but not in flight) recorded during VP surveys 2021 to 2023 breeding and non-breeding seasons are summarised in Table A7.11. These include birds that were not in flight, birds that were heard but not seen and birds that were observed well beyond the survey area. Secondary species observed during the breeding and non-breeding season VP surveys are summarised in Table A7.12.

[13] Etheridge, B. & Baines, D. (1995). Instructions for the Black Grouse Survey 1995/6: a Joint RSPB/GCT/JNCC/SNH Project. Unpublished.

[14] Gilbert, G., Gibbons, D.W. & Evans, J. (1998). Bird Monitoring Methods. RSPB, Sandy.

Table A7.9: Target species VP flight activity survey results breeding seasons April to August 2021 and March to August 2022

Year	Species	No. Flights	No. Individuals	Legal protection*	UK BoCC*	Biodiversity Lists*
2021**	Snipe	6	7		Amber	
	Lesser black-backed gull	18	37		Amber	
	Goshawk	1	1	Schedule 1		
	Hen harrier	1	1	Annex I, Schedule 1	Red	SBL
2022***	Greylag goose	1	2		Amber	
	Herring gull	3	18		Red	SBL
	Lesser black-backed gull	15	18		Amber	
	Goshawk	2	2	Schedule 1		
	Hen harrier	1	1	Annex I, Schedule 1	Red	SBL
	Red Kite	1	1	Annex I, Schedule 1		SBL
	Peregrine	1	1	Annex I, Schedule 1		SBL

**Annex I: listed on Annex I of the Birds Directive 2009[5]; Schedule 1: listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)[6], Red/Amber: listed on the UK BoCC Red or Amber List[4], SBL: Scottish Biodiveristy List[7].*

Records without flight details are included in this table but excluded from CRM analyses, therefore total numbers may differ.

*Source: **MBEC; ***Natural Power*

Table A7.10: Target species VP flight activity survey results non-breeding seasons (September to February) 2021-2022 and 2022-2023

Year	Species	No. Flights	No. Individuals	Legal protection*	UK BoCC*	Biodiversity Lists*
2021-2022	Barnacle goose	2	250	Annex I	Amber	SBL
	Whooper swan	1	22			
	Golden plover	4	61			SBL
	Goshawk	1	1			
	Hen harrier	3	3	Annex I, Schedule 1	Red	SBL
	Peregrine	2	2	Annex I, Schedule 1		SBL
2022-2023	Pink-footed goose	2	125			
	Whooper Swan	1	5	Annex I, Schedule 1	Amber	
	Woodcock	1	1		Red	SBL
	Snipe	3	3		Amber	
	Goshawk	1	1	Schedule 1		

**Annex I: listed on Annex I of the Birds Directive 2009[5]; Schedule 1: listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)[6], Red/Amber: listed on the UK BoCC Red or Amber List[4], SBL: Scottish Biodiveristy List[7].*

Records without flight details are included in this table but excluded from CRM analyses, therefore total numbers may differ.

Source: Natural Power

Table A7.11: Incidental observations of target species recorded during the 2022 breeding season and non-breeding season VP surveys (2021 – 2022 and 2022-2023)

Year	Season	Species	No. of records	No. of individuals	Legal protection	UK BoCC	Biodiversity Lists
2021-2022	Non-breeding	Golden Plover	1	1			SBL
		Woodcock	1	1		Red	SBL
		Snipe	5	6		Amber	
2022	Breeding	Curlew	1	1		Red	SBL
		Hen Harrier	1	1	Annex I, Schedule 1	Red	SBL
		Red Kite	1	1	Annex I, Schedule 1		SBL
2022-2023	Non-breeding	Whooper Swan	1	1	Annex I, Schedule 1	Amber	
		Snipe	1	1		Amber	
		Peregrine	1	1	Annex I, Schedule 1		SBL

**Annex I: listed on Annex I of the Birds Directive 2009[5]; Schedule 1: listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)[6], Red/Amber: listed on the UK BoCC Red or Amber List[4], SBL: Scottish Biodiveristy List[7].*

Natural Power

Table A7.12: Records of secondary species recorded during the 2022 breeding season and non-breeding season VP surveys (2021 – 2022 and 2022-2023)

	Number of records		
Species	< 10 times	10-100 times	> 100 times
Canada goose	4		
Cuckoo	3		
Cormorant	1		
Grey heron	2		
Sparrowhawk		17	
Buzzard	1		306
Kestrel		100	
Raven			230
Redwing	9		
Fieldfare	2		
Common crossbill			107

Source: Natural Power

Moorland Breeding Bird Surveys

7.1.5.4 Territory analysis results are presented in Chapter 7: Ornithology, Volume 1 of the EIAR.

7.1.5.5 Target species detected during MBBS that did not undergo territory analysis (wader species where a lack of evidence of breeding was observed during MBBS) are listed in Table A7.13.

Table A7.13: Species recorded during MBBS in 2021 and 2022 that did not undergo territory analysis

Species	2021	2022
Golden plover	9	-
Common sandpiper	-	1

Source: Natural Power

Breeding Raptor Survey

7.1.5.6 Barn owl were recorded as breeding during breeding raptor surveys in 2022. Further information on this can be found in Confidential Technical Appendix 7.2: Ornithology. Except for barn owl, no evidence was observed to indicate any breeding activity by any target species within the Proposed Development Area and surrounding 2 km buffer in 2021 or 2022. There was a total of five flights of two target species recorded during breeding raptor surveys in 2022. Target species flights recorded during the breeding raptor surveys in 2022 are shown in Table A7.14. Details of confidential records are provided in Confidential Technical Appendix 7.2: Ornithology.

Table A7.14: Target species recorded during the breeding raptor surveys in 2022

Date	Flight or point?	Species	No. Individuals	Sign	Notes
18/03/2022	Flight	Red Kite	1	Individual	Flew over pine trees on north side of road B741, circled above trees then drifted north.
19/07/2022	Flight	Red Kite	2	Individual	One juvenile flew over clearfell at Stony Knowes Hill and joined another juvenile present in dead trees within clearfell. One juvenile mobbed the other juvenile then both flew together before eventually flying off high to the south east. Both juveniles were younger than a 2nd calendar year.

Source: Natural Power

Black Grouse Surveys

7.1.5.7 No records of black grouse were recorded during the 2021 and 2022 surveys. During the surveys, one flight of a species of note was recorded and is shown in Table A7.15.

Table A7.15: Species of note recorded during black grouse surveys in 2021 and 2022

Date	Observer	Flight or point?	Species	No. of individuals	Sign
18/04/2022	AM	Flight	Golden plover	24	Flock passing over/transiting

Source: Natural Power

7.1.6 Collision Risk Modelling

Parameters

7.1.6.1 CRM was carried out for vantage point data collected at the Proposed Development Area between April 2021 and February 2023 inclusive from VPs 1, 2, 3, 4, 5 and 6 (though note that the viewshed from VP6 did not overlap with the collision risk zone (CRZ)).

7.1.6.2 Bird flights considered to represent a potential collision risk were those that passed within the CRZ, a 285 m buffer of the proposed turbine locations representing half the rotor diameter of the maximum turbine specification proposed at the site plus a 200 m precautionary buffer zone, at collision height. Bird activity on site was recorded relative to 3 height bands, presented in Table A7.16.

Table A7.16: Height bands used to record bird flight activity

Height band	Height range (m)
HB1	<10
HB2	10-210
HB3	>210

Source: Natural Power

7.1.6.3 Since the height within which the proposed turbine blades will rotate (potential collision height – PCH) falls within height band 2, only flight activity within this height band was considered to be at potential collision risk. A precautionary approach was taken in which it was assumed that all bird activity within the 10 m – 210 m height range covered by the height bands was assumed to be within the 30 m – 200 m height range that would be rotor-swept under the scenario in which the maximum turbine size is used.

7.1.6.4 Collision risk modelling was only run for birds for which at least 3 flights or 10 individuals were recorded within the CRZ at PCH during the course of the surveys. At South Kyle II, two target species fulfilled this criterion: barnacle goose and lesser black-backed gull.

7.1.6.5 CRM was carried out according to the Band (2024) Collision Risk Model[1] and analysis carried out using the spreadsheet provided alongside the most recent NatureScot collision risk modelling guidance (NatureScot, 2024)[2]. Data collected during flight activity vantage point surveys were used to predict the number of individuals per species expected to collide with the turbine rotors per season and annually.

7.1.6.6 Barnacle goose and lesser black-backed gull are typically considered as commuting species which will likely pass directly through a site. For these species, the number of observed passages through the VP viewsheds are used to derive a flux rate (also referred to as mean traffic rate (MTR)) which can then be converted into a bird density for using within the Band Model[1].

7.1.6.7 This methodology was applied to data collected for lesser black-backed gull during the breeding season (based on data collected during March to August inclusive in 2021 and 2022) and barnacle goose during the non-breeding season (based on data collected between September 2021 and February 2022 inclusive, and September 2022 and February 2023 inclusive).

7.1.6.8 The risk of collision for an individual given that it passes through the rotor swept area is estimated based on the characteristics of the birds and of the turbines. The wind farm specifications and the bird parameters used in the model are provided in Table A7.17 to Table A7.19 below.

Table A7.17: Wind turbine array attributes used in CRM

Attribute	Value
Latitude (degrees)	55.32954 (centroid of the CRZ)
Number of turbines	11
Hub height (metres)	115
Rotor diameter (metres)	170
Number of blades	3
Rotation speed (rpm)	7.03
Maximum blade width (metres)	4.5
Pitch (degrees)	15*

*Sources: Vattenfall; *Not available so tool default applied*

Table A7.18: Proportion of time turbines were assumed to be operational by month of the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Proportion of time available (i.e. not shut down for maintenance/repair)*	0.94	0.94	0.92	0.94	0.85	0.85	0.85	0.92	0.92	0.94	0.94	0.94
Proportion of time above cut-in and below cut-out (i.e. at operational wind speeds)**	0.96	0.97	0.93	0.92	0.92	0.86	0.87	0.90	0.92	0.96	0.95	0.96
Total proportion of time operational	0.91	0.91	0.86	0.86	0.78	0.73	0.74	0.82	0.85	0.90	0.90	0.90

*Source: *Indicative values taken from worked example in NatureScot, 2024, **Provided by the Developer*

Table A7.19: Bird attributes used in collision risk analysis

Attribute	Barnacle goose	Lesser black-backed gull
Bird length (metres)*	0.7	0.58
Wingspan (metres)*	1.45	1.43
Bird speed (metres/second)**	17	13.1
Flapping or gliding	Flapping	Flapping
Percentage of flights upwind (%)	50	50
Nocturnal activity ranking	2	1
Recommended avoidance rate***	0.998	0.995

*Sources: *Snow and Perrins, 1998[15]; **Alerstam et al., 2007[16]; *** NatureScot, 2018[17] (barnacle goose) and Furness, 2019[18] (lesser black-backed gull)*

Species Collision Risk

7.1.6.9 Target species recorded during the breeding season are shown in Table A7.20 with those species that met the criteria for CRM highlighted. Table A7.21 shows the target species recorded in the non-breeding season, with those species that met the criteria to run CRM highlighted.

Table A7.20: Number of flights and individuals observed passing through the risk area at risk height during breeding season flight activity surveys (April to August 2021 inclusive, and March to September inclusive, 2022)

Species	Total Flights	Risk flights	Risk individuals	CRM carried out
Greylag goose	1	1	2	No
Snipe	6	0	0	No
Herring gull	3	0	0	No
Lesser black-backed gull	**33**	**6**	**9**	**Yes**
Goshawk	3	0	0	No
Hen harrier	2	1	1	No
Red kite	1	0	0	No
Peregrine	1	0	0	No

Source: Natural Power

[15] Snow, D.W. and Perrins, (1998) *The birds of the Western Palearctic – concise edition. Volume 1 – Non-passerines*. Oxford University Press, UK.

[16] Alerstam, T., Rosén, M., Bäckman, J., Ericson, P.G.P., and Hellgren, O. (2007) *Flight speeds among bird species: allometric and phylogenetic effects*. PLoS biology, 5, e197.

[17] SNH (2018) *Avoidance rates for the onshore SNH wind farm collision risk model.* Scottish Natural Heritage (now NatureScot), Battleby.

[18] Furness, R.W. (2019). Avoidance rates of herring gull, great black-backed gull and common gull for use in the assessment of terrestrial wind farms in Scotland. Scottish Natural Heritage Research Report No. 1019.

Table A7.21: Number of flights and individuals observed passing through the risk area at risk height during non-breeding season flight activity surveys (September 2021 to February 2022 inclusive, and September 2022 to February 2023 inclusive). Bold cells represent species that met the requirements for CRM

Species	Total Flights	Risk flights	Risk individuals	CRM carried out
Barnacle goose	**2**	**2**	**250**	**Yes**
Pink-footed goose	2	0	0	No
Whooper swan	2	1	5	No
Golden plover	4	0	0	No
Woodcock	1	0	0	No
Snipe	3	0	0	No
Goshawk	2	2	2	No
Hen harrier	3	0	0	No
Peregrine	2	0	0	No

Source: Natural Power

7.1.6.10 The risk of collision for each species, calculated with avoidance factors of 95%, 98%, 99%, 99.2% and 99.8%, are presented in Table A7.22 and Table A7.23 below, and Table 7.10 in Chapter 7: Ornithology, Volume 1 of the EIAR. Values shown in bold represent species-specific avoidance levels recommended for collision risk analysis by NatureScot.

Table A7.22: Predicted number of barnacle goose collisions per year*

Avoidance rate	Breeding	Non-breeding	Annual
95%	0	0.0231 (0.0063 - 0.0399)	0.0231 (0.0063 - 0.0399)
98%	0	0.0092 (0.0025 - 0.0160)	0.0092 (0.0025 - 0.0160)
99%	0	0.0046 (0.0013 - 0.0080)	0.0046 (0.0013 - 0.0080)
99.5%	0	0.0023 (0.0006 - 0.0040)	0.0023 (0.0006 - 0.0040)
99.8%	**0**	**0.0009 (0.0003 - 0.0016)**	**0.0009 (0.0003 - 0.0016)**

**Numbers in bold represent NatureScot recommended avoidance rates. Annual estimates are the sum of the breeding and non-breeding estimates for species with at-risk flight activity across more than one season. Confidence intervals are shown in brackets.*

Table A7.23: Predicted number of lesser black-backed gull collisions per year*

Avoidance rate	Breeding	Non-breeding	Annual
95%	0.0009 (0.0002 - 0.0016)	0	0.0009 (0.0002 - 0.0016)
98%	0.0004 (0.0001 - 0.0006)	0	0.0004 (0.0001 - 0.0006)
99%	0.0002 (<0.0001 - 0.0003)	0	0.0002 (<0.0001 - 0.0003)
99.5%	**0.0001 (<0.0001 - 0.0002)**	**0**	**0.0001 (<0.0001 - 0.0002)**
99.8%	<0.0001 (<0.0001 - 0.0001)	0	<0.0001 (<0.0001 - 0.0001)

**Numbers in bold represent NatureScot recommended avoidance rates. Annual estimates are the sum of the breeding and non-breeding estimates for species with at-risk flight activity across more than one season. Confidence intervals are shown in brackets.*

CRM Calculations

7.1.6.11 Details of the calculations used to produce estimates for collision risk models for each species eligible for CRM during the breeding and non-breeding season are shown in Table A7.24 to Table A7.30.

Temporal Effort

7.1.6.12 Temporal survey effort is summarised by month in Table A7.5. Temporal effort is used in a calculation of density of seconds of bird flight activity per km^2 per second of survey effort. The Band (2024) collision risk model can incorporate density inputs at a monthly resolution, however here, densities were calculated on a seasonal basis due to relatively low sampling effort per vantage point per month (following NatureScot, 2024). As the survey effort was evenly distributed at each VP during each season, temporal effort used for the CRM was 129600 seconds per VP during the breeding season and the non-breeding season.

Spatial Effort

7.1.6.13 Spatial effort is also used in the calculation of density of seconds of bird flight activity per km^2 per second of survey effort. The full area of the CRZ is 2.78 km^2. The areas used in the CRM are presented in Table A7.24.

Table A7.24: Spatial effort used in the CRM.

VP	Area of the CRZ covered (km^2)	Proportion of the CRZ covered (%)
1	0.83	29.81
2	0.46	16.67
3	2.37	85.48
4	0.11	3.94
5	0.25	8.91
6	0	0

Source: Natural Power

Mean Rotor Speed

7.1.6.14 Mean rotor speed was calculated based on wind speed frequency distribution data for the Site and the cut-in, cut-out and rated speeds of the turbine model indicated for the Project (SG6.6-155), as well as the minimum and maximum operational rotor speeds. These values are presented in Table A7.25. The calculation was based on an assumption of the following relationship between wind speed and rotor speed: Rotor speed is assumed to be 0 until the wind speed reaches cut-in speed, at which point the rotor will start rotating at the minimum rotation speed. The rotation speed is then assumed to increase linearly until the rated wind speed at which it will be rotating at the maximum operational rotor speed. The turbine is assumed to continue to rotate at this speed until the cut-out wind speed is reached at which point rotor speed returns to 0. This relationship is visualised, in Figure 7.1.1.

Table A7.25: Manufacturers data used as input parameters to calculate mean rotor speed for the Project

Parameter	Units	Value
Cut-in wind speed	m/sec	3
Rated wind speed	m/sec	11.5
Cut-out wind speed	m/sec	25
Minimum operational rotor speed	RPM	5.1
Maximum operational rotor speed	RPM	8.8

7.1.6.15 Wind speed distribution data for the Site was provided by the Developer. The distribution is visualised in Figure 7.1.1.

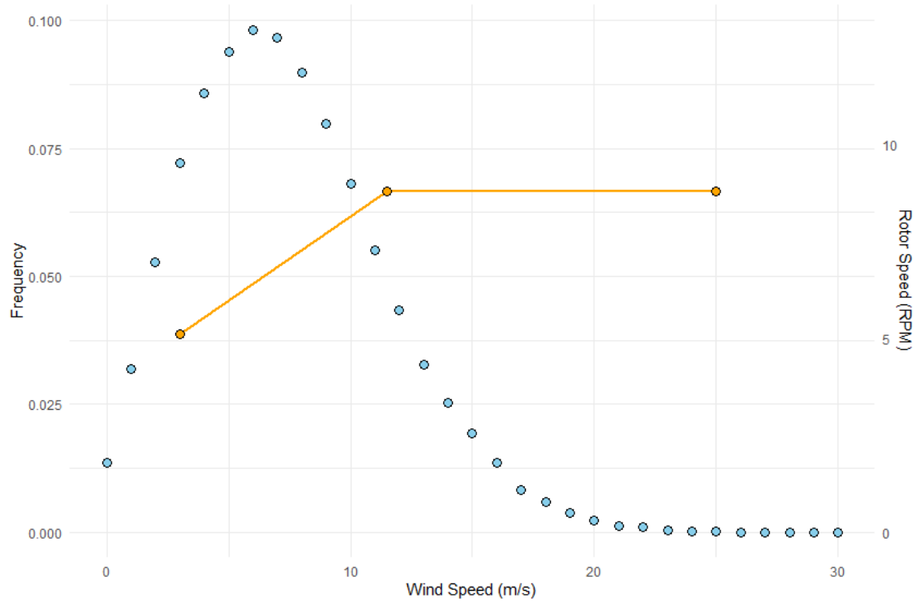

Figure 7.1.1: Wind speed distribution calculated and assumed relationship of wind speed and rotor speed based on manufacturers wind speed cut-in, operational range and cut-out and minimum and maximum operational rotor speeds.

7.1.6.16 The average rotor speed parameter required for the CRM modelling was calculated as an average of rotor speeds at a 1 m/s, weighted by the frequency at which each wind speed increment is expected to occur on site. This calculation is presented in Table A7.26.

Table A7.26: Calculation of mean rotor speed

Wind speed (m/s)	Wind speed frequency	Turbine rotor speed (RPM)	Product of wind speed frequency and turbine rotor speed
0	(0.014)	0.000	-
1	(0.032)	0.000	-
2	(0.053)	0.000	-
3 (Cut-in)	0.072	5.100	0.367584862
4	0.086	5.511	0.473025722
5	0.094	5.922	0.555258996
6	0.098	6.333	0.621616175
7	0.097	6.744	0.652273753
8	0.090	7.156	0.643226268
9	0.080	7.567	0.603455303
10	0.068	7.978	0.542880535
11	0.055	8.389	0.462253881
12 (Operational range)	0.043	8.800	0.381722785
13	0.033	8.800	0.288675974
14	0.025	8.800	0.222629802
15	0.019	8.800	0.170636007
16	0.014	8.800	0.118943334
17	0.008	8.800	0.073373483
18	0.006	8.800	0.051793047
19	0.004	8.800	0.033324208
20	0.002	8.800	0.021078566
21	0.001	8.800	0.011844146
22	0.001	8.800	0.009134045
23	0.000	8.800	0.004316087
24	0.000	8.800	0.002007482
25 (Cut-out)	0.000	8.800	0.001304864
26	(0.000)	0.000	-
27	(0.000)	0.000	-
28	(0.000)	0.000	-
29	(0.000)	0.000	-
30+	(0.000)	0.000	-
Sum of operational frequencies:	**0.897**	**Sum of operational products:**	**6.312**
Weighted average turbine operational rotor speed (Sum of product / Sum of frequencies)			**7.034 RPM**

Analysis

Density

7.1.6.17 Bird density was calculated separately for each viewshed, season and year. Whilst density inputs for the Band model can be provided per month, monthly survey effort was not considered sufficient to enable robust monthly density estimates to be generated, therefore average seasonal estimates were calculated and used as the input for the months covering that season.

7.1.6.18 Bird density was calculated as follows:

1. The average flight direction of each commuting species was calculated using all data available (i.e. including flights recorded outside of the CRZ) for that species to maximise the sample size used.
2. Each viewshed surveyed was clipped by a polygon representing the CRZ as defined previously (i.e. a 277.5 m buffer around the proposed turbine locations). Since viewsheds changed during the survey period, this was done for both sets of viewsheds used.
3. The maximum width of each clipped viewshed perpendicular to the average flight direction for each species was measured using QGIS. Since viewsheds changed during the first breeding season, a weighted average based on temporal effort at each viewshed was calculated for this season. These values are presented in Table A7.27.
4. The number flights of each species within each viewshed and season, excluding those only occurring in the uppermost unbounded height band (to allow inclusion of a height parameter for the bird density calculation - see below), was calculated.
5. Flux rate in metres per second for each year, season and vantage point was calculated as:

$$Flux\ rate_{sp} = N\ flights_{sp}\ /\ Seconds\ surveyed\ /\ Maximum\ viewshed\ width$$

Where *sp* is species and *Maximum viewshed width* is measured in metres and N flights excludes flights only passing through the unbounded upper height band (to allow inclusion of a height parameter for the bird density calculation - see below).

6. Bird density was then calculated as:

$$Bird\ density_{sp} = Flux\ rate_{sp} \times (\pi/2)\ /\ (bird\ speed_{sp} \times height\ of\ bounded\ survey\ area)$$

Where the height of the bounded survey area corresponds to the highest height of the topmost height band, in this case 200 m.

Table A7.27: Maximum length of the baseline perpendicular to flight direction covered by each viewshed. Vantage point 6 is not included since this the viewshed did not verlap with the CRZ.

Vantage point	Length of the baseline covered by the viewshed (m)	
	Barnacle goose	Lesser black-backed gull
VP1	2707	2940
VP2	1935	1924
VP3	3336	3095
VP4	306	309
VP5	570	570

7.1.6.19 Seasonal averages were then constructed by averaging across VPs and years for each season, weighted by effort in km^2 seconds.

7.1.6.20 Final densities used are presented in Table A7.28.

Table A7.28: Densities used for collision risk modelling of directional flights

Species	Breeding		Non-breeding	
	Mean	Standard deviation	Mean	Standard deviation
Barnacle goose	0	0	0.0000479	0.0001128
Lesser black-backed gull	0.0000025	0.0000035	0	0

Proportion

7.1.6.21 The Band (2024) model also requires an input representing the proportion of birds at risk height. This was calculated based on only those birds passing through the CRZ. All flights passing through the collision risk height range at any time were considered to be at risk height. Any birds that passed only through the unbounded upper height band would have been excluded in order for the proportion of birds at risk height to reflect the subset of flights applied for the density estimation. However, in this case, no such flights were observed. Proportions used in the modelling are presented in Table A7.29.

Table A7.19: Proportion of directional flights at risk height within the CRZ

Species	Total birds flying within the CRZ	Birds ever flying at risk height	Percentage birds ever at risk height
Barnacle goose	250	250	100%
Lesser black-backed gull	10	9	90%

Uncertainty

7.1.6.22 There is the potential for a high degree of uncertainty in outputs of the CRM due to variance and uncertainty in:

1. The input parameters used. This includes input parameters relating to the birds including the biometric and behavioural parameters applied and in the estimation of flight activity arising from sampling error and inaccuracy of flight mapping and/or estimation of flight height, and uncertainty in turbine and wind farm input parameter values used, which may be indicative or average values.
2. Simplifications made within the collision model itself.
3. Uncertainty in the final design option applied.

7.1.6.23 The latter doesn't apply in this case since the turbine and wind farm parameters are known. Uncertainty for each of the components are guesstimated in Table A7.30 and an overall estimate was calculated as the square root of the sum of the squares of these guesstimates. This uncertainty was then applied to calculate limits around collision estimates, shown as confidence intervals in Chapter 7: Ornithology Table 7.22 and Table 7.23.

Table A7.30: Approximation of uncertainty

Source of uncertainty	Range of uncertainty
Variance and uncertainty in flight activity/migration passages and other input parameters	± 70.0%
Simplifications in the collision model	± 20.0%
Design options yet to be finalised	N/A
Overall	± 72.8%