



Breezy Hill Energy Project Additional Information Technical Appendix 7.1

Annex E: Collision Risk Assessment

Brockwell Energy

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Annex E Collision Risk Assessments

A Collision Risk Analysis Area (CRAA) was created using a 500 metre (m) buffer around proposed turbine locations (**Figure 7.3**). Using the larger 500 m area around the turbines (rather than rotor diameter) accounts for possible inaccuracies in the recording of flightlines, micro-siting and ensures the assessment is precautionary.

Table E-1, **Table E-2** and



Table E-3 present the parameters which apply to each Collision Risk Model (CRM).

Table E-1: Wind farm parameters

Size of wind farm envelope	877.44	hectares (ha)
Number of turbines	20	turbines
Rotor diameter	136	metres (m)
Hub height	81.9	m
Max. rotor depth	0.43	m (at 15° pitch angle)
Max. chord	4.1	m
Pitch	6	degrees (°)
Rotation period	4.29	seconds (secs)
Turbine operation time	0.875	percent (%)
Risk height: lowest	13.9	m
Risk height: highest	149.9	m
Flight risk volume	1193316723	m3

Table E-2: CRM parameters per species

Species	Length (m)	Wingspan (m)	Assumed flight speed, v (ms-1)	Avoidance rate	Probability of collision	Bird transit time (secs)
Curlew	0.6	1	13	0.98	0.0697	0.0791
Golden plover	0.28	0.72	17.9	0.98	0.0493	0.0396
Goshawk	0.62	1.65	9.7	0.98	0.0832	0.1081
Hen harrier	0.48	1.1	12	0.99	0.0659	0.0757
Herring gull	0.64	1.5	12.8	0.98	0.0736	0.0835
Hobby	0.36	0.92	11.3	0.98	0.0601	0.0698
Merlin	0.28	0.56	13	0.98	0.0522	0.0545
Osprey	0.58	1.7	11.4	0.98	0.0749	0.0885
Peregrine falcon	0.48	1.1	12.1	0.98	0.0657	0.0751



Table E-3: Visible area within the CRAA per vantage point

VP	Area (ha)
1	223.64
2	338.01
3	258.90

Birds are assumed to be active during all the daylight hours and this is estimated by calculating the number of hours per day between sunrise and sunset (adjusting for correct latitude) for the survey seasons as defined in **Table E-4** below.

Table E-4: Season definitions per species/species group

Species	Breeding season			Non-breeding season		
	Start date	End date	Hours presumed present	Start date	End date	Hours presumed present
Raptors	15th March	31st August	2,643	1st September	14th March	1,852
Gulls	15th March	31st August	1,967	1st September	14th March	2,528
Waders	1st April	31st July	2,643	1st August	31st March	1,852

Detailed outputs for the CRM are presented in the following order below:

- Curlew
- Golden plover
- Goshawk
- Hen harrier
- Herring gull
- Hobby
- Merlin
- Osprey
- Peregrine falcon



E.1 Curlew

Breeding Season 2020

Table E-5: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	66.98	9126.39	0.0000012

Table E-6: Mortality estimates

Mean activity in wind farm at rotor height	0.0010	hr ⁻¹
Total Combined rotor swept volume	298834	m ³
Bird occupancy	2.0279	hrs/season
Bird occupancy of rotor swept volume	1.8282	bird-sec
No. of transits through rotors	23.1062	per season
Estimated collisions	1.6094	per season
Estimated collisions after correction for operation	1.4082	per season
Estimated collisions after avoidance factor	0.0282	per season

Non-Breeding Season 2021/2022

Table E-7: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	53.82	14703.64	0.0000004

Table E-8: Mortality estimates

Mean activity in wind farm at rotor height	0.0003	hr ⁻¹
Total Combined rotor swept volume	298834	m ³
Bird occupancy	0.8569	hrs/season
Bird occupancy of rotor swept volume	0.7725	bird-sec
No. of transits through rotors	9.7638	per season
Estimated collisions	0.6801	per season
Estimated collisions after correction for operation	0.5951	per season
Estimated collisions after avoidance factor	0.0119	per season



E.2 Golden Plover

Non-Breeding Season 2020/2021

Table E-9: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHaHr ⁻¹)
2	18.84	22984.99	0.00000011

Table E-10: Mortality estimates

Mean activity in wind farm at rotor height	0.00009	hr ⁻¹
Total Combined rotor swept volume	205863	m ³
Bird occupancy	0.2401	hrs/season
Bird occupancy of rotor swept volume	0.1491	bird-sec
No. of transits through rotors	3.7675	per season
Estimated collisions	0.1858	per season
Estimated collisions after correction for operation	0.1625	per season
Estimated collisions after avoidance factor	0.0033	per season

Non-Breeding Season 2021/2022

Table E-11: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHaHr ⁻¹)
1	222.17	10511.08	0.0000016
2	118.85	14703.64	0.0000009

Table E-12: Mortality estimates

Mean activity in wind farm at rotor height	0.0021	hr ⁻¹
Total Combined rotor swept volume	205863	m ³
Bird occupancy	5.4298	hrs/season
Bird occupancy of rotor swept volume	3.3721	bird-sec
No. of transits through rotors	85.1878	per season
Estimated collisions	4.2003	per season
Estimated collisions after correction for operation	3.6752	per season
Estimated collisions after avoidance factor	0.0735	per season



E.3 Goshawk

Breeding Season 2020

Table E-13: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	12.85	8051.04	0.0000002
2	93.36	15210.66	0.0000011

Table E-14: Mortality estimates

Mean activity in wind farm at rotor height	0.0011	hr ⁻¹
Total Combined rotor swept volume	304645	m ³
Bird occupancy	2.9407	hrs/season
Bird occupancy of rotor swept volume	2.7027	bird-sec
No. of transits through rotors	25.0018	per season
Estimated collisions	2.0789	per season
Estimated collisions after correction for operation	1.8191	per season
Estimated collisions after avoidance factor	0.0364	per season

Non-Breeding Season 2020/2021

Table E-15: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	59.55	15210.66	0.00000045
3	3.71	12427.34	0.00000003

Table E-16: Mortality estimates

Mean activity in wind farm at rotor height	0.0004	hr ⁻¹
Total Combined rotor swept volume	304645	m ³
Bird occupancy	0.7761	hrs/season
Bird occupancy of rotor swept volume	0.7132	bird-sec
No. of transits through rotors	6.5981	per season
Estimated collisions	0.5486	per season
Estimated collisions after correction for operation	0.4801	per season
Estimated collisions after avoidance factor	0.0096	per season



Breeding Season 2021

Table E-17: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	99.33	12168.53	0.0000009
3	30.41	11650.64	0.0000003

Table E-18: Mortality estimates

Mean activity in wind farm at rotor height	0.0010	hr ⁻¹
Total Combined rotor swept volume	304645	m ³
Bird occupancy	2.6220	hrs/season
Bird occupancy of rotor swept volume	2.4097	bird-sec
No. of transits through rotors	22.2916	per season
Estimated collisions	1.8536	per season
Estimated collisions after correction for operation	1.6219	per season
Estimated collisions after avoidance factor	0.0324	per season

Non-Breeding Season 2021/2022

Table E-19: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	33.09	12337.53	0.0000003

Table E-20: Mortality estimates

Mean activity in wind farm at rotor height	0.0003	hr ⁻¹
Total Combined rotor swept volume	304645	m ³
Bird occupancy	0.4843	hrs/season
Bird occupancy of rotor swept volume	0.4451	bird-sec
No. of transits through rotors	4.1174	per season
Estimated collisions	0.3424	per season
Estimated collisions after correction for operation	0.2996	per season
Estimated collisions after avoidance factor	0.0060	per season



E.4 Hen Harrier

Non-Breeding Season 2021/2022

Table E-21: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	41.67	12337.53	0.0000004

Table E-22: Mortality estimates

Mean activity in wind farm at rotor height	0.0003	hr ⁻¹
Total Combined rotor swept volume	263970	m ³
Bird occupancy	0.6099	hrs/season
Bird occupancy of rotor swept volume	0.4857	bird-sec
No. of transits through rotors	6.4144	per season
Estimated collisions	0.4225	per season
Estimated collisions after correction for operation	0.3697	per season
Estimated collisions after avoidance factor	0.0037	per season

E.5 Herring Gull

Breeding Season 2021

Table E-23: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	0.52	11650.64	0.000000005

Table E-24: Mortality estimates

Mean activity in wind farm at rotor height	0.000004	hr ⁻¹
Total Combined rotor swept volume	310455	m ³
Bird occupancy	0.0106	hrs/season
Bird occupancy of rotor swept volume	0.0099	bird-sec
No. of transits through rotors	0.1190	per season
Estimated collisions	0.0088	per season
Estimated collisions after correction for operation	0.0077	per season
Estimated collisions after avoidance factor	0.0002	per season



E.6 Hobby

Breeding Season 2021

Table E-25: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	20.70	8051.04	0.0000002

Table E-26: Mortality estimates

Mean activity in wind farm at rotor height	0.0002	hr ⁻¹
Total Combined rotor swept volume	229106	m ³
Bird occupancy	0.4182	hrs/season
Bird occupancy of rotor swept volume	0.2891	bird-sec
No. of transits through rotors	4.1424	per season
Estimated collisions	0.2488	per season
Estimated collisions after correction for operation	0.2177	per season
Estimated collisions after avoidance factor	0.0044	per season

E.7 Merlin

Non-Breeding Season 2020/2021

Table E-27: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	6.1	15210.7	0.00000005

Table E-28: Mortality estimates

Mean activity in wind farm at rotor height	0.00004	hr ⁻¹
Total Combined rotor swept volume	205863	m ³
Bird occupancy	0.0748	hrs/season
Bird occupancy of rotor swept volume	0.0465	bird-sec
No. of transits through rotors	0.8526	per season
Estimated collisions	0.0445	per season
Estimated collisions after correction for operation	0.0390	per season
Estimated collisions after avoidance factor	0.0008	per season



E.8 Osprey

Breeding Season 2021

Table E-29: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	4.20	8051.04	0.00000004
2	17.58	12168.53	0.00000015

Table E-30: Mortality estimates

Mean activity in wind farm at rotor height	0.0002	hr ⁻¹
Total Combined rotor swept volume	293023	m ³
Bird occupancy	0.4402	hrs/season
Bird occupancy of rotor swept volume	0.3891	bird-sec
No. of transits through rotors	4.3983	per season
Estimated collisions	0.3296	per season
Estimated collisions after correction for operation	0.2884	per season
Estimated collisions after avoidance factor	0.0058	per season

E.9 Peregrine Falcon

Breeding Season 2020

Table E-31: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	7.07	15210.66	0.00000008

Table E-32: Mortality estimates

Mean activity in wind farm at rotor height	0.00007	hr ⁻¹
Total Combined rotor swept volume	263970	m ³
Bird occupancy	0.1957	hrs/season
Bird occupancy of rotor swept volume	0.1559	bird-sec
No. of transits through rotors	2.0757	per season
Estimated collisions	0.1363	per season
Estimated collisions after correction for operation	0.1193	per season
Estimated collisions after avoidance factor	0.0024	per season



Breeding Season 2021

Table E-33: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	1.84	12168.53	0.00000002

Table E-34: Mortality estimates

Mean activity in wind farm at rotor height	0.000014	hr ⁻¹
Total Combined rotor swept volume	263970	m ³
Bird occupancy	0.0372	hrs/season
Bird occupancy of rotor swept volume	0.0296	bird-sec
No. of transits through rotors	0.3941	per season
Estimated collisions	0.0259	per season
Estimated collisions after correction for operation	0.0226	per season
Estimated collisions after avoidance factor	0.0005	per season

Non-Breeding Season 2021/2022

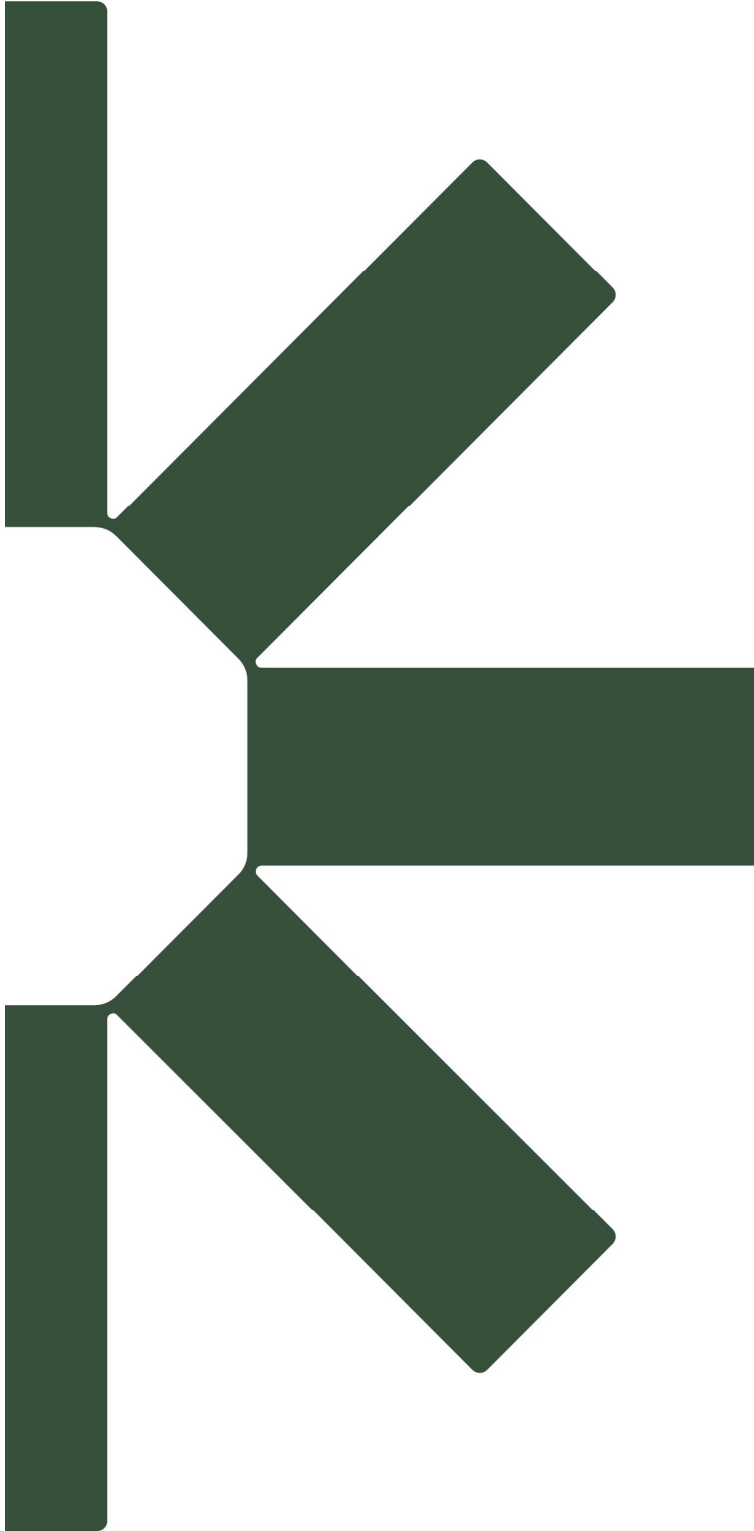
Table E-35: Flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
2	11.36	12337.53	0.00000010
3	7.25	9341.22	0.00000007

Table E-36: Mortality estimates

Mean activity in wind farm at rotor height	0.00015	hr ⁻¹
Total Combined rotor swept volume	263970	m ³
Bird occupancy	0.2723	hrs/season
Bird occupancy of rotor swept volume	0.2169	bird-sec
No. of transits through rotors	2.8884	per season
Estimated collisions	0.1897	per season
Estimated collisions after correction for operation	0.1659	per season
Estimated collisions after avoidance factor	0.0033	per season





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