Lochluichart Wind Farm Extension II

on behalf of Bluebell Wind Limited

Further Environmental Information

Technical Appendix 3.A: Ornithological Appendix

avianecology

Document Control				
Project Name:		Lochluichart Extension II Wind Farm		
Project Number:		Infin-342-1358		
Report Title:		Ornithological Appendix		
Issue	**Date**	**Notes**	**Prepared**	**Reviewed**
V1	11/10/2021	Draft for client comment	A. Wolfenden *PhD MSc*	C. Garratt *PhD*
V2	31/03/2022	First issue	Z. Hinchcliffe *MRes BSc*	Nicole Robinson *MSc BSc (Hons) ACIEEM*

CONTENTS

1 INTRODUCTION

1.1 Background

1.1.1 This report details the results of a desk study and ornithology surveys undertaken for the Lochluichart Wind Farm Extension II (LXX).

1.1.2 The following terms are used throughout this report:

- Proposed Development – land encompassing the entire development, as shown on **Figure 3.0.**
- Study Areas – defined as relevant within survey methodologies.

1.1.3 Throughout this report only common names of bird species are used. A summary of each species referred to within this report including its common name, species name and conservation status is presented within **Annex 1**.

2 FIELD SURVEY METHODOLOGY

2.1.1 The following field surveys have been completed:

- Vantage Point (VP) flight activity surveys (February 2021 to February 2022);
- Moorland Breeding Bird Survey (MBBS) (May to August 2021);
- Breeding Black Grouse Searches(April 2021); and,
- Breeding Raptor and Diver Searches (April to August 2021; February and March 2022).

2.1.2 Surveys have been undertaken in accordance with NatureScot guidance *Recommended bird survey methods to inform impact assessment of onshore wind farms* (NatureScot, 2017). Any deviations from recommended guidance are described and discussed in Section 3.79 and 3.84 of the FEI.

2.2 Field Survey Personnel

2.2.1 Field surveys have been undertaken by experienced ornithologists, some of whom have previously undertaken surveys for the adjacent Corriemoillie and Kirkan Wind Farms and are therefore knowledgeable of the local area.

2.2.2 Ornithologists were competent, experienced and professional and fully conversant in recognised bird survey methodologies for proposed wind turbine developments.

2.2.3 The following surveyors are named: P. Carroll, R. Jenkins, S. Macdonald, A. McNab, V. Hastie and M. Wood.

2.3 Vantage Point (VP) Surveys

2.3.1 The Vantage Point (VP) survey methodology followed current NatureScot guidance *Recommended bird survey methods to inform impact assessment of onshore wind farms* NatureScot (SNH, 2017), using one VP (VP2 from surveys undertaken for the Consented Development; see **Figure 11.1** of the EIA Report).

2.3.2 This VP provides complete visual coverage of the VP study area required for the Proposed Development, defined here as the 'rotor swept' area within a 500m buffer around the proposed turbine locations.

2.3.3 The total survey effort in hours completed is summarised in **Table 2.1**. Each VP survey session was up to three hours in duration.

Table 2.1: VP survey effort (hrs).

VP/Month	2021											2022		Total (hrs)
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
VP2	6	12	9	6	6	-	12	6	-	12	6	2	10	87

2.3.4 Survey times were dispersed throughout the day and were completed in a range of weather conditions suitable for survey (i.e. not during periods of poor visibility). Full details of all survey times and conditions are presented in **Annex 2**.

2.3.5 Flight lines were mapped for all target species passing through the VP survey area. Details of species, number of birds, flight height (in bands), duration and direction were noted on standardised recording forms.

2.3.6 The following height bands (HT) were therefore used in the field to record target species activity "at", "below" or "above" collision risk height for subsequent use in the calculation of collision mortality risks:

- HT1 0-10m;
- HT2 10-25m;
- HT3 25-150m; and,
- HT4 >150m.

2.3.7 The Proposed Development includes for turbines up to 149.9m tip and 136m rotor diameter.

2.3.8 Any flights recorded within HT2 and HT3 and also within 268m (200m plus blade length) of the proposed turbine locations would be classified as being "at collision risk". NatureScot guidance (SNH, 2000) defines the 'risk window' as 'equal to the width of the wind farm across the general flight direction of the birds, and of height equal to the maximum height of the highest turbine'. For the purposes of precautionary assessment, the collision risk radius from proposed turbine locations, was rounded up to 275m.

Target Species

2.3.9 Target species for survey and recorded have primarily included those species identified as "Priority" bird species within NatureScot guidance (2018) and listed on/as:

- Qualifying interests of nearby designated sites for nature conservation;
- Annex 1 of the European Union Directive 2009/147/EC (the 'Birds Directive'); and,
- Schedule 1 of the Wildlife & Countryside Act 1981 (as amended for Scotland).

2.3.10 Target species have also been identified with reference to the following key documents:

- Scottish Natural Heritage (2017). Recommended bird survey methods to inform impact assessment of onshore wind farms. Nature Scot, Edinburgh;
- The Consented Development ES (2018) and appendices.

2.3.11 Target species have therefore broadly included all Schedule 1/Annex 1 raptors, all waders, black grouse, divers, ducks (excl. mallard), swans, geese (excl. feral species) and grebes.

2.3.12 Greylag geese in Britain comprise three populations; the Iceland migratory population present between October and April predominantly in Scotland and northern England; the northwest Scotland remnant population which predominantly occur within western Scotland and in mainland northern Scotland; and the re-established (naturalised) introduced population which is widespread throughout Britain and Ireland (Hearn & Mitchell, 2004). For the purposes of baseline field surveys the local wintering population (September to April) was considered to form part of the migratory Icelandic population. Observations of the species outside of October to April were considered part of the re-established (naturalised feral) population.

Secondary Species

2.3.13 Secondary species were recorded in 15-minute summary intervals, noting the number of birds present and general behaviour in order to build an overall picture of activity. Fifteen-minute periods were considered appropriate to ensure the surveyor was fully alert to target species activity.

2.3.14 Secondary species were defined as commoner raptors, all gulls, mallard and feral species, along with any large concentrations of commoner passerine species.

2.4 Collision risk Modelling

2.4.1 Where sufficient “at collision risk” flight activity justifies it, collision risk mortality estimates as a result of birds colliding with rotor blades has been assessed using the SNH Collision Risk Model (CRM) as detailed in Band *et al*. (2007).

2.4.2 Band *et al*. (2007) details two CRMs; one model for directional flights, and another for non-directional (or space-filling) flights. The former model is based upon the total number of birds passing through the CRW, whereas the non-directional model is based upon the total time a bird is recorded within the CRW volume. Target species have therefore been assigned to a single model based on the nature of flight activity data obtained during VP surveys.

2.4.3 Collision risk mortality has subsequently been calculated in three stages:

• Directional: calculating the total number of birds recorded to pass though the CRW. Non-directional: estimating the time an individual bird spent passing through the CRW volume.

• Estimating the probability that a bird will be struck by a rotor blade when passing through the area swept by the rotors.

• Applying an 'avoidance rate', whereby it is assumed that most birds will take action to avoid collision.

2.5 Moorland Breeding Bird Survey

2.5.1 The methodology employed followed the Brown and Shepherd (1993) method for censusing upland breeding waders, based upon the recommendations set out in Calladine *et al*. (2009) as per current guidance (SNH, 2017). The methodology is suitable for moorland and open country species including,

waders, skuas, gulls and some wildfowl species however, incidental observations of any raptors, owls or notable passerines (i.e. Schedule 1 and BoCC red-listed) may also be recorded.

2.5.2 The MBBS study area is defined here as all open moorland within the Site extended to include all areas within approximately 500m of the Site, as access allowed.

2.5.3 During each survey visit a pre-determined route was walked through the study area and all birds seen or heard, and their behaviours (e.g. singing, carrying food etc.) were mapped in the field.

2.5.4 All surveys were undertaken during daylight hours and in fine conditions conducive to survey. Survey effort is presented in **Table 2.2**. Full details of all survey times, field surveyors used and weather conditions are presented in **Annex 2.**

Table 2.2: Breeding bird survey effort.

Date	Start Time	End Time
18/05/2021	08:30	16:15
29/06/2021	08:30	14:30
04/08/2021	08:30	14:30

2.6 Breeding Black Grouse Searches

2.6.1 Searches for lekking black grouse with reference to Gilbert *et al.* (1998) were undertaken in April 2021. Searches were made of all suitable habitats within the study area, defined as a 1.5km buffer of the proposed turbines and where access allowed.

2.6.2 The survey effort is presented in **Table 2.3** and detailed survey effort including survey conditions are presented in **Annex 2.**

Table 2.3: Breeding black grouse search effort.

Date	Start Time	End Time
16/04/2021	05:00	08:00
30/04/2021	04:30	07:30

2.7 Breeding Raptor and Diver Searches

2.7.1 Searches for Annex 1/Schedule 1 breeding raptors, owls and divers were undertaken between April and July 2021, and in February and March 2022, with reference to species-specific methodologies outlined in Hardey *et al.* (2013).

2.7.2 Searches in 2021 were undertaken within a 1km buffer of the Site for breeding divers, a 2km buffer of the Site for all Annex 1/Schedule 1 raptors and owls.

2.7.3 Further details on the approach concerning searches for breeding divers is provided in **Appendix 3.B**.

2.7.4 In response to advice received from NatureScot, further searches for breeding evidence of golden eagle within 6km of the Site were undertaken during the eagle display period in February and early March 2022. Observations were undertaken over suitable habitat features, where access permissions allowed and/or from public roads and rights of way, in order to try to determine the presence and location of any active or possible nest sites.

2.7.5 Study areas used in 2021 and 2022 are shown in **Figure 3.3**. All surveys were undertaken during daylight hours with good visibility. Survey effort is presented in **Table 2.4**. Survey conditions are presented in **Annex 2**.

Table 2.4: Raptor and Diver survey effort.

Date	Start Time	End Time
29/04/2021	08:45	14:45
28/05/2021	07:35	13:45
28/06/2021	11:50	17:50
03/08/2021	10:15	17:00
28/02/2022	08:00	14:00
02/03/2022	09:10	15:10
07/03/2022	10:00	16:00
10/03/2022	09:40	15:10

2.8 Field Survey Limitations

2.8.1 All habitats within the Site were accessible for survey.

2.8.2 In 2021, direct access to study Areas used for the MBBS (500m), breeding black grouse searches (1.5km) and breeding diver searches (1km), were curtailed at the Corriemoillie Estate boundary. Observations were however possible into these parts of the study area using elevated survey points within the Site boundary.

2.8.3 The curtailment of study areas was made on the understanding of ongoing ornithological operational monitoring for the Corriemoillie Wind Farm and the completion of baseline ornithological studies for the Lochluichart Extension II Wind Farm S37 Grid Connection route, and which would provide survey coverage of these parts of the study areas.

2.8.4 A data sharing agreement was made between to share information gathered from these studies for the purposes of establishment baseline conditions for the Proposed Development and subsequent impact assessment. As such, full survey coverage of study areas required in accordance with NatureScot guidance (SNH, 2017) has been obtained and no limitations to surveys are identified. The co-ordination of surveys in this manner is considered good practice with regards the avoidance of unnecessary disturbance to sensitive breeding species and is in accordance with good practice guidance.

2.8.5 Further details on the completion of searches for breeding divers is provided in Appendix 3.B.

2.8.6 Searches for Annex 1/ Schedule 1 breeding raptors owls (≥2km and <6km) were surveyed from suitable locations within the Site or public rights of way (PRoWs), scanning the Study Areas with the use of optics (telescope and binoculars).

2.8.7 Plantation woodland habitats within the survey area were surveyed by traversing tracks and clearings rather than walking directly through dense plantation habitat, due to logistical and health and safety considerations. The survey area was appropriately covered from the accessible tracks and clearings and this is not therefore considered a limitation to the results obtained.

2.8.8 No surveys were carried out in July due to access restrictions in relation to estate management activities (including shooting) or in October due to adverse weather conditions. Survey effort was doubled in August and November to make up the missed effort.

2.8.9 VP flight activity surveys commenced after a short period of "settling in", to ensure any potential disturbance to target species present within each viewshed had reasonably passed.

2.8.10 Other information regarding survey limitations is presented in Chapter 3 of the FEI.

3 RESULTS

3.1 Vantage Point Surveys

Target Species

3.1.1 All target species flight activity recorded during VP surveys between February 2021 and February 2022 is summarised in **Table 3.1** below. The total number of flights, total number of birds recorded and the total time spent in each height band (in seconds) are presented.

3.1.2 Detailed flight records for target species are presented in **Annex 3**, with flight lines illustrated in **Figure 3.1**.

Table 3.1: Summary of target species flight activity (February 2021-February 2022).

Species	Total No. of Flights	Total No. of Birds	HT1 (s)	Collision Risk Height		HT4 (s)
				HT2 (s)	HT3 (s)	
Golden eagle	36	50	1,617	5,045	7,992	4,194
White-tailed eagle	3	3	0	0	131	1,094
Whooper swan	1	27	0	0	0	3,159
Greylag goose	2	76	0	0	0	19,419
Pink-footed goose	2	740	0	0	48,000	8,820
Golden plover	4	5	42	55	44	330
Hen harrier	1	1	47	0	0	0
Red kite	1	1	0	0	592	560
Merlin	1	1	20	0	0	0

3.1.3 Additional observations include golden plover which were heard during two VP sessions in February and July 2021 but no birds were seen.

3.2 Collision mortality risk

3.2.1 "At collision risk" flight activity recorded during VP flight activity surveys is summarised in **Table 3.2** below. The total number of flights, total number of birds and total time spent at collision risk height is presented.

3.2.2 **Annex 4** provides further details of target species "at collision risk" flight activity.

Table 3.2: "At collision risk" flight activity – February 2021 to February 2022.

Species	Total No. of Flights	Total No. of Birds	Total Time at Collision Risk Height (s)
Golden eagle	5	7	3,327

Collision Risk Analysis Parameters

3.2.3 Species and turbine parameters used in collision risk analysis are presented in **Tables 3.3 and 3.4**.

3.2.4 Collision risk analysis has only been undertaken for golden eagle.

3.2.5 No other species had more than three "at collision risk" flights between March 2021 and February 2022, none of which comprised large flocks. Overall flight activity for all other target species was considered to be very infrequent. As such, it can reasonably be concluded without further detailed analysis, that collision mortality risk estimates would be inconsequential for any other target species, at any population level.

Table 3.3: Turbine Parameters[1],

Parameter	Value	Unit
No. of rotors	5	
No. of blades	3	
Height to tip	149.9	meters
Hub height	82	meters
Rotor diameter	136	meters
Rotor radius	66.7	meters
Max cord	4.1	meters
Pitch	5	degrees
Rotation period	3.4	Seconds
Downtime	15	%

Table 3.4: Target species parameters
As per Proven & Whitfield (2007), unless where otherwise specified.

Species	Length	Wing span	Flight Speed	Collision Probability[2]	Avoidance Rate[3]	Occupancy
Golden eagle	0.85	2.12	15.0	6.6	99%	All year

3.3 Golden Eagle

3.3.1 **Table 3.5** presents collision probability calculations for golden eagle using flight activity data obtained from VP surveys February 2021-2022:

- Wind farm area (275m): 110.42 ha

[1] Based upon Technical specifications for a Vesta V136-4.3 MW (https://www.vestas.com/en/products/4-mw-platform/v136-_3_45_mw#!at-a-glance)
[2] See **Annex 4**.
[3] SNH (2018).

- Assumed daylight flying hours (potential): 3659[4] (Year Round Occupancy)
- Down time: 15%

Table 3.5: Golden eagle (2021-2022).

Mean activity hr^-1 in wind farm				**WIND FARM DATA**	
Risk height	0.00097	0.0966%		Wind farm area (ha)	110.42

Daylight hours	3659				
Downtime	15	0.85		D	136
Vw =	150169840			L + d	4.92
Vr =	357357	**No. of turbines**	5		
Vr/Vw =	0.0023797				
Speed	15				
Vw Occupancy =	3.5350	12726.0			
Vr Occupancy =	0.0084	30.3			
Transit time =	0.3280				
Transits =	92.329				
Collision probability from SNH sheet	0.088				
Collisions with no avoidance	8.125				
Collisions with 99% avoidance	0.081				
Collisions with 99% avoidance & downtime	0.069				
30 year mortality	2.437				
30 year mortality with 15% downtime etc	2.072				
Years for 1 death	14.48				

3.4 Moorland Breeding Bird Survey

3.4.1 All species recorded along with an estimate of the number of pairs present within the study area are detailed in **Table 3.6**.

[4] Potentially active hours for golden eagle has been calculated using a latitude of 57.671665 as per Forsythe, W. C., Rykiel, Jr., E. J., Stahl, R. S., Wu, H and Schoolfield, R. M. (1995) "A Model Comparison for Daylength as a Function of Latitude and Day of the Year. *Ecological modelling*, **80**, pp. 87-95. Hours exclude 29th February as field surveys were not undertaken over a leap year and July and October, as no surveys were carried out during those months.

3.4.2 In summary, the study area in 2021 was found to supports a breeding bird assemblage typical of upland moorland and wetland habitats. This included a small number of pairs of breeding waders including golden plover and greenshank.

Table 3.6: MBBS results 2021.

Species	Estimated Population (Maximum No. Pairs)
Mallard	3
Teal	2
Little grebe	1
Common sandpiper	1
Ringed plover	1
Golden plover	4
Greenshank	4
Red throated diver	1

3.5 Breeding Black Grouse Searches

3.5.1 Searches of all suitable habitats within the study area recorded eight active black grouse leks.

3.5.2 Four Black grouse lekks were located on both surveys in April 2021.

3.5.3 A summary of the leks is provided in **Table 3.7.**

Table 3.7: Breeding Woodland Grouse Survey Results 2021.

Date	Grid reference	Comments
16/4/2021	NH 33469 69845	Single male lekking.
	NH 33050 70587	Single male lekking.
	NH 33517 67902	Single male lekking.
	NH 34093 69890	5 males observed lekking.
30/04/2021	NH 361 706	Two males lekking.
	NH 343 699	Two males lekking.
	NH 341 719	Eight males lekking.
	NH 333 702	Single male lekking.

3.6 Breeding Raptor, Owl and Diver Searches

3.6.1 Eight searches for breeding raptors, owls and diverswere undertaken between April and August 2021 and February and March 2022 (see Table A2.4, Annex 2 for details).

Golden Eagle

3.6.2 Golden eagle flights were recorded during six of the eight surveys. During the April survey a single adult was seen soaring approximately 2km from the Site boundary. In June an adult and an immature

golden eagle were seen hunting separately within the 2km buffer. In February two adult and immature male golden eagles were seen displaying within 2km of the Site and a female golden eagle was seen hunting close to the Site boundary.

3.6.3 Golden eagles were observed mating in March 2022 suggesting the presence locally of breeding golden eagles. Flights are presented on **Figure 3.4**.

Other Raptors

3.6.4 No breeding evidence of any other Annex 1/Schedule 1 raptors or owls was recorded within the study area.

3.6.5 A pair of red kites was observed displaying outside the 2km buffer in May 2021, but no nest location was recorded.

3.6.6 Single flights of kestrel and buzzard were recorded during the April survey and it is likely these species hold breeding territories locally.

Divers

3.6.7 Breeding evidence of red-throated diver was recorded during searches in 2021. Incidental observations of red-throated divers were also made during MBBS visits and breeding black grouse searches.

3.6.8 Information pertaining to the breeding locations of red-throated divers is considered sensitive and has therefore been made confidential. Full details are therefore provided in **Appendix 3.B**.

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ANNEX 1 – BIRD SPECIES

Table A.1 provides a summary of all bird species referred to within the Appendix including common names, species names and current conservation status.

The following abbreviations are used to describe each species conservation status:

- Annex 1: species listed on Annex 1 of the EC Birds Directive.
- S1: species listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).
- UKBAP: species listed on the UK Biodiversity Action Plan.
- LBAP: Ross and Cromarty (East) LBAP.
- SBL: Scottish Biodiversity List (SBL) 2013.
- BoCC: Birds of Conservation Concern 5 (Stanbury *et al.*, 2021). Red or Amber list categories are given.

Table A1: Summary of bird species referred to within this Appendix.

Common Name	Species Name	Conservation Status
Black grouse	*Lyrurus tetrix*	UKBAP, BoCC – Red, LBAP.
Whooper swan	*Cygnus cygnus*	Annex 1, S1, BoCC – Amber, LBAP.
Pink-footed goose	*Anser brachyrhynchos*	BoCC – Amber, LBAP.
Greylag goose	*Anser anser*	BoCC – Amber, LBAP.
Mallard	*Anas platyrhynchos*	BoCC – Amber.
Teal	*Anas crecca*	BoCC – Amber.
Little grebe	*Tachybaptus ruficollis*	-
Golden plover	*Pluvialis apricaria*	Annex 1.
Ringed plover	*Charadrius hiaticula*	BoCC – Red.
Common sandpiper	*Actitis hypoleucos*	BoCC – Amber.
Greenshank	*Tringa nebularia*	S1, BoCC – Amber.
Red-throated diver	*Gavia stellata*	Annex 1, S1.
Hen harrier	*Circus cyaneus*	Annex 1, S1, BoCC - Red, LBAP, SBL.
Red kite	*Milvus milvus*	Annex 1, S1, LBAP.
Golden eagle	*Aquila chrysaetos*	Annex 1, S1, LBAP.
White-tailed eagle	*Haliaeetus albicilla*	Annex 1, S1, BoCC – Amber, LBAP.
Buzzard	*Buteo buteo*	-
Kestrel	*Falco tinnunculus*	BoCC – Amber.
Merlin	*Falco columbarius*	Annex 1, S1, BoCC – Red, SBL.

ANNEX 2 – SURVEY EFFORT

Tables A2.1-3 presents field survey efforts.

The following codes are used to record weather conditions within **Tables A2.1-3**:

Wind Speed			**Wind Direction**			**Cloud Height**	
Calm	0		16 point compass			<150m	0
Light air	1		Variable			150-500m	1
Light breeze	2					>500m	2
Gentle breeze	3		**Rain**				
Moderate breeze	4		None	0			
Fresh breeze	5		Drizzle/mist	1			
Strong breeze	6		Light showers	2			
Moderate gale	7		Heavy showers	3			
Fresh gale	8		Heavy rain	4			
Strong gale	9						
Whole gale	10		**Visibility**				
Storm	11		Poor	0			
			<1km	1			
			>1km	2			

Table A2.1: VP survey effort.

Date	VP	Surveyor	Start Time	Finish Time	VP Hours	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
28/02/2021	2	PC	10:30	13:30	3	4/4/3	WSW/WSW/SW	0/0/0	3/4/5	2/2/2	2/2/2	0/0/0	1/1/1
28/02/2021	2	PC	14:00	17:00	3	3/3/2	SW/SW/SSW	2/2/2	7/7/7	2/2/2	2/2/2	0/0/0	1/1/1
12/03/2021	2	SM	07:15	10:15	3	5/5/4	WSW/W/W	0/2/2	7/7/8	2/2/2	2/2/2	1/0/0	1/1/1
12/03/2021	2	SM	10:45	13:45	3	4/4/5	W/W/W	0/2/0	8/8/5	2/2/2	2/2/2	1/0/0	1/1/1
01/04/2021	2	SM	09:40	12:40	3	2/1/2	E/E/ESE	0/0/0	1/0/0	2/2/2	2/2/2	1/0/0	2/2/2
01/04/2021	2	SM	13:10	16:10	3	1/1/1	SE/SSE/SE	0/0/0	0/0/0	/-/-/-/	2/2/2	0/0/0	2/2/2
17/05/2021	2	SM	11:55	14:55	3	2/2/3	NW/WSW/WNW	0/0/0	8/8/8	2/2/2	2/2/2	0/0/0	0/0/0
17/05/2021	2	SM	15:25	18:25	3	3/3/3	NW/NW/NW	0/0/0	8/7/6	2/2/2	2/2/2	0/0/0	0/0/0
25/06/2021	2	MW	08:25	11:25	3	3/3/2	N/N/N	0/1/0	8/8/8	2/2/2	2/2/2	0/0/0	0/0/0
25/06/2021	2	MW	11:55	14:55	3	3/3/3	N/N/N	1/1/1	8/8/8	2/2/2	2/2/2	0/0/0	0/0/0
02/08/2021	2	SM	13:40	16:40	3	1/1/1	NNE/NNE/N	0/0/0	6/6/6	2/2/2	2/2/2	0/0/0	0/0/0
02/08/2021	2	SM	17:10	20:10	3	1/1/3	NNW/NNW/NNW	0/0/0	6/4/6	2/2/2	2/2/2	0/0/0	0/0/0
06/08/2021	2	SM	04:55	17:55	3	4/4/4	E/E/ENE	0/0/2	8/7/7	2/2/2	2/2/2	0/0/0	0/0/0
06/08/2021	2	SM	08:25	11:25	3	4/4/4	ENE/E/ENE	2/2/0	8/8/8	1/2/2	2/2/2	0/0/0	0/0/0
29/09/2021	2	SM	09:55	12:55	3	3/3/4	WNW/W/W	2/0/0	7/4/5	2/2/2	2/2/2	0/0/0	0/0/0
29/09/2021	2	SM	13:25	16:25	3	4/3/3	WNW/NW/WNW	2/0/2	7/7/7	2/2/2	2/2/2	0/0/0	0/0/0
04/11/2021	2	SM	09:25	12:25	3	4/4/4	WNW/WNW/WNW	0/0/0	7/6/6	2/2/2	2/2/2	0/0/0	0/0/0

Date	VP	Surveyor	Start Time	Finish Time	VP Hours	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
04/11/2021	2	SM	12:55	15:55	3	4/5/4	WNW/WNW/WNW	0/0/0	7/6/8	2/2/2	2/2/2	0/0/0	0/0/0
15/11/2021	2	SM	10:00	13:00	3	2/2/3	WSW/SW/WSW	0/0/0	7/6/7	2/2/2	2/2/2	0/0/0	0/0/0
15/11/2021	2	SM	13:30	16:30	3	5/3/4	SW/SW/SW	0/0/0	5/8/8	2/2/2	2/2/2	0/0/0	0/0/0
06/12/2021	2	SM	09:20	12:20	3	4/4/3	WSW/WSSW/WSW	3/0/0	3/0/0	8/4/6	1/2/2	2/2/2	1/1/1
06/12/2021	2	SM	12:50	15:50	3	4/2/3	WSW/WSW/WSW	2/2/0	8/8/8	2/1/2	2/1/2	2/2/2	1/1/1
26/01/2022	2	GD	09:15	11:15	3	2/6/9	W/W/W	0/1/3	6/8/8	2/1/1	2/1/0	0/0/0	0/0/0
04/02/2022	2	SM	08:50	11:50	3	4/6/5	WNW/WNW/W	1/0/1	6/6/8	2/2/2	2/2/2	2/2/2	1/1/1
04/02/2022	2	SM	12:20	13:20	1	6/6/6	W/W/W	2/2/2	8/8/8	2/2/2	2/2/2	2/2/2	1/1/1
27/02/2022	2	GD	10:30	13:30	3	3/4/4	SSW/SSW/S	0/0/0	6/5/6	2/2/2	2/2/2	0/0/0	1/1/1
27/02/2022	2	GD	14:00	17:00	3	5/5/4	SSE/SSE/SSW	0/0/0	7/8/7	2/2/2	2/2/2	0/0/0	1/1/1

Table A2.2: MBBS effort.

Date	Surveyor	Start Time	Finish Time	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
18/05/2021	AJM	08:30	14:30	2/2/3/3/2/2	W/W/W/W/WNW/WNW	0/0/2/0/0/0	6/6/6/6/6/7	2/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0	0/0/0/0/0/0
	SM	08:45	16:15	2/2/2/2/2/3/3	WSW/W/WNW/WNW/WNW/NW/NW	2/2/2/0/0/0/0	7/7/8/7/6/7/7	2/2/2/2/2/2/2	2/2/2/2/2/2/2	0/0/0/0/0/0/0	0/0/0/0/0/0/0

29/06/2021	SM	08:30	14:30	3/2/3/3/3/4	NNW/NW/NNE/NNW/NNW/NNW	0/0/0/0/0/0	1/2/1/1/2/1	2/2/2/2/2/2	2/2/2/2/2/2/2	0/0/0/0/0/0/0	0/0/0/0/0/0/0
	MW	08:30	14:30	2/2/3/3/3/3	SW/SW/SW/SW/SW/SW	0/0/0/0/0/0	4/1/0/0/2/3	2/2/-/-/2/2/	2/2/2/2/2/2/2	0/0/0/0/0/0/0	0/0/0/0/0/0/0
04/08/2021	VH	08:30	14:30	2/2/3/3/3/3	SE/SE/SE/SE/S/S	2/0/0/0/0/0	7/6/7/8/7/7	2/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0/0	0/0/0/0/0/0/0
	SM	08:30	14:30	2/2/3/3/2/3	SSW/SSW/SSW/S/S/WSW	0/0/0/0/0/0	8/8/7/8/8/8	2/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0/0	0/0/0/0/0/0/0

Table A2.3: Breeding black grouse search effort.

Date	Surveyor	Start Time	Finish Time	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
16/04/2021	MW	05:00	08:00	1/0/0	S/-/-	0/0/0	0/0/0	-/-/-	2/2/2	1/1/1	1/1/1
30/04/2021	SM	04:30	07:30	2/2/2	NW/NW/NNW	0/0/0	6/7/6	2/2/2	2/2/2	0/0/0	2/2/2

Table A2.4: Annex 1/Schedule 1 breeding raptor, owl and diver search effort.

Date	Surveyor	Start Time	Finish Time	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
29/04/2021	SM	08:45	14:45	3/4/4/4/3/4	NE/NNE/NE/ENE/ENE/NE	0/0/0/2/2/2	5/6/6/7/7/7	2/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0	2/2/2/2/2/2
28/05/2021	AJM	07:35	13:45	1/2/2/2/3/3	SE/SSE/SSE/SW/WSW/SW	0/0/0/0/0/0	8/8/5/3/3/2	1/1/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0	0/0/0/0/0/0
28/06/2021	SM	11:50	17:50	3/4/4/3/3/3	WNW/WNW/WNW/WNW/WNW/WNW	0/0/0/0/0/0	0/1/1/1/2/4	-/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0	0/0/0/0/0/0
03/08/2021	SM	10:15	17:00	1/2/3/3/3/2	SE/SW/WSW/WSW/WSW/W	0/0/0/0/0/0	8/8/8/8/8/8	2/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0	0/0/0/0/0/0

28/02/2022	GD	08:00	14:00	4/5/5/5/5/5	SW/SW/SW/SW/SW/SW	1/0/0/0/0/3	6/2/2/2/7/8	2/2/2/2/2/2	2/2/2/2/2/2	0/0/0/0/0/0	1/1/1/1/1/1
02/03/2022	SM	09:10	15:10	4/5/5/4/4/3	ESE/ESE/ESE/ESE/SE/SE	0/0/0/0/0/0	1/0/0/0/1/7	2/2/2/2/2/2	2/2/2/2/2/2	1/1/1/1/0/0	2/2/2/2/2/2
07/03/2022	GD/SM	10;00	16:00	2/1/1/3/2/2	S/SW/S/SE/SE/SE	0/0/0/0/0/0	2/2/1/4/2/2	2/2/2/2/2/2	2/2/2/2/2/2	1/1/0/0/0/0	1/1/1/1/1/1
10/03/2022	SM	09:40	15:10	1/2/3/3/3/3	SW/S/S/SSE/SSE/SSE	0/0/0/0/0/1	8/8/8/7/7/8	1/2/2/2/2/2/	2/2/2/2/2/2	0/0/0/0/0/0	2/2/2/2/2/2

ANNEX 3 – SURVEY RESULTS

The following British Trust for Ornithology (BTO) species codes are used to denote species in **Table A3.1**:

EA – golden eagle; GJ – greylag goose; GP – golden plover; WS – whooper swan; WE – white-tailed eagle; ML – merlin; HH – hen harrier; and, KT – Red kite.

Flight times at HT1-4 comprise duration (seconds) multiplied by flock size.

Table A3.1: VP survey results – target species flight activity (February 2021-February 2022).

Date	VP	Species	No.	Start Time	Total Duration (s)	HT1 (s)	HT2 (s)	HT3 (s)	HT 4 (s)
28/02/2021	2	EA	1	16:28	219	0	0	0	219
01/04/2021	2	GJ	47	10:03	291	0	0	0	13,677
01/04/2021	2	GP	1	10:23	25	0	25	0	0
01/04/2021	2	EA	1	10:50	620	0	0	0	620
01/04/2021	2	GJ	29	11:09	198	0	0	0	5,742
01/04/2021	2	WS	27	12:12	117	0	0	0	3,159
01/04/2021	2	EA	2	13:19	323	0	0	0	646
01/04/2021	2	EA	2	14:18	1242	0	0	525	1,434
17/05/2021	2	EA	1	14:32	156	0	0	156	0
17/05/2021	2	EA	1	17:03	198	0	0	198	0
17/05/2021	2	EA	2	17:19	293	0	0	300	286
17/05/2021	2	EA	1	17:39	126	0	0	36	90
17/05/2021	2	EA	1	17:54	344	0	15	120	209
02/08/2021	2	EA	1	15:36	452	30	15	347	60
02/08/2021	2	EA	1	15:46	208	0	13	195	0
06/08/2021	2	EA	1	05:54	126	21	60	45	0
06/08/2021	2	EA	2	05:59	1397	360	934	1,230	270
06/08/2021	2	EA	2	06:31	1282	240	674	1,410	240
06/08/2021	2	EA	1	06:57	243	0	33	210	0

Date	VP	Species	No.	Start Time	Total Duration (s)	HT1 (s)	HT2 (s)	HT3 (s)	HT 4 (s)
06/08/2021	2	EA	1	07:21	265	75	145	45	0
29/09/2021	2	EA	1	13:34	308	0	0	308	0
29/09/2021	2	WE	1	15:58	877	0	0	0	877
29/09/2021	2	EA	2	16:01	287	0	214	360	0
29/09/2021	2	WE	1	16:09	217	0	0	0	217
04/11/2021	2	EA	2	10:43	126	0	252	0	0
04/11/2021	2	EA	1	10:45	307	0	210	97	0
04/11/2021	2	EA	1	10:45	40	0	15	25	0
04/11/2021	2	EA	1	11:43	379	0	45	334	0
04/11/2021	2	EA	2	12:12	64	0	8	120	0
04/11/2021	2	EA	3	13:14	910	630	1515	585	0
04/11/2021	2	EA	1	14:04	86	0	0	86	0
04/11/2021	2	EA	2	14:09	72	0	60	84	0
04/11/2021	2	EA	4	14:32	114	216	240	0	0
04/11/2021	2	EA	1	15:11	282	15	15	252	0
04/11/2021	2	WE	1	15:27	131	0	0	131	0
15/11/2021	2	ML	1	10:21	20	20	0	0	0
15/11/2021	2	EA	1	11:08	50	0	0	50	0
15/11/2021	2	EA	1	11:39	169	0	15	79	75
15/11/2021	2	HH	1	11:43	47	47	0	0	0
15/11/2021	2	EA	1	13:37	122	0	2	75	45
15/11/2021	2	EA	1	14:23	48	0	0	48	0
15/11/2021	2	EA	2	14:24	40	0	0	80	0
15/11/2021	2	EA	1	14:50	34	0	34	0	0
06/12/2021	2	EA	1	11:28	67	0	0	67	0
06/12/2021	2	KT	1	11:52	1152	0	0	592	560
27/02/2022	2	GP	1	11:14	52	22	30	0	0

ANNEX 4 – "AT COLLISION RISK" FLIGHT ACTIVITY

Table A4-1 presents "at collision risk" flight activity for target species recorded within 275m of a proposed turbine location between March 2021 and February 2022; the number of birds, total flight duration and time spent below (HT1), at (HT2 and HT3) and above (HT4) collision risk height is presented.

Table A4-1: Target species "at collision risk" flight activity.
HT1 (0-10m); HT2 (10-25m); HT3 (25-150m); HT4 (>150m).

Date	VP	Species	No. of Birds	Start Time	Total Flight Duration (s)	Total Time Spent (s)			
						HT1	HT2	HT3	HT4
06/08/2021	2	Golden eagle	2	05:59	1397	180	467	615	135
06/08/2021	2	Golden eagle	2	06:31	1282	120	337	705	120
06/08/2021	2	Golden eagle	1	07:21	265	75	145	45	0
29/09/2021	2	Golden eagle	1	13:34	308	0	0	308	0
04/11/2021	2	Golden eagle	1	11:43	379	0	45	334	0

Table A4-2: CALCULATION OF COLLISION RISK FOR GOLDEN EAGLE PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
No. Blades	3					**Upwind:**			**Downwind:**		
Max Chord	4.1	m	**r/R**	**c/C**	**a**	**collide**		**contribution**	**collide**		**contribution**
Pitch (degrees)	5		**radius**	**chord**	**alpha**	**length**	**p (collision)**	**from radius r**	**length**	**p (collision)**	**from radius r**
Bird Length	0.82	m	0.025	0.575	4.77	21.54	1.00	0.00125	21.13	1.00	0.00125
Wingspan	2.12	m	0.075	0.575	1.59	7.32	0.43	0.00323	6.91	0.41	0.00305
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.95	5.01	0.29	0.00368	4.51	0.27	0.00332
			0.175	0.860	0.68	4.15	0.24	0.00427	3.53	0.21	0.00364
Bird speed	15	m/sec	0.225	0.994	0.53	3.63	0.21	0.00481	2.92	0.17	0.00387
Rotor Diam	136	m	0.275	0.947	0.43	2.94	0.17	0.00475	2.26	0.13	0.00366
Rotation Period	3.40	sec	0.325	0.899	0.37	2.49	0.15	0.00476	1.85	0.11	0.00353
			0.375	0.851	0.32	2.23	0.13	0.00492	1.62	0.10	0.00358
			0.425	0.804	0.28	2.03	0.12	0.00507	1.45	0.09	0.00364
			0.475	0.756	0.25	1.87	0.11	0.00521	1.33	0.08	0.00370
Bird aspect ratio: b	0.39		0.525	0.708	0.23	1.73	0.10	0.00534	1.22	0.07	0.00378
			0.575	0.660	0.21	1.62	0.10	0.00547	1.14	0.07	0.00387
			0.625	0.613	0.19	1.52	0.09	0.00558	1.08	0.06	0.00397
			0.675	0.565	0.18	1.43	0.08	0.00568	1.03	0.06	0.00407
			0.725	0.517	0.16	1.35	0.08	0.00577	0.98	0.06	0.00419
			0.775	0.470	0.15	1.28	0.08	0.00585	0.95	0.06	0.00432
			0.825	0.422	0.14	1.22	0.07	0.00592	0.92	0.05	0.00446
			0.875	0.374	0.14	1.16	0.07	0.00598	0.89	0.05	0.00461
			0.925	0.327	0.13	1.11	0.07	0.00603	0.88	0.05	0.00476
			0.975	0.279	0.12	1.06	0.06	0.00607	0.86	0.05	0.00493
				Overall p(collision) =			**Upwind**	**10.0%**		**Downwind**	**7.6%**
								Average	**8.8%**		