

Graffy Wind Park

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GRAFFY WIND PARK Environmental Impact Assessment Report (EIAR) VOLUME 3A: APPENDICES 7-10

GRAFFY WIND PARK, GLENTIES, COUNTY DONEGAL

VOLUME 3A – APPENDICES

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Appendix I: Avi-fauna Ornithological study area

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Vantage Point	Irish grid reference	Lat.	Long.	X (ITM)	Y (ITM)	Details
VP 1	G 88997, 95678	54.80899	-8.17191	588948	895688	On hillock above road - oriented looking east over the slopes of Graffy Hill covering T8 & up valley south of VP3
VP 2	G 91759, 98071	54.83054	-8.12902	591710	898081	On area of outcropping adjacent to plantation - oriented looking west covering edge of plantation backing VP, uphill through T2 & towards T3, T4 & VP3
VP 3	G 90598, 96709	54.81829	-8.14704	590549	896719	On hillock in rushy field - oriented looking north towards middle planation & up slopes through T4, T6, T7 & towards VP2 & T1
VP 4	G 89723, 97754	54.82765	-8.16069	589674	897763	On lower crags of Aghla Mountain - oriented looking south scanning over the tops of plantations, providing down slope - views of almost the whole site, including over VP2 & T1

Vantage Point	Irish grid reference	Lat	Long	X (ITM)	Y (ITM)	Details
VP 1	G 8897, 95678	54.80899	-8.17191	588948	895688	On hillock above road - oriented looking east over the slopes of Grain Hill covering T8 & up valley south of VP3
VP 2	G 91759, 98071	54.83054	-8.12902	591710	898081	On area of outcropping adjacent to plantation - oriented looking west covering edge of plantation backing VP, uphill through T2 & towards T3, T4 & VP3
VP 3	G 90598, 96709	54.81829	-8.14704	590549	896719	On hillock in gully field - oriented looking north towards middle plantation & up slopes through T4, T6, T7 & towards VP2 & T1
VP 4	G 89723, 97754	54.82765	-8.16069	589674	897763	On lower crags of Achilla Mountain - oriented looking south scanning over the tops of plantations, providing down slope - views of almost the whole site - including over VP2 & T1

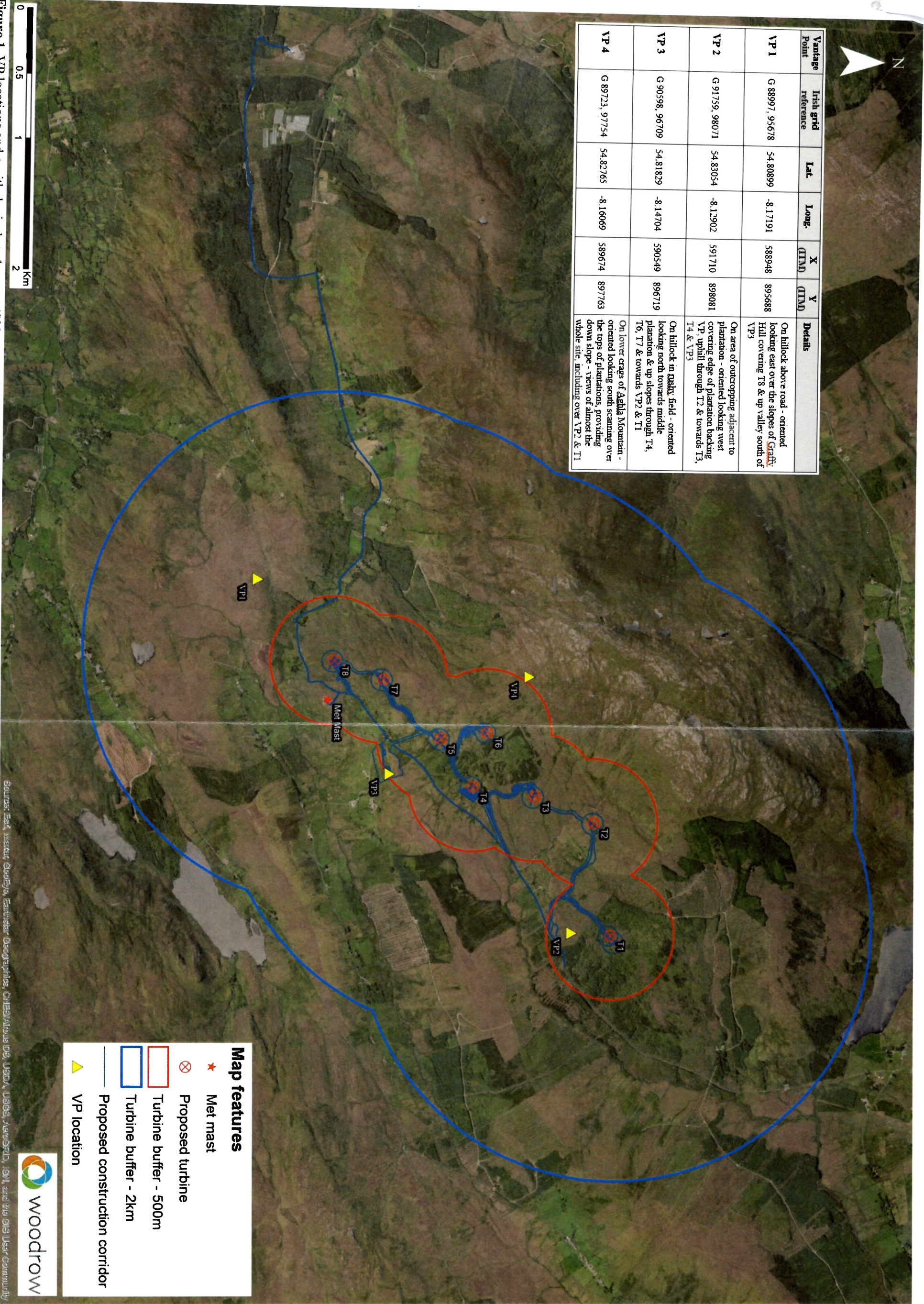


Figure 1. VP locations and ornithological study areas (500 m & 2 km turbine buffers)

Source: Esri, DeLorme, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



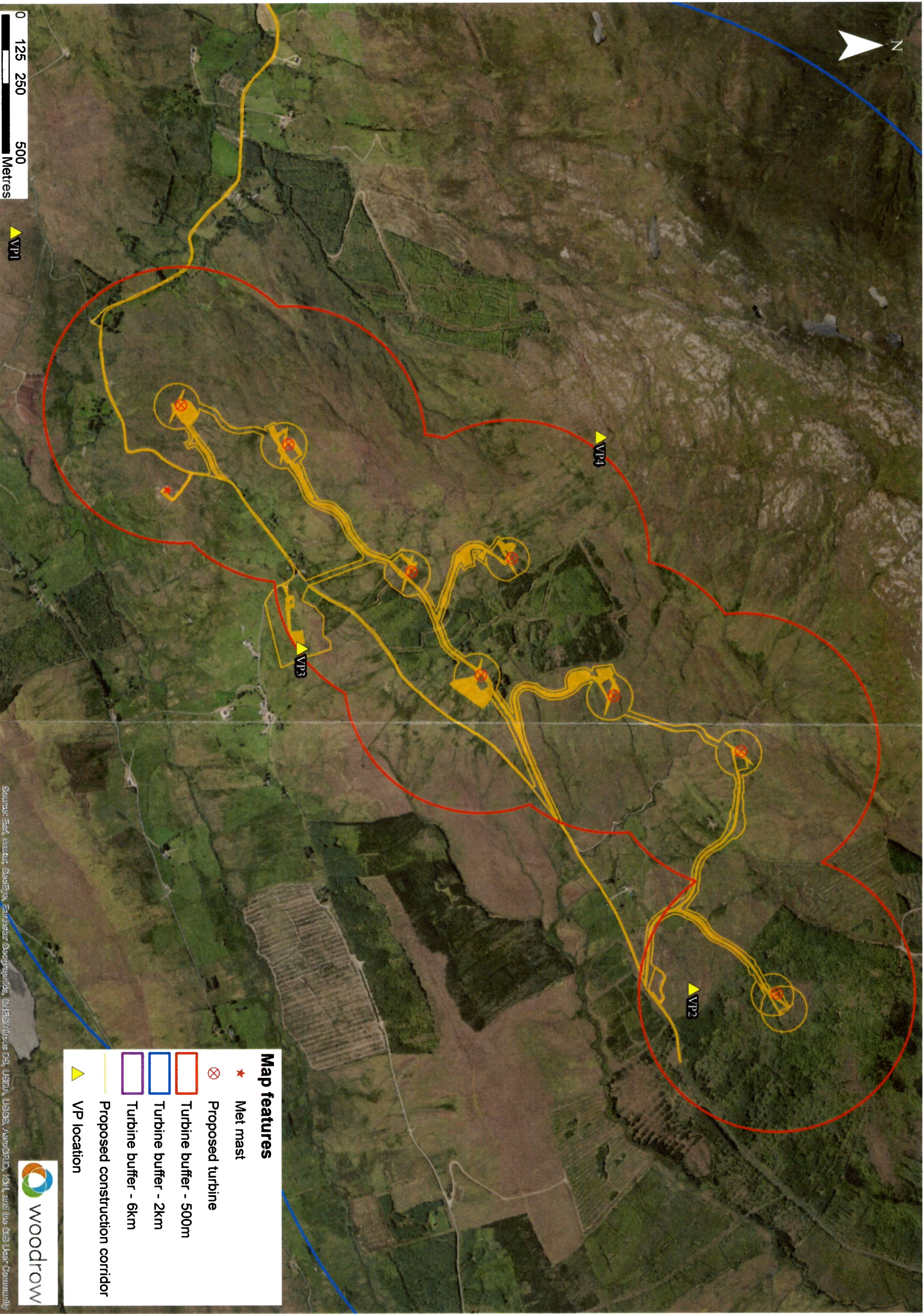


Figure 2. Proposed turbine layout and construction corridor in relation to 500 m turbine buffer

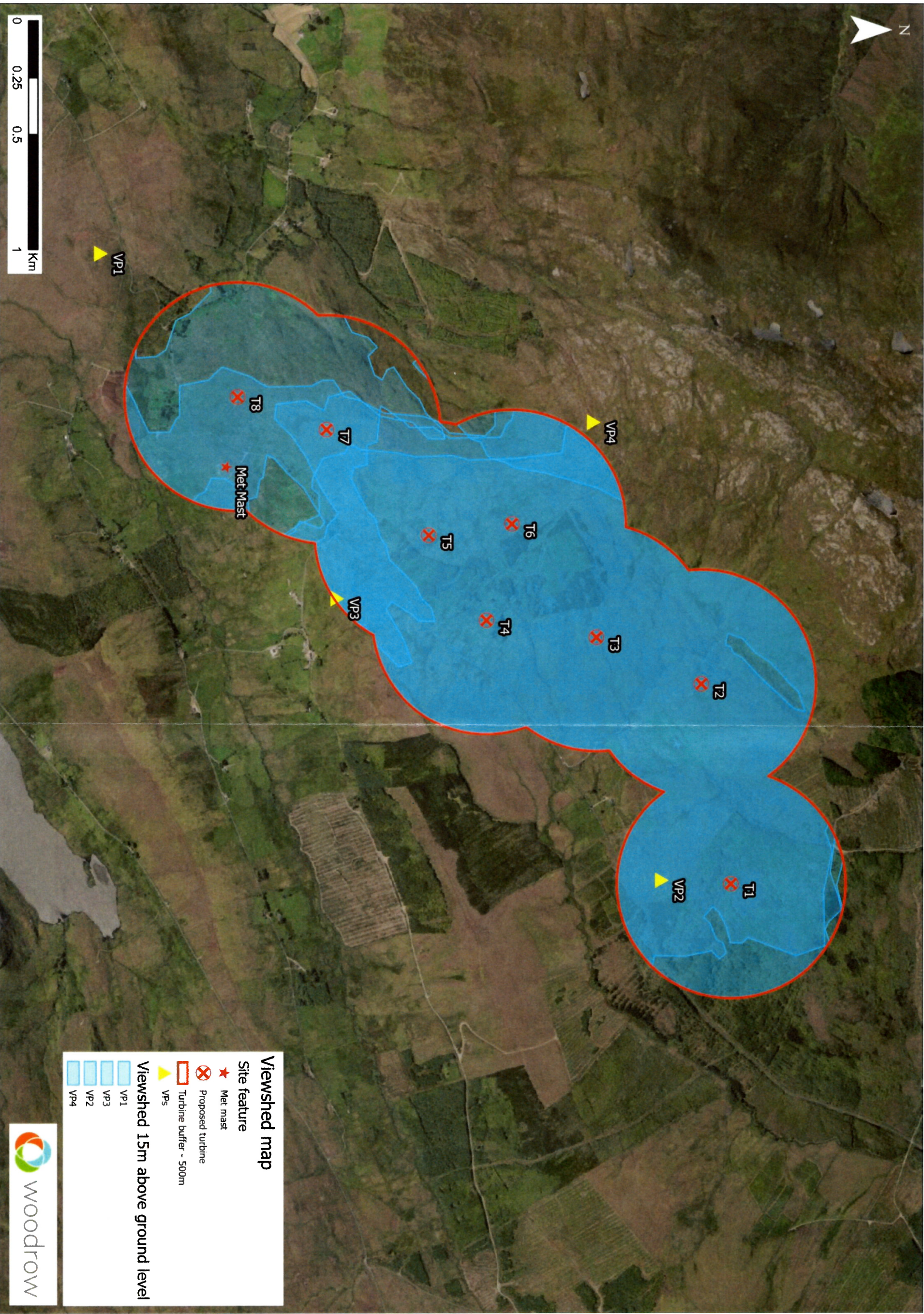


Figure 3. VP coverage: 15 m above ground (rotor swept area) viewsheds within 500 m turbine buffer

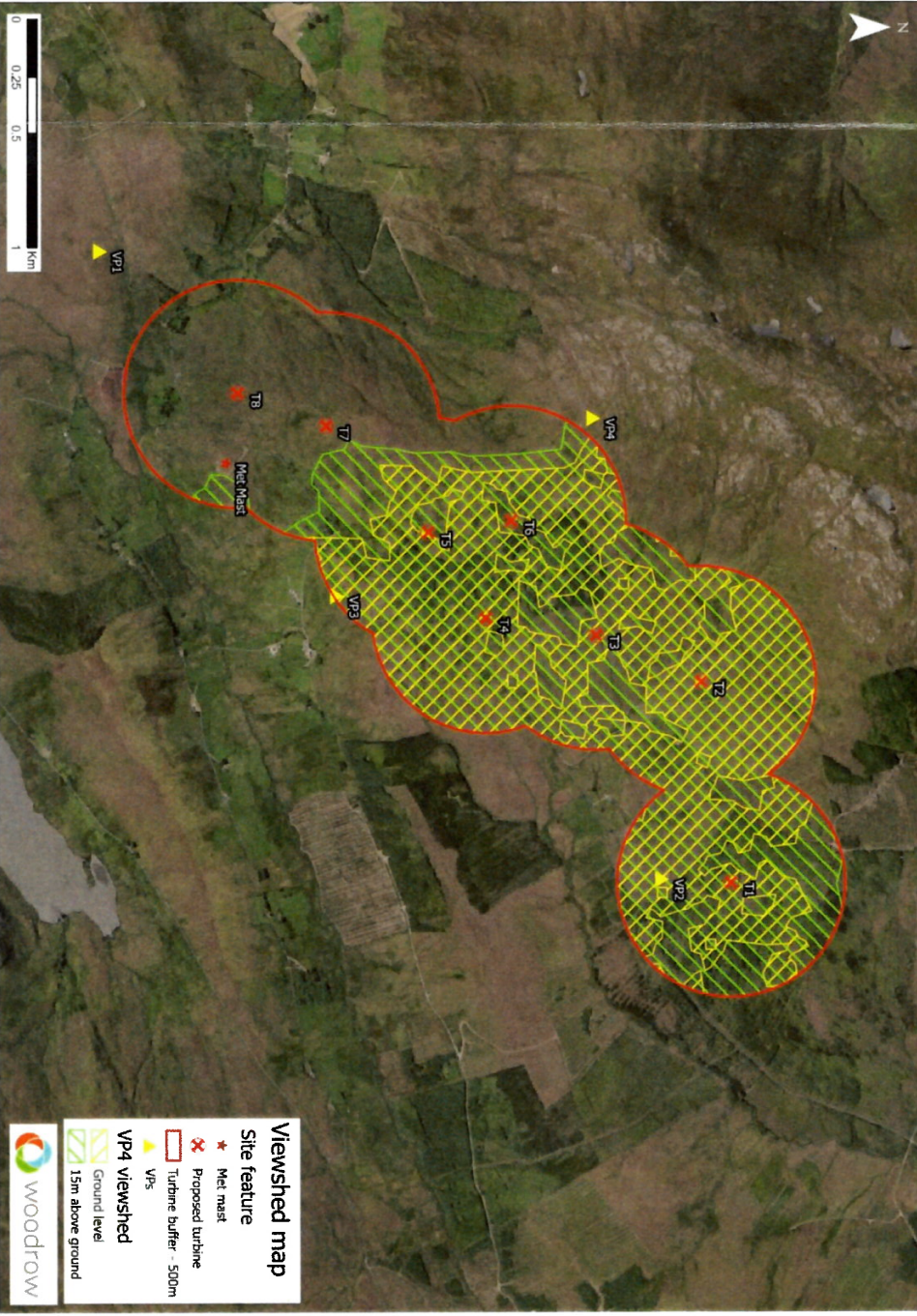
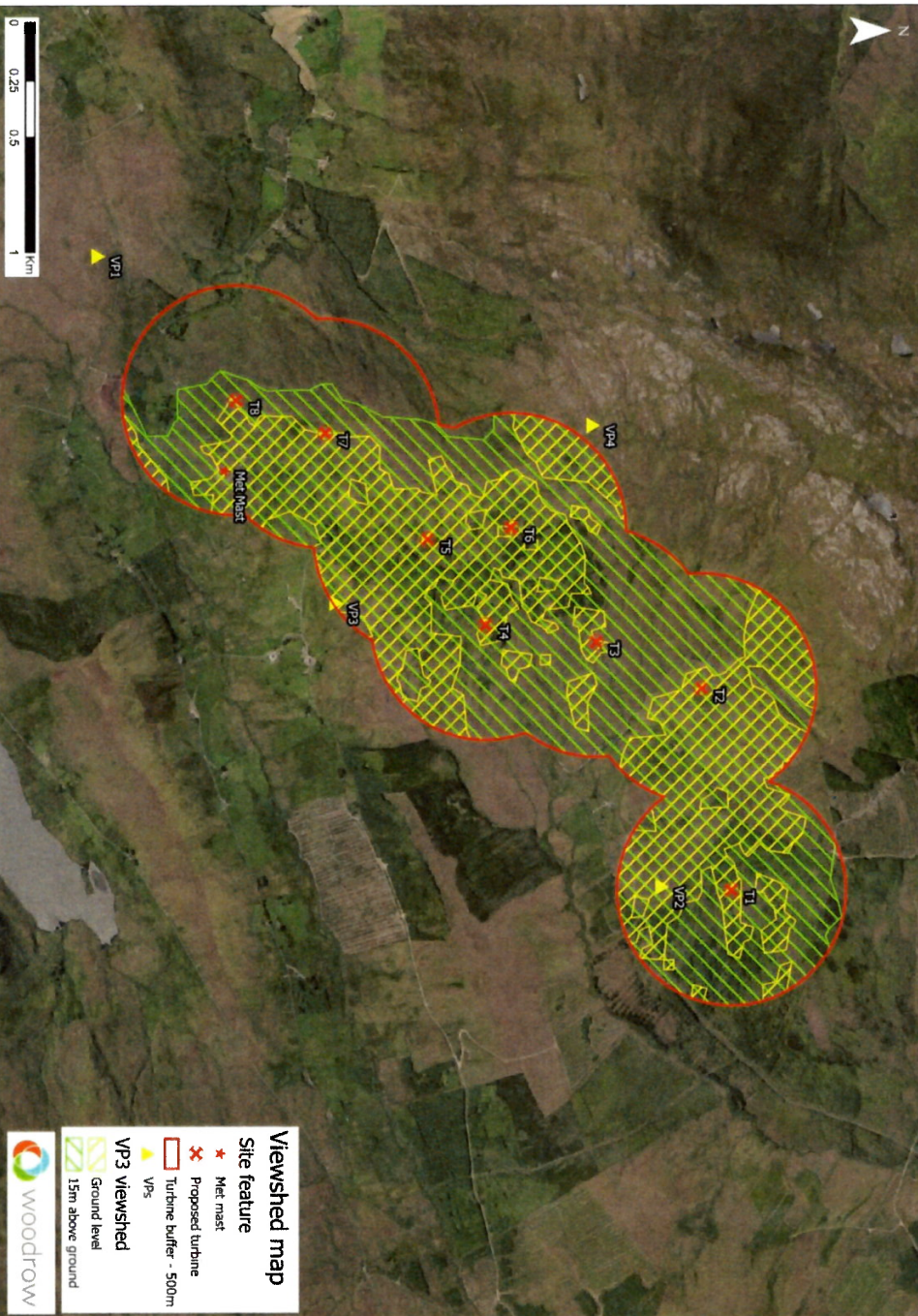
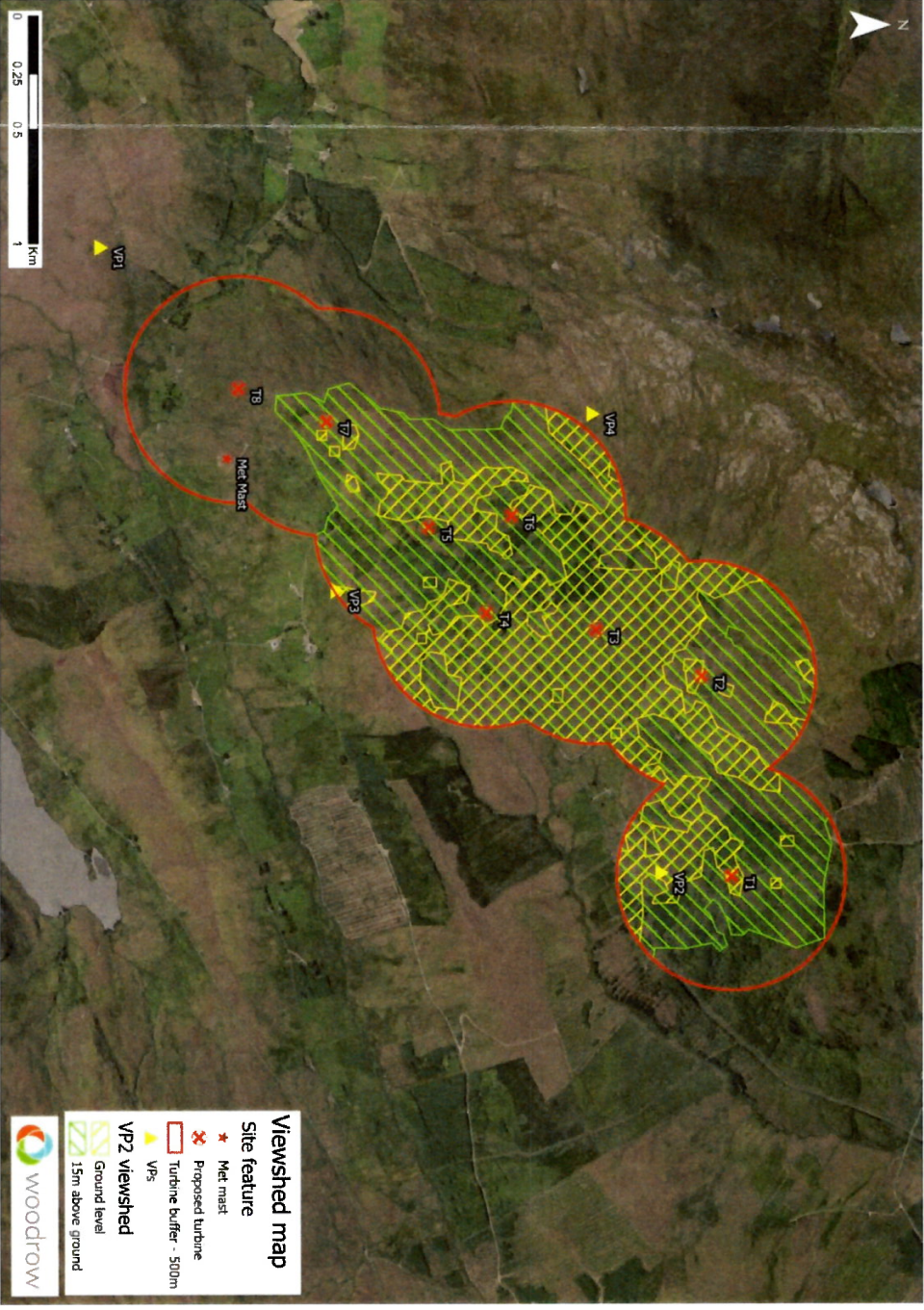
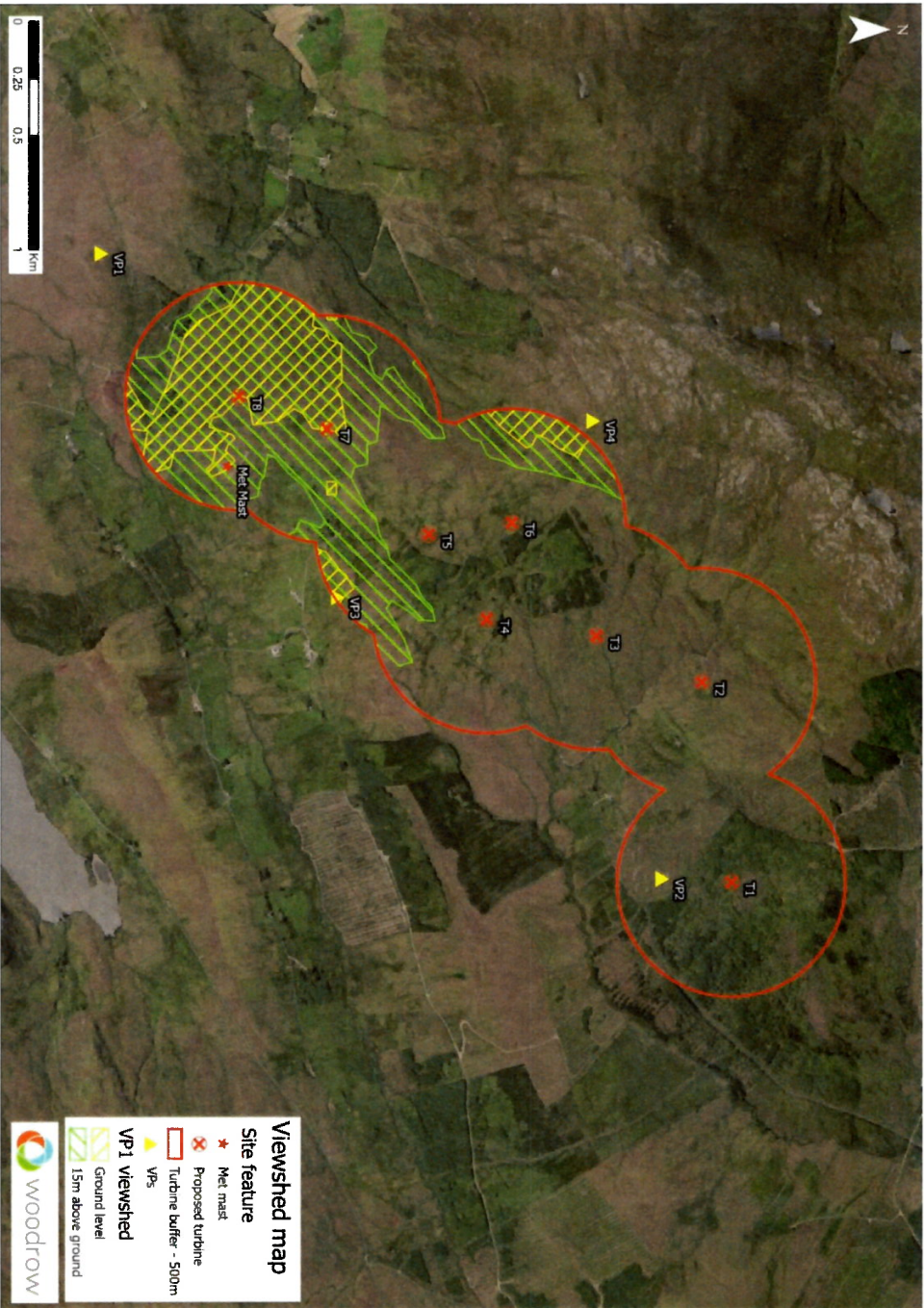


Figure 4. Ground level & 15 m above ground viewsheds for each VP within 500 m turbine buffer

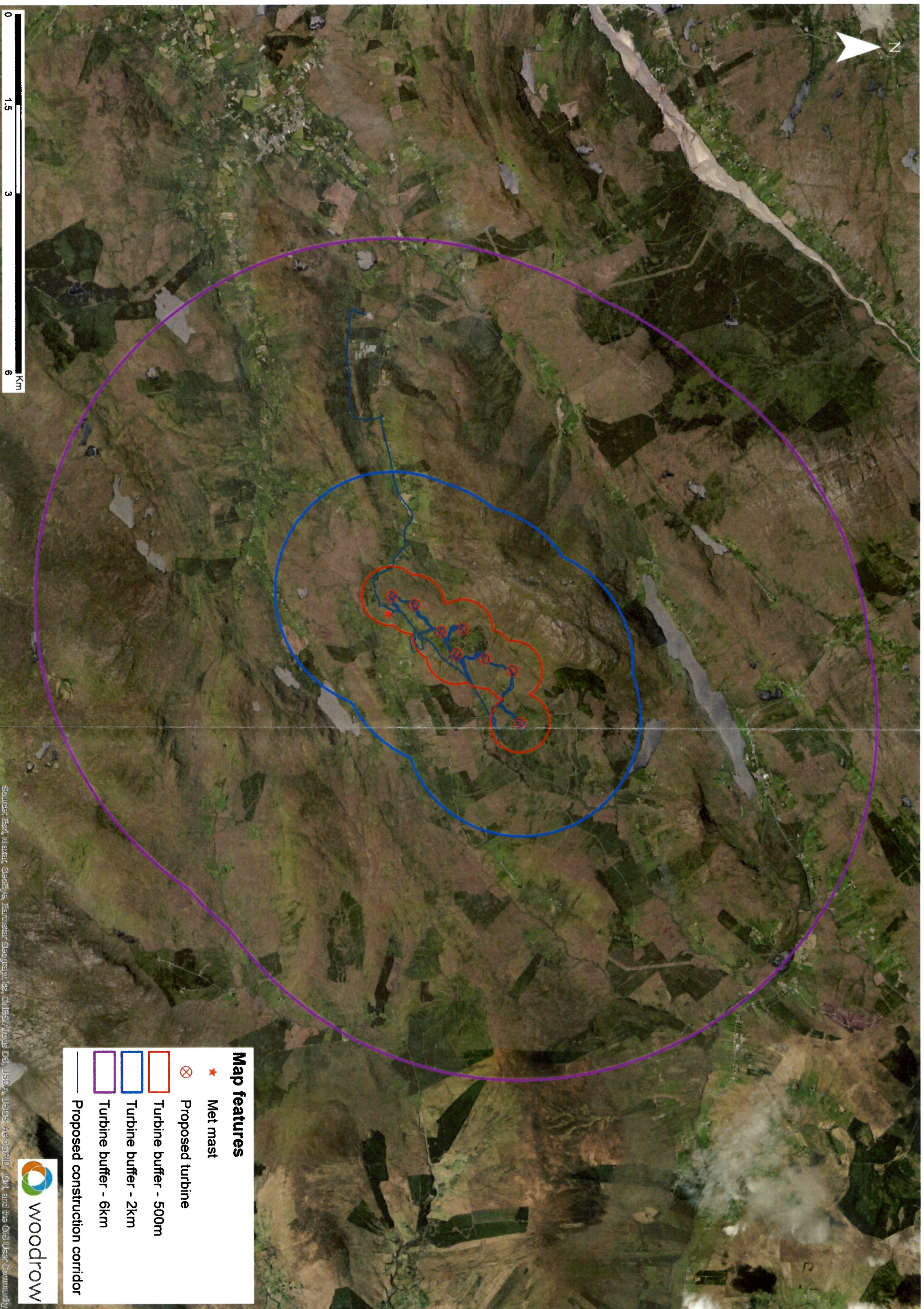


Figure 5. Map showing extent of 6 km search area for breeding eagles

Appendix 2: Avi-fauna – Survey effort

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Table 1 Year 1: Non-breeding season 2018-19 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	MT	30/10/2018	815	2.00	RZ, WS	Wind: F3-2, S-E Oktas:7 Temp: 4-5°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	MT	01/11/2018	1004	2.00	No target sp.	Wind: F2-3, WNW-NW Oktas:6-4 Temp: 5-6°C Ground cond: wet/damp Rainfall: nil Visibility: good Factors affect vis: none
1	KW	09/11/2018	800	3.00	No target sp.	Wind: F6, SE Oktas:8 Temp: not rec: °C Ground cond: dry Rainfall: showers Visibility: good Factors affect vis: none
1	KW	23/11/2018	840	3.00	BZ, HG	Wind: F3-4, E-NE Oktas:5-8 Temp: 3-6°C Ground cond: wet Rainfall: light passing showers Visibility: good Factors affect vis: none
1	KW	23/11/2018	1200	2.00	No target sp.	Wind: F3-4, E-NE Oktas:5-7 Temp: 6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	11/12/2018	950	3.00	H	Wind: F3-4, SE Oktas:7-8 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good-mod. Factors affect vis: none
1	HPD	11/12/2018	1315	3.00	No target sp.	Wind: F4-5, SE Oktas:8 Temp: 8°C Ground cond: dry Rainfall: mostly dry, single passing shower Visibility: mod. Factors affect vis: low cloud on highest hills and some mist lower later
1	KW	10/01/2019	845	3.00	No target sp.	Wind: F1, W Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	10/01/2019	1315	3.00	BZ	Wind: F1, W Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	05/02/2019	900	3.00	BZ	Wind: F4-5, S Oktas:8 Temp: 8°C Ground cond: damp Rainfall: light, occ heavy showers Visibility: mod. Factors affect vis: low cloud base over hilltops
1	HPD	05/02/2019	1225	3.00	H	Wind: F4-5, S Oktas:8 Temp: 8°C Ground cond: damp Rainfall: rain from 1420 Visibility: mod-poor Factors affect vis: low cloud - showers at times
1	KW	22/02/2019	825	3.00	No target sp.	Wind: F3-5, S Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	22/02/2019	1150	3.00	SN	Wind: F5-6, S Oktas:8 Temp: 12°C Ground cond: wet Rainfall: mostly dry, occ. Showers Visibility: good-mod. Factors affect vis: misty at times
2	MT	30/10/2018	1049	3.00	H, WE	Wind: F3, S Oktas:7-8 Temp: 4°C Ground cond: wet Rainfall: mostly dry, occ. spots Visibility: good Factors affect vis: none
2	KW	19/11/2018	815	4.00	BZ	Wind: F1-2, E Oktas:4-7 Temp: 6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud covering mountain to west
2	KW	19/11/2018	1245	4.00	BZ, K	Wind: F1-2, E Oktas:5-8 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud covering mountain to west
2	KW	11/12/2018	1015	3.00	HH, ML	Wind: F3-4, ESE-SE Oktas:7-8 Temp: 9-10°C Ground cond: wet Rainfall: nil Visibility: good-mod. Factors affect vis: cloud covering mountain top
2	KW	11/12/2018	1335	3.00	No target sp.	Wind: F3-2, SE Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good-mod. Factors affect vis: mist - light
2	HPD	10/01/2019	845	3.00	GP	Wind: F1-2, W Oktas:8 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	HPD	10/01/2019	1215	3.00	No target sp.	Wind: F2, NW Oktas:8 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: mist/low cloud - occasional pockets
2	KW	05/02/2019	900	3.00	No target sp.	Wind: F4, ESE-SE Oktas:8 Temp: 5-10°C Ground cond: wet Rainfall: showers Visibility: mod-good. Factors affect vis: low cloud, with passing showers
2	KW	05/02/2019	1230	3.00	No target sp.	Wind: F4, SE Oktas:8 Temp: 10°C Ground cond: wet Rainfall: showers Visibility: mod-good. Factors affect vis: low cloud, with passing showers
2	HPD	22/02/2019	830	3.00	No target sp.	Wind: F4-5, S Oktas:8 Temp: 12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: good vis, low cloud covering hilltops above Graffy
2	HPD	22/02/2019	1155	3.00	No target sp.	Wind: F5-6, S Oktas:8 Temp: 12°C Ground cond: dry Rainfall: showers Visibility: mod-good. Factors affect vis: mod vis during showers, otherwise good
2	KW	20/03/2019	1635	1.00	No target sp.	Wind: F4, SW Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to SW

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
3	MT	30/10/2018	1524	2.00	K, RG	Wind: F3-2, S Oktas:8-5 Temp: 5-3°C Ground cond: wet Rainfall: mostly dry, occ. light passing shower Visibility: good Factors affect vis: low cloud over high ground until 1630, low light - dusk at 1738
3	MT	09/11/2018	710	4.00	No target sp.	Wind: F3-6, SE-SSE Oktas:7-8 Temp: 7°C Ground cond: wet/damp Rainfall: mostly dry, occ. light drizzle Visibility: good Factors affect vis: low light, occ. moderate vis due to passing showers
3	KW	20/11/2018	815	3.00	BZ	Wind: F2-4, NE Oktas:2-5 Temp: 6°C Ground cond: wet Rainfall: not rec. Visibility: good Factors affect vis: low cloud base over hills
3	MT	01/12/2018	923	3.00	No target sp.	Wind: F1-3, E-NE Oktas:7-8 Temp: 5-9°C Ground cond: wet Rainfall: periods of light drizzle Visibility: good-mod. Factors affect vis: low cloud on top of mountain, vis mod during periods of drizzle, cloud base drops, slightly misty
3	KW	18/12/2018	845	3.00	No target sp.	Wind: F3-4, S Oktas:4-8 Temp: 8-10°C Ground cond: wet Rainfall: showers Visibility: good, occ. mod. Factors affect vis: low cloud
3	KW	18/12/2018	1205	3.00	ML, BZ	Wind: F3-4, S Oktas:4-8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	23/01/2019	920	3.00	No target sp.	Wind: F1, W Oktas:8 Temp: 1.5-3°C Ground cond: snow/ wet Rainfall: showers rain & sleet Visibility: mod. Factors affect vis: low cloud
3	KW	23/01/2019	1245	3.00	No target sp.	Wind: F1-3, W Oktas:8 Temp: 3°C Ground cond: wet-snow Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hills
3	KW	12/02/2019	1025	3.00	No target sp.	Wind: F3-4, SSW-S Oktas:8-5 Temp: 9°C Ground cond: wet Rainfall: nil Visibility: mod-good Factors affect vis: low cloud & mist
3	KW	12/02/2019	1355	3.00	No target sp.	Wind: F4-5, S Oktas:7-3 Temp: 9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hills periodically
3	KW	01/03/2019	930	3.00	BZ	Wind: F2-4, S-SSE Oktas:4-8 Temp: 8-9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	HPD	20/03/2019	945	3.00	BZ, LB, WE	Wind: F5, SW Oktas:8 Temp: 11°C Ground cond: dry Rainfall: showers Visibility: mod-good Factors affect vis: fog on hills, clear lower down around VP
4	MT	01/11/2018	1258	4.50	K, EA	Wind: F3-2, NW-W Oktas:5-8 Temp: 6°C Ground cond: wet/damp Rainfall: mostly dry, occ. passing shower Visibility: good, occ. mod. Factors affect vis: glare - occasionally intense glare & showers
4	KW	18/11/2018	915	3.00	No target sp.	Wind: F4-5, E Oktas:4-1 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: mod-good Factors affect vis: glare to E, intermittent low cloud
4	KW	18/11/2018	1245	3.00	No target sp.	Wind: F4-5, E Oktas:3-1 Temp: 7-6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to E
4	KW	19/12/2018	905	3.00	EA	Wind: F4, S Oktas:8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: good Factors affect vis: low cloud base over hills
4	KW	19/12/2018	1235	3.00	K	Wind: F4-5, S Oktas:8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: good Factors affect vis: low cloud base over hills
4	KW	24/01/2019	915	3.00	No target sp.	Wind: F3-4, WNW Oktas:8 Temp: 5-9°C Ground cond: wet Rainfall: misty drizzle Visibility: mod-poor Factors affect vis: low cloud & mist
4	KW	24/01/2019	1240	3.00	No target sp.	Wind: F2-4, WNW Oktas:8 Temp: 9-10°C Ground cond: wet Rainfall: showers Visibility: poor Factors affect vis: fog, low cloud, mist
4	KW	29/01/2019	900	3.00	No target sp.	Wind: F4-2, NW Oktas:4-8 Temp: 1.5°C Ground cond: snow Rainfall: snow showers Visibility: mod-good Factors affect vis: snow showers
4	KW	29/01/2019	1220	3.50	No target sp.	Wind: F2-1, NW Oktas:8-5 Temp: 1-3°C Ground cond: snow Rainfall: snow showers Visibility: mod-good Factors affect vis: snow showers - low cloud - glare
4	KW	14/02/2019	1315	4.50	No target sp.	Wind: F3-5, S Oktas:8 Temp: 9-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: murky light beyond 2km
4	KW	21/03/2019	1415	3.00	BZ, LB, RG, WE, WS	Wind: F4, SW Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hills

Table 2 Year 1: Breeding season 2019 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
1	HPD	20/03/2019	1630	1.00	BZ	Wind: F4, SW Oktas:7-8 Temp: 12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: good vis, low cloud covering hillsops above Grafty
1	KW	21/03/2019	930	3.00	LB	Wind: F2, SW Oktas:8 Temp: 12°C Ground cond: wet Rainfall: mist Visibility: poor Factors affect vis: low cloud
1	KW	28/03/2019	1200	3.00	ML	Wind: F3-5, SW Oktas:2-4 Temp: 13-14°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	17/04/2019	1400	3.00	BZ	Wind: F1-5, SE-E Oktas:3-7 Temp: 10-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	09/05/2019	900	3.00	BZ, LB, RG, SN, WC, WM	Wind: F1-2, NE Oktas:8 Temp: 8°C Ground cond: dry Rainfall: showers Visibility: mod.-good Factors affect vis: mod vis during showers, otherwise good
1	KW	18/05/2019	815	3.00	No target sp.	Wind: F5, NW Oktas:7-8 Temp: 12-14°C Ground cond: dry Rainfall: mostly dry, v. light shower at end Visibility: good Factors affect vis: none
1	KW	18/05/2019	1145	3.00	WE	Wind: F3-3, NW Oktas:7-8 Temp: 14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	14/06/2019	800	2.00	LB	Wind: F2, W Oktas:4-6 Temp: 12-13°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	25/06/2019	1100	3.00	SN	Wind: F2-3, NE Oktas:8 Temp: 18°C Ground cond: not rec. Rainfall: mist Visibility: good Factors affect vis: low cloud base over hillsops
1	KW	16/07/2019	915	3.00	BZ	Wind: F3-4, SW Oktas:4-7 Temp: 16-18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none Visibility: good Factors affect vis: none
1	KW	23/07/2019	1300	3.00	LB	Wind: F4-5, S Oktas:2-4 Temp: 22°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	16/08/2019	815	3.00	LB, MA	Wind: F4-5, S-SW Oktas:3-8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: mod.-good Factors affect vis: low cloud & passing showers
1	KW	03/09/2019	900	3.00	RK *	Wind: F2-3, SW Oktas:8 Temp: 16-17°C Ground cond: wet Rainfall: passing showers Visibility: poor-good Factors affect vis: low cloud & passing showers
2	HPD	21/03/2019	930	3.00	JS, LB, WS	Wind: F3, SW Oktas:8 Temp: 12°C Ground cond: damp Rainfall: light shower Visibility: mod.-poor Factors affect vis: fog thick, vis 500-800m average, occ better, also some light drizzle
2	KW	27/03/2019	1330	3.00	BZ	Wind: F3, SW Oktas:5-8 Temp: 8-9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	KW	17/04/2019	1000	3.00	ML	Wind: F1-4, E-ESE-SE Oktas:4-6 Temp: 9-10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	HD	09/05/2019	930	3.00	ML	Wind: F2, E Oktas:7-8 Temp: 7°C Ground cond: wet Rainfall: persistent light rain Visibility: mod.-good Factors affect vis: low cloud
2	KW	17/05/2019	915	3.00	BZ	Wind: F3-4, SE-E Oktas:2-8 Temp: 1-4°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	17/05/2019	1245	3.00	ML	Wind: F2-1, E Oktas:8 Temp: 4°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	07/06/2019	745	3.00	BZ, MA, ML	Wind: F2-3, SE Oktas:5-8 Temp: 11-13°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	19/06/2019	1800	3.00	ML(on nest)	Wind: F2-5, SW Oktas:6-8 Temp: not rec. °C Ground cond: wet Rainfall: showers Visibility: mod.-good Factors affect vis: low cloud
2	KW	02/07/2019	915	3.00	ML & PE before start	Wind: F2, NW Oktas:7-8 Temp: 13-14°C Ground cond: dry Rainfall: mostly dry, occ. v light misty drizzle Visibility: good Factors affect vis: occ. misty drizzle
2	KW	17/07/2019	1000	3.00	ML, H	Wind: F3-4, S Oktas:8 Temp: 16°C Ground cond: wet Rainfall: showers, light rain & mist Visibility: good Factors affect vis: low cloud base over hillsops
2	KW	08/08/2019	900	3.00	No target sp.	Wind: F1, NE-ENE Oktas:6-8 Temp: 14-18°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	KW	21/08/2019	830	3.00	No target sp.	Wind: F4, S Oktas:7-8 Temp: 12-13°C Ground cond: wet Rainfall: passing showers - occ. heavy Visibility: mod.-good Factors affect vis: low cloud over mountain top, with passing showers

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
3	KW	27/03/2019	930	3.00	BH, BZ, LB, SH, WE	Wind: F5, SW Oktas:8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	10/04/2019	1045	3.00	BZ, EA, K	Wind: F3-4, E-SE Oktas:3-6 Temp: 10-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	10/04/2019	1405	3.00	BZ, WE	Wind: F4-3, SE Oktas:4-2 Temp: 11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	HPD	09/05/2019	1330	3.00	ML	Wind: F1, E Oktas:7-8 Temp: 17°C Ground cond: damp Rainfall: passing showers Visibility: good Factors affect vis: occ. showers
3	HPD	18/05/2019	845	3.00	ML	Wind: F4-5, NW Oktas:8 Temp: 14°C Ground cond: dry Rainfall: showers Visibility: good Factors affect vis: fog covering hill tops above Grafty, otherwise good lower down
3	HPD	18/05/2019	1200	3.00	No target sp.	Wind: F4-5, NW Oktas:7-8 Temp: 13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: fog covering hill tops above Grafty, cleared later (1330), light heat haze
3	KW	07/06/2019	1100	3.00	BZ, LB	Wind: F2-4, SE-S Oktas:7-8 Temp: 12-13°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	19/06/2019	1500	3.00	SN	Wind: F3-5, SW Oktas:8 Temp: 14°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: low cloud
3	KW	02/07/2019	1300	3.00	SH	Wind: F2-4, NW Oktas:7-8 Temp: 17-18°C Ground cond: dry Rainfall: not rec. Visibility: good Factors affect vis: none
3	KW	17/07/2019	1700	3.00	ML	Wind: F2-4, SW Oktas:3-6 Temp: 16-17°C Ground cond: wet Rainfall: not rec. Visibility: good Factors affect vis: none
3	KW	08/08/2019	1230	3.00	K	Wind: F1, ENE-E Oktas:5-8 Temp: 18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	KW	21/08/2019	1200	1.00	No target sp.	Wind: F4-5, S Oktas:8 Temp: 13°C Ground cond: wet Rainfall: light drizzle becomes heavy & persistent Visibility: mod-poor Factors affect vis: rain
3	KW	03/09/2019	1230	2.00	SH	Wind: F3, SW Oktas:8 Temp: 16-17°C Ground cond: wet Rainfall: misty rain shower Visibility: poor-mod. Factors affect vis: rain & mist
4	KW	11/04/2018	1015	3.00	No target sp.	Wind: F1-2, SE-S Oktas:8 Temp: 9-11°C Ground cond: wet Rainfall: nil Visibility: mod-good Factors affect vis: low cloud/ haze beyond 2k
4	KW	11/04/2018	1340	3.00	BZ	Wind: F1-2, S Oktas:8 Temp: 11°C Ground cond: wet Rainfall: nil Visibility: mod-good Factors affect vis: low cloud/ haze beyond 2k
4	KW	26/03/2019	1015	3.00	RG	Wind: F5-6, SW Oktas:8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hillsops periodically
4	KW	26/03/2019	1335	3.00	No target sp.	Wind: F5, SW Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hillsops periodically
4	KW	29/05/2019	850	3.00	No target sp.	Wind: F1-2, SE Oktas:8 Temp: 10-11°C Ground cond: wet Rainfall: mostly dry, occ. light showers Visibility: good Factors affect vis: low cloud base over hillsops
4	KW	29/05/2019	1215	3.00	No target sp.	Wind: F2, S Oktas:8 Temp: 11°C Ground cond: wet Rainfall: light passing showers, becoming persistent at end Visibility: good-mod. Factors affect vis: low cloud dropping over lower slopes towards end
4	KW	14/06/2019	1045	3.00	BZ	Wind: F2, W Oktas:4-8 Temp: 13°C Ground cond: wet Rainfall: showers Visibility: good Factors affect vis: occ. showers
4	KW	25/06/2019	1445	3.00	BZ	Wind: F3, NE Oktas:6-8 Temp: 16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	16/07/2019	1300	3.00	No target sp.	Wind: F4-5, SW Oktas:6-8 Temp: 19-20°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	23/07/2019	1645	3.00	No target sp.	Wind: F5, S Oktas:2-4 Temp: 22°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	16/08/2019	1200	3.00	No target sp.	Wind: F5-6 (gusting 7), SW Oktas:8-6 Temp: 15°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	KW	04/09/2019	1315	3.00	No target sp.	Wind: F5-6, NW Oktas:8 Temp: 12-13°C Ground cond: wet Rainfall: passing showers Visibility: good-mod. Factors affect vis: showers

Table 3 Year 2: Non-breeding season 2019-20 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	KW	10/10/2019	930	3.00	ML, RG	Wind: F3, S Oktas:8 Temp: 12-13°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: none
1	RV	27/10/2019	935	3.00	RG	Wind: F1-2, NE Oktas:1-2 Temp: 5-6°C Ground cond: damp Rainfall: single prolonged shower Visibility: good Factors affect vis: shower
1	RV	30/10/2019	1125	3.00	RG	Wind: F3, N-NW Oktas:2-3 Temp: 8-10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	18/11/2019	1245	3.00	No target sp.	Wind: F2-3, SE Oktas:6 Temp: 2°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	07/12/2019	1225	3.00	BZ, K	Wind: F4-5, SSW Oktas:7-8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	JB	31/12/2019	905	3.00	No target sp.	Wind: F2-3, E Oktas:0 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
1	JB	05/01/2020	830	3.00	BZ, EA, GB, RG	Wind: F2-4, S Oktas:8 Temp: 8°C Ground cond: wet Rainfall: mostly dry, occ. drizzle Visibility: good Factors affect vis: low cloud, occasional drizzle
1	JB	12/01/2020	940	3.00	GB	Wind: F3-4, SW Oktas:5 Temp: 3°C Ground cond: wet Rainfall: short rain showers Visibility: good Factors affect vis: none
1	JB	28/01/2020	1200	3.00	H	Wind: F2-4, W Oktas:8 Temp: 3°C Ground cond: snow - patchy/ wet Rainfall: mostly dry, occ. shower/ hail Visibility: good-mod. Factors affect vis: rain/hail
1	JB	13/02/2020	1015	3.00	BZ	Wind: F3-4, ENE-NE Oktas:6-8 Temp: 4°C Ground cond: wet Rainfall: mostly dry, occ. light rain, drizzle Visibility: mostly good Factors affect vis: rain, drizzle
1	JB	27/02/2020	1330	3.17	ML, K, GB, WE	Wind: F3, WNW-W Oktas:7-4 Temp: 6°C Ground cond: snow: 10mm Rainfall: nil Visibility: good Factors affect vis: none
1	RV	03/03/2020	730	3.00	LB, K, LB	Wind: F4, W-MNW Oktas:2-4 Temp: 4°C Ground cond: damp Rainfall: mostly dry occ. light drizzle, some sleet & snow Visibility: good Factors affect vis: occ. sleet, snow showers
2	KW	17/10/2019	1200	3.00	No target sp.	Wind: F2-4, SSE-S Oktas:5-8 Temp: 7-8°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: low cloud
2	RV	27/10/2019	1320	3.00	K	Wind: F1, N Oktas:1-4 Temp: 6-7°C Ground cond: wet Rainfall: showers Visibility: mod. Factors affect vis: glare - intense at times, with single heavy shower
2	RV	30/10/2019	745	3.00	No target sp.	Wind: F2-3, N Oktas:1-3 Temp: 6-9°C Ground cond: damp Rainfall: light drizzle Visibility: good Factors affect vis: none
2	JB	18/11/2019	915	3.00	No target sp.	Wind: F1-3, SW-S Oktas:1-7 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
2	JB	07/12/2019	855	3.00	No target sp.	Wind: F4, SW Oktas:8 Temp: 8°C Ground cond: wet Rainfall: drizzle/light rain Visibility: mod -poor Factors affect vis: low cloud - vis down to 1km at times, high points obscured for most of watch
2	JB	15/12/2019	900	3.00	K/SH?, ML, RG	Wind: F2-3, SW Oktas:2-5 Temp: 0°C Ground cond: snow - light Rainfall: nil Visibility: good Factors affect vis: none
2	JB	31/12/2019	1230	3.00	K, EA	Wind: F2-3, E-SE-S Oktas:0-1 Temp: 2°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: haze - slight during last hour
2	JB	09/01/2020	1235	3.00	K, EA	Wind: F2, SW Oktas:4 Temp: 4°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	JB	28/01/2020	830	3.00	No target sp.	Wind: F2-4, W Oktas:8 Temp: 1°C Ground cond: snow: 40mm Rainfall: rain, hail, sleet Visibility: good Factors affect vis: short hail/select showers
2	JB	13/02/2020	1345	3.00	EA, PE, RG, WE	Wind: F3-2, NE-NNW-E Oktas:6-2 Temp: 5°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to W - occ over last hour
2	JB	27/02/2020	1000	3.00	EA, SH, WE	Wind: F3-4, NW Oktas:3-8 Temp: 3°C Ground cond: snow: 30mm Rainfall: mostly dry - passing snow showers Visibility: good Factors affect vis: snow showers
2	RV	03/03/2020	1430	3.00	ML, SH	Wind: F4-3, WNW-W Oktas:2-4 Temp: 5°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: glare - mild caused by evening sun
3	KW	10/10/2019	1300	3.00	LB	Wind: F3-5, S Oktas:7-8 Temp: 11-12°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: none

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
3	RV	29/10/2019	1245	3.00	K, SH	Wind: F3-4, E Oktas:1-3 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	RV	31/10/2019	815	3.00	BZ, EA, K	Wind: F3, SE Oktas:7 Temp: 8°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: low cloud base over hillsops periodically
3	JB	27/11/2019	1230	3.00	K, EA	Wind: F2-3, NE Oktas:4-7 Temp: 6°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	09/12/2019	1210	3.00	K	Wind: F2, W Oktas:5-8 Temp: 6°C Ground cond: dry Rainfall: v. light drizzle Visibility: good Factors affect vis: none
3	JB	17/12/2019	1215	3.00	SH	Wind: F2, W Oktas:4-8 Temp: 2°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	JB	05/01/2020	1155	3.00	BZ, EA, GB	Wind: F4-5, SW Oktas:8 Temp: 9°C Ground cond: wet Rainfall: drizzle Visibility: mod-good Factors affect vis: low cloud on top of site, drizzle at times
3	JB	17/01/2020	1245	3.00	BZ, K, SH	Wind: F2-3, W Oktas:5-7 Temp: 3°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	JB	06/02/2020	1245	3.17	BZ, CA, EA, K, SH	Wind: F3-5, SW Oktas:5-6 Temp: 5°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	JB	24/02/2020	1000	3.00	No target sp.	Wind: F4-5, W Oktas:7-8 Temp: 3°C Ground cond: snow: 50mm Rainfall: light drizzle Visibility: mod-good Factors affect vis: drizzle
3	JB	24/02/2020	1330	3.00	No target sp.	Wind: F5-6, W Oktas:7-8 Temp: 3°C Ground cond: snow: 20mm Rainfall: light to heavy showers Visibility: good-mod Factors affect vis: showers
3	RV	03/03/2020	1100	3.00	No target sp.	Wind: F4-5, WNW Oktas:1-8 Temp: 5°C Ground cond: wet Rainfall: snow & sleet for 20mins Visibility: good Factors affect vis: low cloud patches clearing, then occ. glare
4	KW	17/10/2019	830	3.00	BZ	Wind: F4-5, SE-SSE Oktas:4-8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	RV	29/10/2019	904	3.00	K, WS	Wind: F3-4, NE-E Oktas:1 Temp: 3-5°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	31/10/2019	1208	3.00	K	Wind: F3-4, SE Oktas:1-3 Temp: 9°C Ground cond: damp Rainfall: nil Visibility: not rec. Factors affect vis: low cloud base over hillsops
4	JB	27/11/2019	840	3.00	RG	Wind: F2-3, NE Oktas:8-6 Temp: 5°C Ground cond: wet Rainfall: mostly dry, occ. light passing shower Visibility: mod-good Factors affect vis: low cloud patches clearing, then occ. glare
4	JB	09/12/2019	840	3.00	No target sp.	Wind: F1-2, NW Oktas:1-4 Temp: 4°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: glare - some at sunrise
4	JB	17/12/2019	845	3.00	EA	Wind: F1-2, W Oktas:5-8 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
4	JB	09/01/2020	900	3.00	No target sp.	Wind: F1, S Oktas:4-7 Temp: 4°C Ground cond: frost/ wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	17/01/2020	900	3.25	RG	Wind: F4-1, SW- W Oktas:7-8 Temp: 1°C Ground cond: wet-snow Rainfall: passing showers - occ. snow Visibility: mod Factors affect vis: low cloud, slight mist (1.5m)
4	JB	06/02/2020	915	3.00	No target sp.	Wind: F3-6, SSW-SW Oktas:6-7 Temp: 2°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	JB	23/02/2020	900	3.00	BZ, EA, RG	Wind: F3-5, W Oktas:5-6 Temp: 2-3°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	23/02/2020	1230	3.00	EA, K	Wind: F4-3, W Oktas:5-6 Temp: 2-4°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	RV	07/03/2020	920	3.00	WK	Wind: F5, W-S Oktas:8 Temp: 3°C Ground cond: wet Rainfall: rain until 1100, heavy at times Visibility: mod Factors affect vis: cloud base above VP

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	JB	21/04/2020	1515	3.00	GB, HG, LB	Wind: F4-3, E Oktas:1 Temp: 13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	22/04/2020	800	3.00	BZ, RG	Wind: F3-2, E Oktas:2-5 Temp: 7-12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	24/04/2020	1415	3.00	K, RG	Wind: F1-3, E-SW-W Oktas:2-4 Temp: 20-18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	13/05/2020	1000	3.00	BZ, K, RG	Wind: F3-4, NNE Oktas:7-8 Temp: 7-11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	RV	16/05/2020	645	3.00	K, LB, SN	Wind: F3, SW Oktas:8 Temp: 7°C Ground cond: dry Rainfall: Drizzle Visibility: mod. Factors affect vis: low cloud, drizzle & some mist
1	JB	27/05/2020	1330	3.00	BZ, EA, K	Wind: F2, SW Oktas:3-8 Temp: 18°C Ground cond: dry Rainfall: nil Visibility: Good Factors affect vis: none
1	JB	04/06/2020	1600	3.00	K, SN	Wind: F3, NNW Oktas:8 Temp: 11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	RV	23/06/2020	520	3.00	H, LB	Wind: F1-F2, S Oktas:1 Temp: 10°C Ground cond: damp Rainfall: nil Visibility: good-mod. Factors affect vis: misty, overcast & dull at start - quickly cleared, occ. low cloud along top of mountain
1	RV	08/07/2020	1715	3.00	BZ, SH	Wind: F3, NE Oktas:1 Temp: 13°C Ground cond: damp Rainfall: drizzle Visibility: Good Factors affect vis: drizzle - light spells, some patches of low cloud but generally clear
1	JB	11/07/2020	1315	3.00	H, HG, SN	Wind: F3, W Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	RV	12/08/2020	630	3.00	ML	Wind: F2-3, NNE Oktas:8-2 Temp: 13°C Ground cond: damp Rainfall: nil Visibility: poor-mod. Factors affect vis: low cloud over hill top, also localised mist
1	RV	19/08/2020	1320	3.00	EA	Wind: F4-5, E Oktas:7-8 Temp: 18°C Ground cond: damp Rainfall: light drizzle from 15:40 Visibility: good-mod. Factors affect vis: drizzle - light for last 40 mins
2	JB	21/04/2020	815	3.00	MA, ML, SH	Wind: F2-3, ESE Oktas:0 Temp: 6-10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	RV	22/04/2020	645	3.00	ML	Wind: F3, E Oktas:2 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	JB	24/04/2020	1045	3.00	EA, GB, ML, RG	Wind: F1-2, E Oktas:2-3 Temp: 15-20°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	RV	10/05/2020	1130	3.00	ML	Wind: F6, NE Oktas:8 Temp: 7°C Ground cond: dry Rainfall: mostly dry, occ. passing drizzle Visibility: good Factors affect vis: none
2	JB	14/05/2020	930	3.00	ML	Wind: F2-3, N-NNW Oktas:1-7 Temp: 9-14°C Ground cond: dry Rainfall: nil Visibility: Good Factors affect vis: heat haze
2	RV	28/05/2020	635	3.17	EA, ML	Wind: F2, S Oktas:4 Temp: 14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: haze - slight during last 30 mins.
2	JB	04/06/2020	1230	3.00	ML	Wind: F3, N Oktas:7-8 Temp: 10-13°C Ground cond: dry Rainfall: mostly dry, occ. v light to light showers Visibility: good Factors affect vis: none
2	RV	15/06/2020	555	1.25	ML(chicks)	Wind: F1, N Oktas:0 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good (poor at end) Factors affect vis: perfect conditions at start - thick fog rolled up valley stopped watch
2	RV	23/06/2020	855	1.75	EA, ML, SH	Wind: F3-4, S Oktas:1 Temp: 13°C Ground cond: damp Rainfall: nil Visibility: Good Factors affect vis: good vis, occ. low cloud over hilltops above Graffy
2	RV	08/07/2020	1345	3.00	ML	Wind: F3, E Oktas:1 Temp: 13°C Ground cond: damp Rainfall: Drizzle Visibility: good Factors affect vis: drizzle - light drizzle for last hour
2	JB	11/07/2020	615	3.00	ML	Wind: F2, W Oktas:8 Temp: 10°C Ground cond: wet Rainfall: mostly dry, single brief, v. light shower Visibility: good Factors affect vis: none
2	RV	19/08/2020	620	3.00	BZ	Wind: F2-3, E Oktas:7-8 Temp: 14°C Ground cond: damp Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops
2	RV	19/08/2020	950	3.00	HH	Wind: F3-4, E Oktas:8 Temp: 15°C Ground cond: damp Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops
3	JB	21/04/2020	1145	3.00	BZ, GB	Wind: F4, ESE Oktas:0-1 Temp: 10-13°C Ground cond: dry Rainfall: nil

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
						Visibility: good Factors affect vis: none
3	RV	29/04/2020	850	3.00	BZ, K, LB, SN, WE	Wind: F4, W-NW Oktas:7 Temp: 7°C Ground cond: damp Rainfall: nil Visibility: Good Factors affect vis: none
3	RV	30/04/2020	645	3.00	SN	Wind: F1-2, N Oktas:1 Temp: 5°C Ground cond: damp Rainfall: drizzle Visibility: poor-mod. Factors affect vis: low cloud, with some fog & showers
3	JB	13/05/2020	1445	3.00	BZ, EA, K, Larus gull sp.	Wind: F3-4, NE-NNE Oktas:8-1 Temp: 11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	21/05/2020	1100	3.00	BZ, EA, SH	Wind: F2-3, SW Oktas:3-4 Temp: 15-17°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	17/06/2020	1015	3.00	No target sp.	Wind: F3, NW Oktas:8 Temp: 12°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	RV	30/06/2020	520	3.00	No target sp.	Wind: F3, W-SW Oktas:1 Temp: 10°C Ground cond: damp Rainfall: Drizzle Visibility: poor-mod. Factors affect vis: fog rolling in with persistent light drizzle
3	JB	11/07/2020	945	3.00	BZ, EA, SN	Wind: F3, W Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	RV	24/07/2020	540	3.00	EA, SH	Wind: F3, S Oktas:1 Temp: 12°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	KW	13/08/2020	815	3.00	No target sp.	Wind: F2, NE Oktas:8 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: poor-mod. Factors affect vis: Low cloud
3	KW	13/08/2020	1140	3.00	EA, K	Wind: F2-1, NE Oktas:8-3 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: low cloud lifting
3	JB	24/08/2020	1000	3.00	BZ, EA, HH, K	Wind: F2-3, S Oktas:6-7 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	22/04/2020	1130	3.00	BZ, EA, WE	Wind: F3, E Oktas:4-6 Temp: 14-16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	JB	22/04/2020	1500	3.00	EA, Falcon sp.	Wind: F3-2, E Oktas:6-8 Temp: 15-17°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	28/04/2020	1320	3.00	EA, ML, RG, WE, CU*, GP*	Wind: F2, E Oktas:2 Temp: 9°C Ground cond: dry Rainfall: showers Visibility: Good Factors affect vis: none
4	RV	10/05/2020	740	3.00	GP, HG, LB, SN	Wind: F6, NE Oktas:8 Temp: 6°C Ground cond: damp Rainfall: Drizzle Visibility: good Factors affect vis: mist on far side of valley
4	JB	21/05/2020	1445	3.00	BZ, GB, K, ML, WE	Wind: F2-4, SW Oktas:5-7 Temp: 16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	26/05/2020	640	3.00	RG	Wind: F3, W Oktas:4 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	JB	17/06/2020	1345	1.00	SN	Wind: F3, NW Oktas:8 Temp: 12-11°C Ground cond: damp Rainfall: nil Visibility: poor-mod. Factors affect vis: cloud base drops - stopped VP watch
4	JB	25/06/2020	1530	2.00	No target sp.	Wind: F2, NNW Oktas:6-8 Temp: 18°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	RV	30/06/2020	855	3.00	RG*	Wind: F2-3, W-SW Oktas:1 Temp: 11°C Ground cond: Wet Rainfall: Drizzle Visibility: poor-mod. Factors affect vis: fog rolling in with drizzle, began to clear from 10-45 - dry & clear for last hour
4	JB	20/07/2020	1530	3.00	EA, SH	Wind: F3-2, W Oktas:5-3 Temp: 16°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
4	RV	29/07/2020	650	3.00	No target sp.	Wind: F2, W-SW Oktas:1 Temp: 11°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	KW	12/08/2020	900	3.00	K	Wind: F1-2, N Oktas:8-3 Temp: 17-20°C Ground cond: dry Rainfall: nil Visibility: poor-mod. Factors affect vis: low cloud - banks rolling through vis ranging poor to good
4	KW	12/08/2020	1225	3.00	No target sp.	Wind: F2, N Oktas:2 Temp: 20-19°C Ground cond: dry Rainfall: nil Visibility: mod.-good Factors affect vis: cloud lifts, only covering tops of hill

Table 5 Transect dates covering wind farm site						
Season	Visit	Date	Surveyor	Coverage	Target species	Weather
1	Non-breeding 2018-19	1.1	MT	Proposed turbine locations		5-7°C, SE wind force 2, no rain, mostly cloudy
		1.2	MT/KW	Full site		4-6°C, NW wind force 4, light rain, partly cloudy
		1.3	HD/HPD	Full site	HH, BZ(2), RG(5), SH, GB(5), SN(2)	8-10°C, SW wind force 3, no rain, mostly cloudy
2	Breeding 2019	2.1	HD/HPD	Full site	WE, EA, BZ, SN, RG	12-15°C, S wind force 4, no rain, cloudy
		2.2	HD/HPD	Full site	ML(M&F), BZ, RGs	14-15°C, NW wind force 3, no rain, cloudy
		2.3	HD	West site	W, RG	10-15°C, N wind force 4, no rain, mostly cloudy
		2.4	HD	East site	SN, BZ, ML	9-12°C, W wind force 3, showers, mostly cloudy
		2.5	HD	Full site	ML fledglings	18-21°C, NW wind force 2, no rain, partly cloudy
3	Non-breeding 2019-20	3.1	JB	4.5 hrs		0-1°C, S wind force 5, sleet, full cloudy cover
		3.2	RV	3 hrs		8°C, wind force 0, light rain, mostly cloudy
4	Breeding 2020	4.1	RV	4 hrs		21°C, var. wind force 2, no rain, no cloud
		4.2	RV	1.5 hrs		13°C, S wind force 4, no rain, mostly cloudy
		4.3	RV	2.5 hrs		11°C, W-SW wind force 3, constant rain, mostly cloudy
		4.4	RV	2 hrs		14°C, S wind force 3, no rain, full cloudy cover
		4.5	RV	2.5 hrs		13°C, SW wind force 4, rain showers, full cloudy cover

Appendix 3: Avi-fauna – Results: Flight-line maps

- Flight identification numbers on maps cross-reference with numbers in attribute tables to provide information for each observation
- Merlin flight-lines are associated with a potential sensitive breeding site and are therefore provide in a separate confidential appendix – see Appendix 7 - Confidential Appendix: Merlin flight-lines and nesting information

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Survey type	Season	Date	Surveyor	Coverage	Summary	Weather
Waterbird	Non-Breeding 2018-19	09.11.19	MT	All loughs checked	WS(17), CA, LG, MA(3)	7°C, wind force 5, occ. drizzle, cludy
Waterbird/raptor	Non-Breeding 2018-19	11.02.19	HD/HPD	All loughs checked	WS(13), GN(3), LG, MA(4), CA, T(8), TU(4), NG	8°C, S wind force 4, no rain, cloudy
Waterbird/raptor survey	Non-Breeding 2018-19	22.02.19	KW/HPD	Loughs		14°C, S wind force 6, no rain, no cloud
Waterbird/raptor survey	Breeding 2019	21.03.19	KW	Driven transects and watch point	WS(65), WE	9°C, NE wind force 4, no rain, partly cloudy
Raptor survey	Breeding 2019	28.03.19	KW	4 hr loop	WE, SH, ML, BZ, PE	14°C, SW wind force 5, no rain, partly cloudy
Raptor survey	Breeding 2019	17.05.19	KW	Loughs and peaks	PE, BZ, SH	16°C, var. wind force 3, no rain, no cloud
Diver survey	Breeding 2019	21.05.19	HPD	Full day	No divers	12°C, NW wind force 3, no rain, no cloud
Eagle survey	Breeding 2019	25.06.19	KW	Half day	BZ	15°C, NE wind force 4, no rain, cloudy
Raptor survey	Breeding 2019	02.07.19	KW	Half day	SH	15°C, NW wind force 3, no rain, cloudy
Diver/raptor survey	Breeding 2019	03.07.19	HD	Full day – covering loughs for divers	No divers, BZ, ML (female w/ 3-4 chicks), WS(2)	15°C, NW wind force 2, no rain, cloudy
Diver/raptor survey	Breeding 2019	23.07.19	HD	Full day	WE?, CA, LB, WS(2), SH, falcon sp., CS(3)	25°C, windy, heat haze, vis poor, good for soaring
Diver/raptor survey	Breeding 2019	24.07.19	HD	Half day 1-2km radius	EA, CA, MA, LB, HG(200), WS(2), SF	19°C, SSW wind force 4, no rain, partly cloudy
Diver/raptor survey	Breeding 2019	01.08.19	HD	Full day	WS, SF(juv), MA, CA, LB, BZ	17°C, NE wind force 3, no rain, cloudy
Eagle survey	Non-Breeding 2019-20	12.02.20	JB	Full day	EA pair displaying	3°C, W wind force 3, snow
Eagle survey	Non-Breeding 2019-20	23.02.20	RV	Full day	EA(2)	2-3°C, WNW wind force 6, no rain
Eagle survey	Non-Breeding 2019-20	07.03.20	RV	Full day		11°C, SSW wind force 6, showers, cloudy
Raptor survey	Breeding 2020	26.03.20	JB	Full day	EA	10°C, WNW wind force 2, no rain
Raptor survey	Breeding 2020	19.04.20	JB	North Fintown Hill, North Bluestacks	WE(2), EA(sub adult)	9-13°C, SSW wind force 2, no rain, full cloudy cover
Raptor survey	Breeding 2020	22.04.20	RV	Full day		15°C, E wind force 2, no rain, no cloud
Raptor survey	Breeding 2020	28.04.20	RV	Full day	Breeding ML at nest site	11°C, NE wind force 3, no rain, no cloud
Raptor survey	Breeding 2020	14.05.20	JB	Half day		13°C, NW wind force 3, no rain, cloudy
Raptor survey	Breeding 2020	26.05.20	RV	Full day	EA pair, PE, BZ	13°C, WNW wind force 3, light rain, mostly cloudy
Raptor survey	Breeding 2020	27.05.20	JB	Half day	EA(Ad., 3 sightings)	16°C, E wind force 2, no rain, mostly to partly cloudy
Eagle survey	Breeding 2020	07.07.20	RV	Full day	WS(2)	3-4°C, WNW wind force 5, heavy showers
Raptor survey	Breeding 2020	24.07.20	RV	4 hrs	no target species	16°C, S wind force 4, light rain, cloudy
Raptor survey	Breeding 2020	29.07.20	RV	Full day	K(2 juveniles)	15°C, NNW wind force 2, no rain, mostly cloudy

Survey type	Season	Date	Surveyor	Coverage	Summary	Weather
Raptor survey	Breeding 2020	31.07.20	RV	2.5 hrs	EA, RH	17°C, S wind force 4, light rain, cloudy
Raptor survey	Breeding 2020	12.08.20	RV	Full day	EA, PE	17°C, N wind force 4, no rain, no cloud
Eagle survey	Breeding 2020	24.08.20	JB	1 hr	EA, K	12°C, S wind force 3, no rain, no cloudy
Eagle survey	Breeding 2020	29.08.20	JB	Full day	WE, K, PE, RG(2)	17°C, N wind force 4, no rain, no cloud

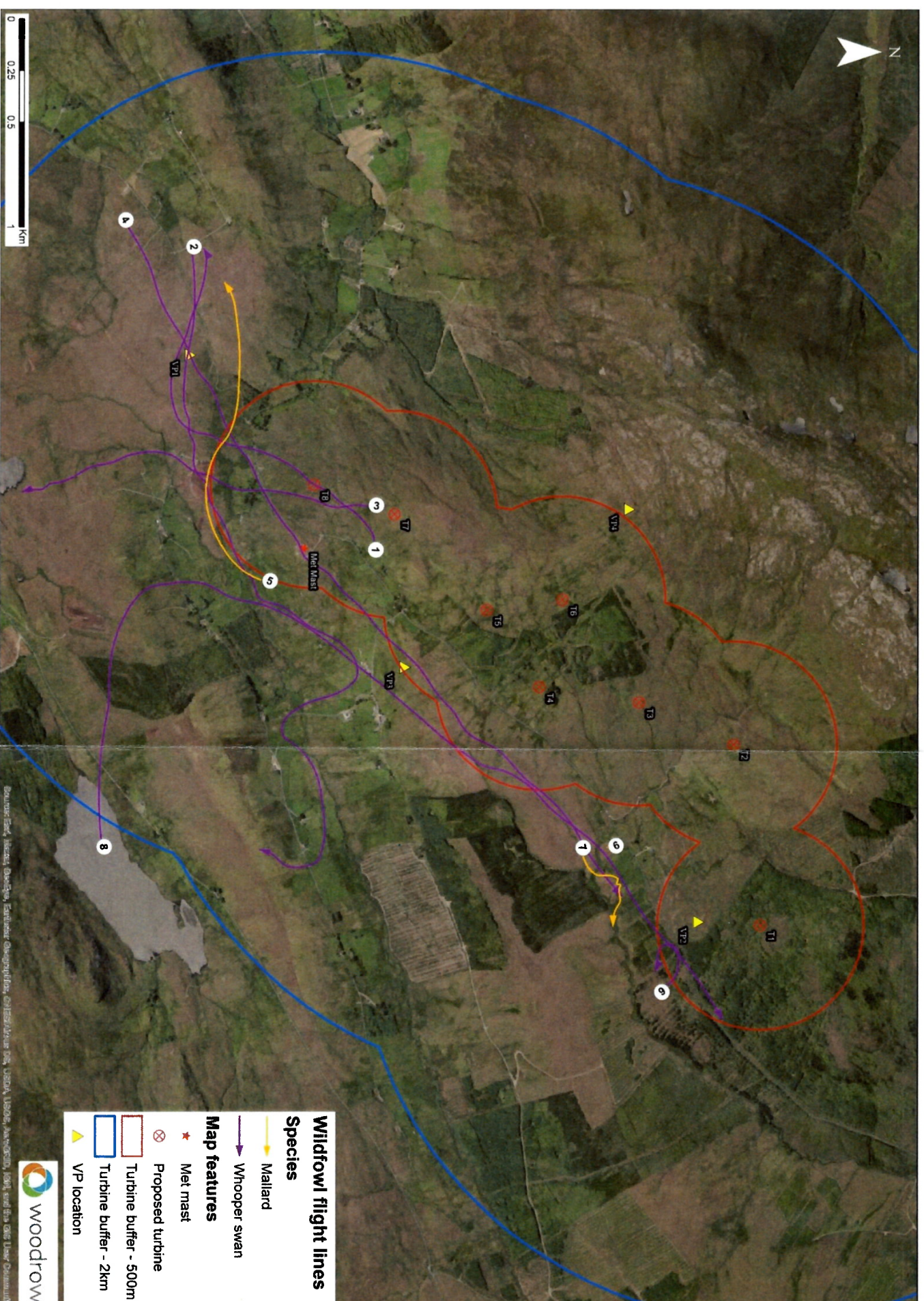


Figure 1 Flight-lines for swan, goose and duck species: Oct-2018 to Aug-2020

Table 1 Flight line data for swans, geese and ducks
WS – whooper swan & MA - mallard

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	30-Oct-18	832	WS	10	200	150 to 200m	Commute		Adult
2	Non-breeding 2018-19	30-Oct-18	818	WS	3	100	60 to 100m	Commute		Adult
3	Non-breeding 2018-19	30-Oct-18	844	WS	5	120	80 to 150m	Commute		Adult
4	Non-breeding 2018-19	21-Mar-19	1611	WS	23	100	c. 100m	Commute		
5	Breeding 2019	16-Aug-19	1008	MA	3	15	10 to 15m	Flying	F	
6	Breeding 2019	21-Mar-19	1026	WS	1	40	c. 40m	Commute		
7	Breeding 2019	07-Jun-19	806	MA	2	15	c. 15m	Flying		
8	Non-breeding 2019-20	29-Oct-19	1039	WS	3	40	30 to 50m	Commute		Adult
9	Breeding 2020	21-Apr-20	825	MA	2		na	Perched	M+F	

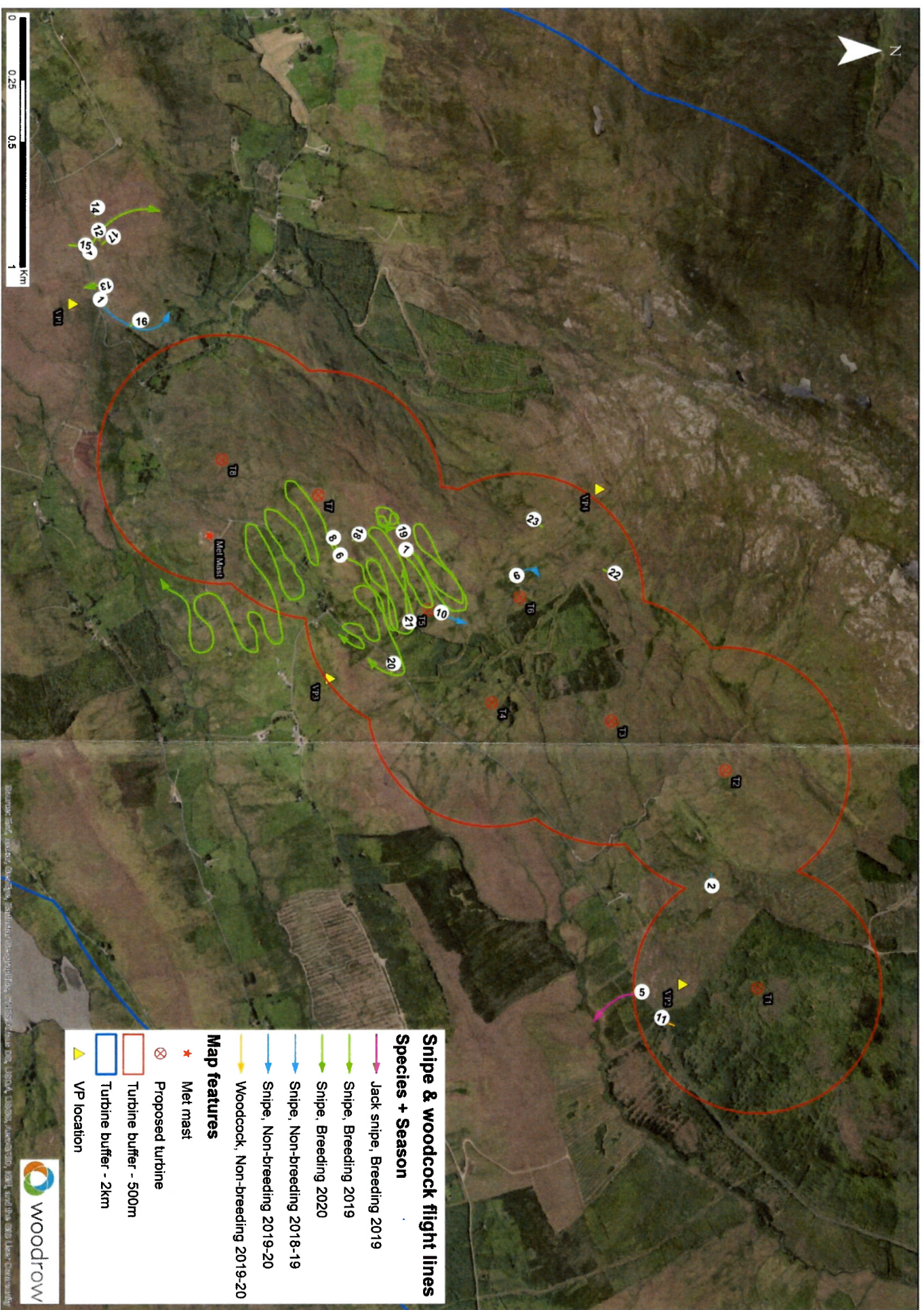


Figure 2 Flight-lines for snipe and woodcock species: Oct-2018 to Aug-2020

Table 2 Flight line data for snipe and woodcock
SN – snipe, JS – jack snipe & WK – woodcock

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	22-Feb-19	1347	SN	1	10	c. 10m	Flushed		
2	Non-breeding 2018-19	30-Oct-18	1030	SN	2	10	c. 10m	Flushed		
3	Breeding 2019	09-May-19	1230	SN	1		na	Chipping		
4	Breeding 2019	25-Jun-19	1059	SN	1	2	c. 2m	Flushed		
5	Breeding 2019	21-Mar-19	1042	JS	1	30	c. 30m	Fly-land		
6	Breeding 2019	19-Jun-19	1634	SN	1	25	25 to 0m	Fly-land		
7	Breeding 2019	19-Jun-19	1628	SN	2	40	20 to 40m	Display flight		
8	Breeding 2019	19-Jun-19	1634	SN	1	20	20 to 0m	Fly-land		
9	Non-breeding 2019-20	09-Dec-19	1430	SN	1		na	Flushed		
10	Non-breeding 2019-20	31-Oct-19	1530	SN	1		na	Flushed		
11	Non-breeding 2019-20	07-Mar-20	850	WK	1		na	Flushed		
12	Breeding 2020	24-Apr-20	1611	SN	1		na	Chipping		
13	Breeding 2020	24-Apr-20	1651	SN	1	2	2 to 0m	Fly-land		
14	Breeding 2020	16-May-20	852	SN	1		na	Chipping		
15	Breeding 2020	04-Jun-20	1649	SN	1		na	Chipping		
16	Breeding 2020	11-Jul-20	1427	SN	1		na	Chipping		
17	Breeding 2020	11-Jul-20	1505	SN	1		na	Chipping		
18	Breeding 2020	29-Apr-20	1053	SN	1		na	Display flight		
19	Breeding 2020	30-Apr-20	936	SN	1	50	20 to 50m	Display flight		
20	Breeding 2020	11-Jul-20	1005	SN	1		na	Chipping		
21	Breeding 2020	11-Jul-20	1020	SN	1	15	c. 15m	Fly-land		
22	Breeding 2020	10-May-20	915	SN	1		na	Display flight		
23	Breeding 2020	17-Jun-20	1409	SN	1		na	Display flight		

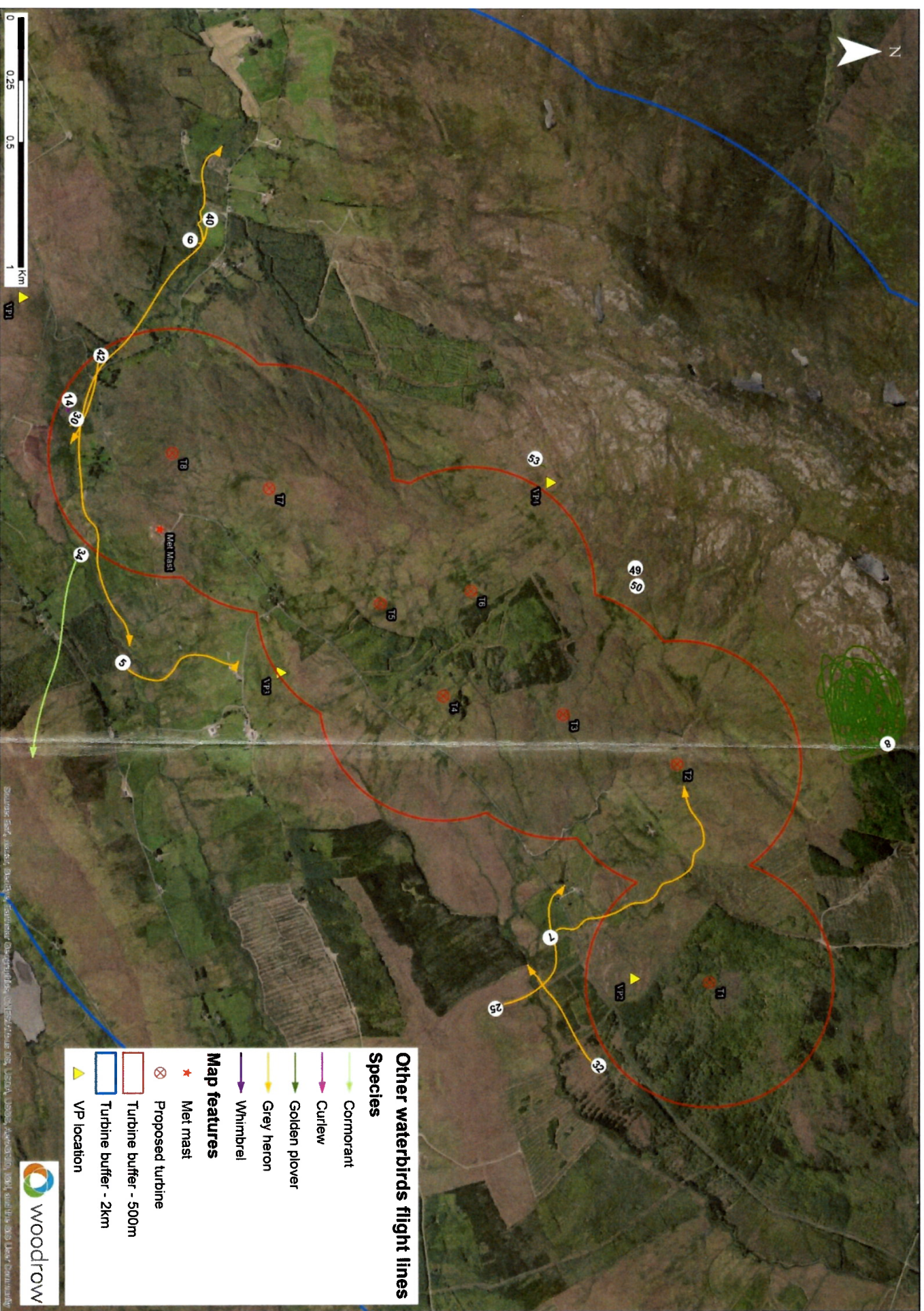


Figure 3 Flight-lines for other waders and waterbird species: Oct-2018 to Aug-2020

Table 3 Flight line data for other waterbirds

CA – cormorant, H – grey heron, GP – golden plover, CU – curlew, WM - whimbrel

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – flight height	Behaviour	Sex	Age
5	Non-breeding 2018-19	11-Dec-18	1009	H	1	20	c. 20m	Fly-land		
6	Non-breeding 2018-19	05-Feb-19	1313	H	1	30	c. 30m	Flying		
7	Non-breeding 2018-19	30-Oct-18	1238	H	1	20	20 to 2m	Fly-land		
8	Non-breeding 2018-19	10-Jan-19	1003	GP	32	150	150 to 0m	Circling		
14	Breeding 2019	09-May-19	1030	WM	1		na	Passage - calling		
25	Breeding 2019	17-Jul-19	1217	H	1	15	5 to 15m	Flying		
30	Non-breeding 2019-20	28-Jan-20	1325	H	1		na	Foraging		Adult
32	Non-breeding 2019-20	30-Oct-19	925	H	1		not rec	Flying		
34	Non-breeding 2019-20	06-Feb-20	1416	CA	1	80	c. 80m	Commute		Adult
40	Breeding 2020	23-Jun-20	611	H	1	30	30 to 50m	Flying		Adult
42	Breeding 2020	11-Jul-20	1347	H	1	4	4 to 0m	Fly-land		
49	Breeding 2020	28-Apr-20	1341	CU	1		na	Alarm call		
50	Breeding 2020	28-Apr-20	1341	GP	1		na	Alarm call		
53	Breeding 2020	10-May-20	1017	GP	1		na	Calling		

Table 4 Flight line data for gull species

BH – black-headed, GB – great black-back, HG – herring, LB – lesser black-back

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	23-Nov-18	1143	HG	1	10	10	Commute		
2	Non-breeding 2018-19	20-Mar-19	1118	LB	2	100	100	Commute		
3	Non-breeding 2018-19	21-Mar-19	1522	LB	2	150	150	Circling		
4	Breeding 2019	21-Mar-19	1142	LB	1	10	10	Flying		
5	Breeding 2019	09-May-19	934	LB	1	80	80	Commute		
6	Breeding 2019	14-Jun-19	932	LB	1	80	80	Commute		
7	Breeding 2019	23-Jul-19	1313	LB	1	50	40-50	Commute		
8	Breeding 2019	23-Jul-19	1313	LB	1	45	40-45	Commute		
9	Breeding 2019	23-Jul-19	1313	LB	1	45	40-45	Commute		
10	Breeding 2019	23-Jul-19	1444	LB	1	100	20-100	Commute		
11	Breeding 2019	16-Aug-19	913	LB	1	25	5-25	Commute		
12	Breeding 2019	21-Mar-19	1230	LB	1	50	50	Commute		
13	Breeding 2019	27-Mar-19	951	LB	1	50	50	Flying		
14	Breeding 2019	27-Mar-19	1049	LB	1	50	50	Flying		
15	Breeding 2019	27-Mar-19	1107	BH	1	20	20	Flying		
16	Breeding 2019	07-Jun-19	1127	LB	1	50	50	Flying		
17	Non-breeding 2019-20	03-Mar-20	936	LB	3	75	50-75	Flying		x1 Juv + 2 Adults
18	Non-breeding 2019-20	10-Oct-19	1451	LB	1	15	10-15	Commute		
19	Breeding 2020	21-Apr-20	1619	LB	4	50	50-4-50-200	Commute		Adult
20	Breeding 2020	21-Apr-20	1813	LB	3	200	200	Commute		
21	Breeding 2020	21-Apr-20	1813	HG	2	200	200	Commute		
22	Breeding 2020	16-May-20	927	LB	1	30	30-40	Flying		Adult
23	Breeding 2020	23-Jun-20	706	LB	1	20	10-20	Commute		Adult
24	Breeding 2020	11-Jul-20	1530	HG	150	100	100-150	Flying		
25	Breeding 2020	29-Apr-20	1032	LB	2	50	50-75	Commute		Adult
26	Breeding 2020	29-Apr-20	1211	LB	1	100	50-100	Flying		Adult
27	Breeding 2020	13-May-20	1617	Gull sp.	50	160	150-400	Circling		
28	Breeding 2020	13-May-20	1736	Gull sp.	60	200	200-400	Circling		
29	Breeding 2020	10-May-20	926	HG	50	50	30-50	Flying		

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – flight height	Behaviour	Sex	Age
30	Breeding 2020	10-May-20	926	LB	1	40	40	Flying		
31	Non-breeding 2019-20	05-Jan-20	1034	GB	2	80	c. 80m	Commute		Adult
32	Non-breeding 2019-20	12-Jan-20	1016	GB	1	70	70-50-25-40m	Commute		Adult
33	Non-breeding 2019-20	27-Feb-20	1628	GB	2	60	4 to 60m	Commute	M	Adult
34	Non-breeding 2019-20	05-Jan-20	1322	GB	1	50	0-10-20-50-15m	Commute		Adult
35	Non-breeding 2019-20	05-Jan-20	1310	GB	1		na	On ground		Adult
36	Breeding 2020	21-Apr-20	1603	GB	1	30	10-20-30m	Flying		Adult
37	Breeding 2020	24-Apr-20	1257	GB	1	50	50-10-60m	Commute		Adult
38	Breeding 2020	21-Apr-20	1443	GB	1	80	60-40-4-80m	Foraging		
39	Breeding 2020	21-May-20	1512	GB	1	100	50 to 150m	Foraging		Adult
40	Breeding 2020	21-May-20	1516	GB	1	180	150 to 180m	Commute		Adult

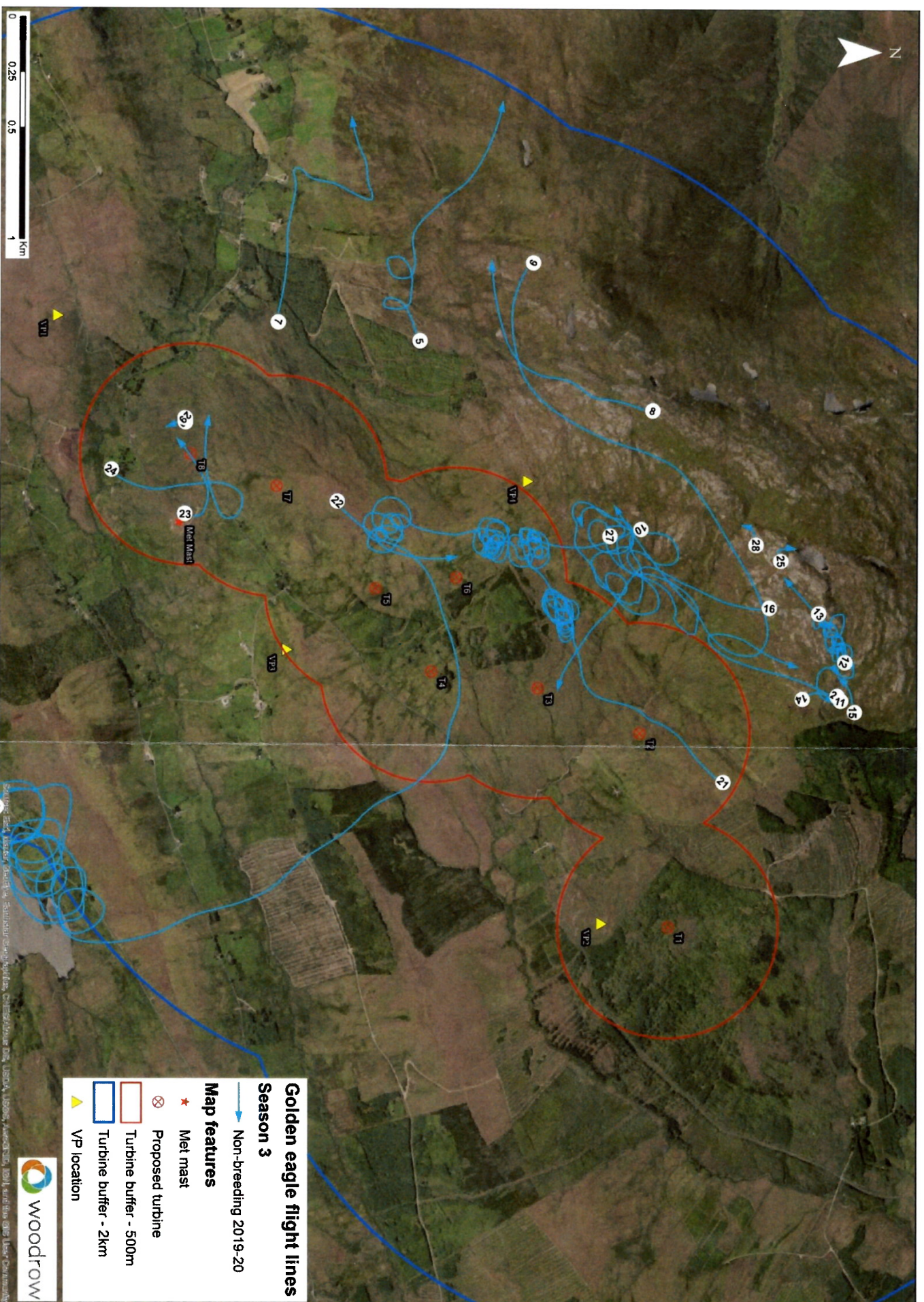


Figure 7 Flight-lines for golden eagle: Season 3 – non-breeding 2019-20

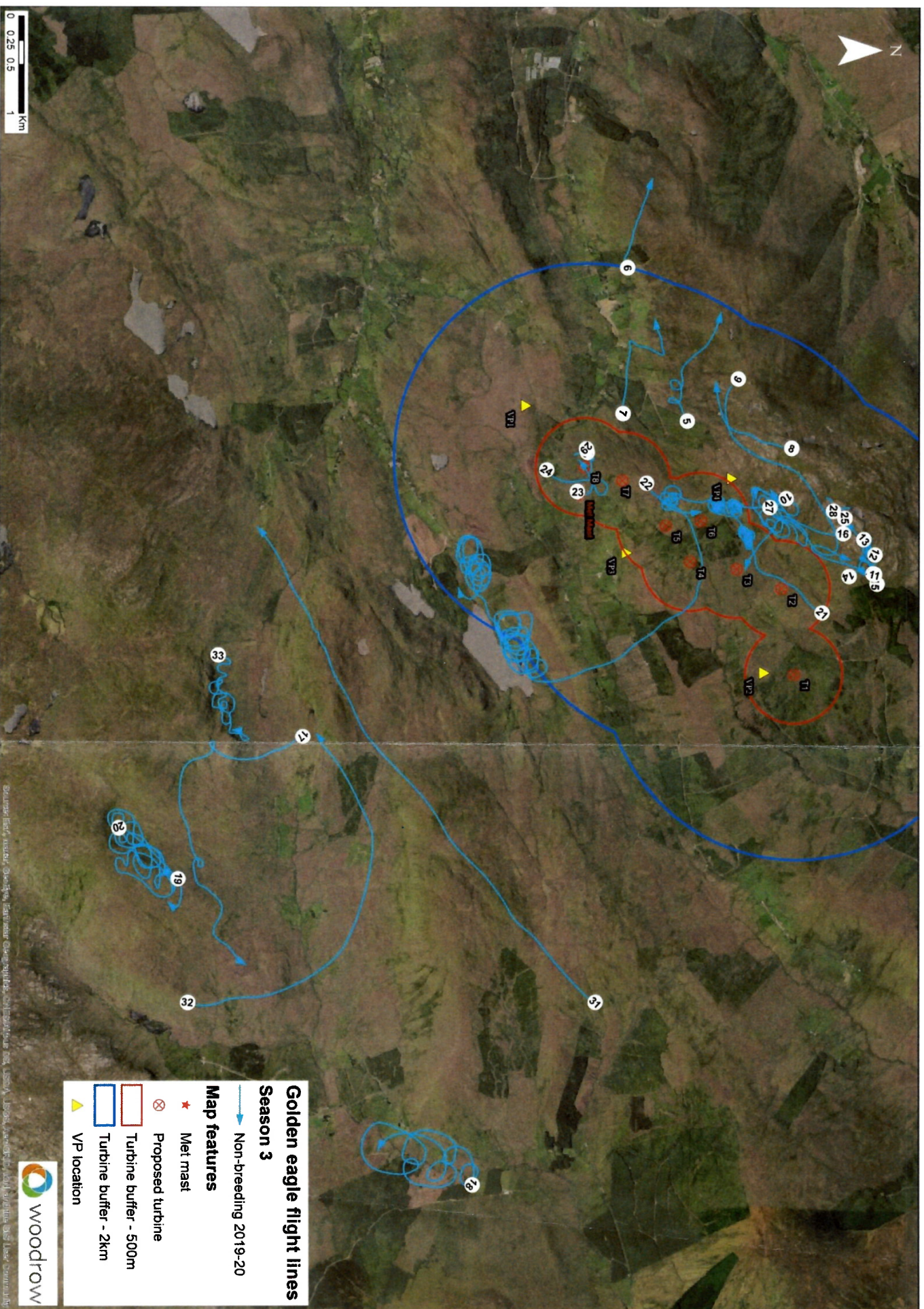


Figure 8 Flight-lines for golden eagle: Season 3 – wider view

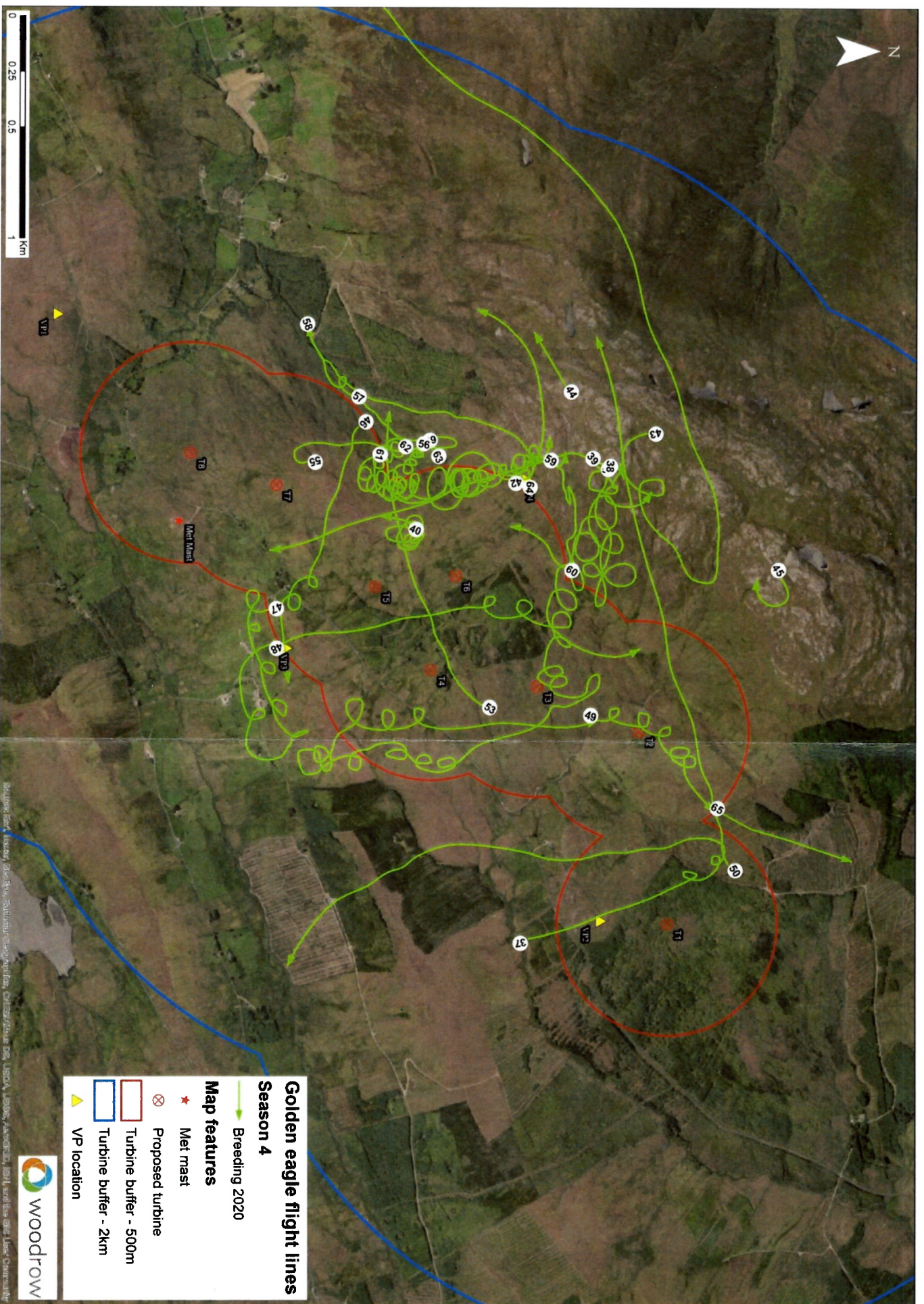


Figure 9 Flight-lines for golden eagle: Season 4 – breeding 2020

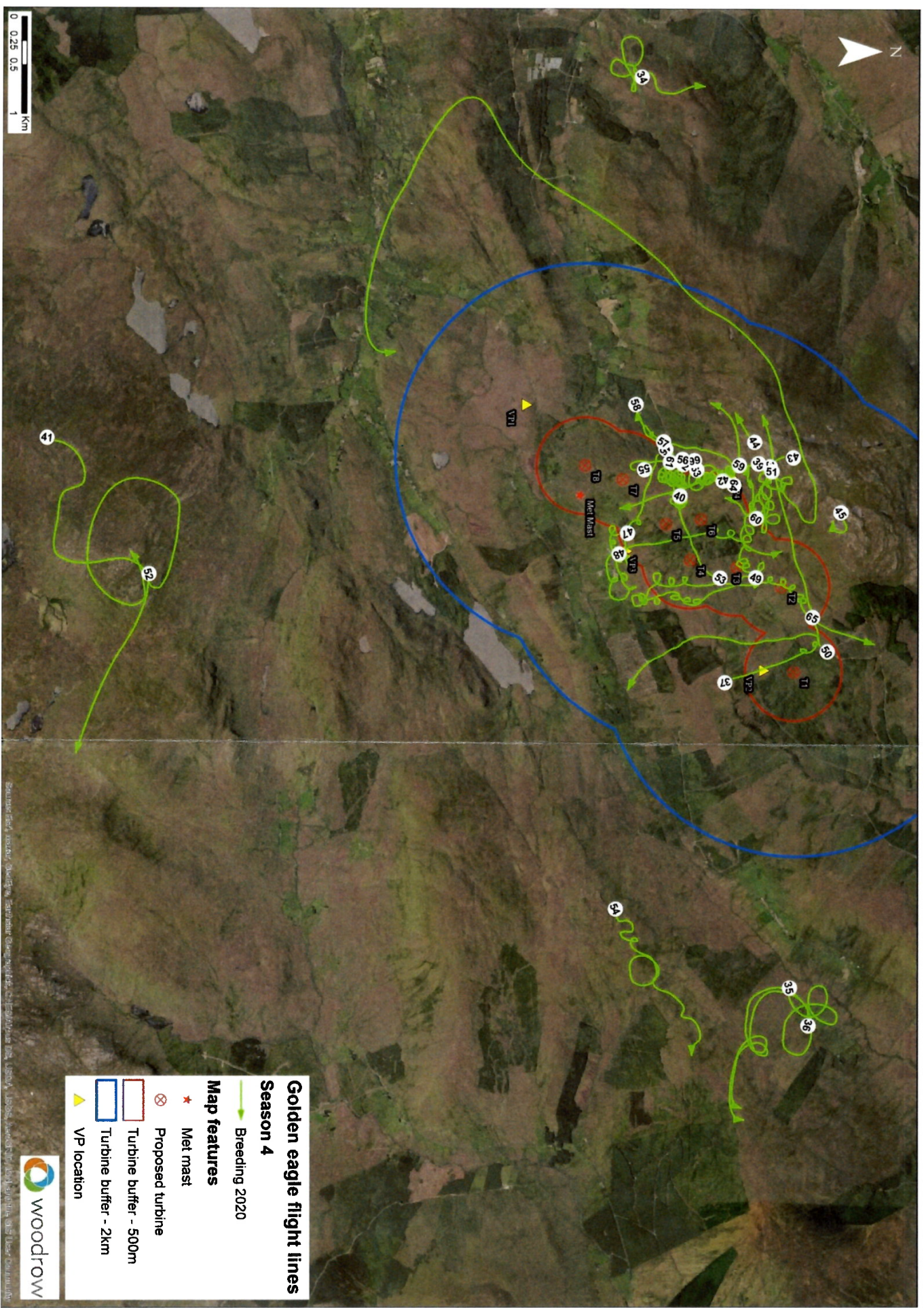


Figure 10 Flight-lines for golden eagle: Season 4 – wider view

Table 5 Flight line data for golden eagle

EA – golden eagle NOTE: Includes records of eagles observed beyond the 500m turbine buffer

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	01-Nov-18	1317	EA	1	80	40 to 80m	Commute		1st winter (poss. 2nd)
2	Non-breeding 2018-19	01-Nov-18	1323	EA	1	30	10 to 30m	Flying		1st winter (poss. 2nd)
3	Non-breeding 2018-19	19-Dec-18	1101	EA	1	30	c. 30m	Hunting		
4	Breeding 2019	10-Apr-19	1144	EA	1	180	c. 180m	Foraging		
5	Non-breeding 2019-20	05-Jan-20	1010	EA	2	50	50 to 0m	Flying		Adult
6	Non-breeding 2019-20	05-Jan-20	1032	EA	2	40	c. 40m	Flying		Adult
7	Non-breeding 2019-20	05-Jan-20	1054	EA	1	50	50-10-50m	Foraging		Juvenile
8	Non-breeding 2019-20	31-Dec-19	1434	EA	1	50	70 to 20m	Flying		Juvenile
9	Non-breeding 2019-20	31-Dec-19	1438	EA	1	40	40 to 0m	Fly-land		Juvenile
10	Non-breeding 2019-20	31-Dec-19	1510	EA	1	10	0 to 10m	Flying		Juvenile
11	Non-breeding 2019-20	09-Jan-20	1418	EA	1	6	4 to 6m	Flying		Adult
12	Non-breeding 2019-20	09-Jan-20	1420	EA	1	20	20 to 0m	Fly-land		Adult
13	Non-breeding 2019-20	09-Jan-20	1429	EA	1	3	3 to 0m	Fly-land		Adult
14	Non-breeding 2019-20	13-Feb-20	1440	EA	1	15	c. 15m	Flying	M	Adult
15	Non-breeding 2019-20	13-Feb-20	1442	EA	1	15	c. 15m	Flying	M	Adult
16	Non-breeding 2019-20	13-Feb-20	1444	EA	1	200	50 to 200m	Flying	M	Adult
17	Non-breeding 2019-20	13-Feb-20	1448	EA	1	200	200-250-180m	Flying	M	Adult
18	Non-breeding 2019-20	13-Feb-20	1508	EA	2	200	200 to 150m	Flying	M+F	Adult
19	Non-breeding 2019-20	27-Feb-20	1210	EA	1	150	50 to 250m	Display flight	M	Adult
20	Non-breeding 2019-20	27-Feb-20	1219	EA	2	150	100 to 250m	Display flight	M+F	Adult
21	Non-breeding 2019-20	31-Oct-19	1102	EA	1	40	10 to 80m	Foraging		Sub-adult
22	Non-breeding 2019-20	27-Nov-19	1307	EA	1	50	0-50-100-200m	Flying		Adult
23	Non-breeding 2019-20	05-Jan-20	1213	EA	1	50	50 to 10m	Foraging		Adult
24	Non-breeding 2019-20	05-Jan-20	1220	EA	1	40	c. 40m	Foraging		Adult
25	Non-breeding 2019-20	06-Feb-20	1534	EA	1	5	c. 5m	Flying		
26	Non-breeding 2019-20	06-Feb-20	1538	EA	1	80	30-80-220m	Flying	F	Adult
27	Non-breeding 2019-20	06-Feb-20	1540	EA	2	100	c. 100m	Display flight	M+F	Adult
28	Non-breeding 2019-20	06-Feb-20	1550	EA	1	15	15 to 12m	Fly-land		
29	Non-breeding 2019-20	17-Dec-19	1007	EA	1		na	Perched		
30	Non-breeding 2019-20	17-Dec-19	1020	EA	1	1	0 to 1m	Fly-land		

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
31	Non-breeding 2019-20	23-Feb-20	953	EA	1	200	200-150	Flying		
32	Non-breeding 2019-20	23-Feb-20	1438	EA	1	300	c. 300m	Flying		
33	Non-breeding 2019-20	23-Feb-20	1450	EA	1	60	60 to 20m	Display flight		
34	Breeding 2020	27-May-20	1346	EA	2		not rec	Flying	Pair	
35	Breeding 2020	27-May-20	1507	EA	1	250	250+m	Soaring		
36	Breeding 2020	27-May-20	1517	EA	2	400	400+m	Soaring		
37	Breeding 2020	24-Apr-20	1345	EA	1	300	300+m	Flying		Adult
38	Breeding 2020	28-May-20	942	EA	1	50	50 to 100m	Circling	M	Adult
39	Breeding 2020	28-May-20	1039	EA	1	100	50 to 100m	Circling	M	Adult
40	Breeding 2020	23-Jun-20	937	EA	1	50	40 to 50m	Circling	M	Adult
41	Breeding 2020	13-May-20	1639	EA	1		not rec	Soaring		
42	Breeding 2020	21-May-20	1134	EA	1	100	80-120m	Foraging		
43	Breeding 2020	21-May-20	1300	EA	1		not rec	Soaring		
44	Breeding 2020	11-Jul-20	948	EA	1	25	c. 25m	Flying		
45	Breeding 2020	24-Jul-20	811	EA	1	20	20 to 30m	Circled		
46	Breeding 2020	13-Aug-20	1318	EA	1	100	30-80-100m	Foraging	M	Sub-adult
47	Breeding 2020	13-Aug-20	1327	EA	1	120	100 to 150m	Circling	M	Sub-adult
48	Breeding 2020	13-Aug-20	1341	EA	1	180	100 to 200m	Fly-land	M	Sub-adult
49	Breeding 2020	13-Aug-20	1403	EA	1	10	c. 10m	Flying	M	Sub-adult
50	Breeding 2020	13-Aug-20	1409	EA	2	100	80-100m	Circling	M+F	Sub-adult (M) + Adult (F)
51	Breeding 2020	22-Apr-20	1225	EA	1	125	c. 125m	Soaring	M	
52	Breeding 2020	22-Apr-20	1731	EA	1		not rec	Flying		
53	Breeding 2020	28-Apr-20	1334	EA	1	100	50 to 100m	Flying		Adult
54	Breeding 2020	20-Jul-20	1809	EA	1		not rec	Fly-land		
55	Breeding 2020	24-Aug-20	1245	EA	1	145	120 to 150m	Foraging		
56	Breeding 2020	24-Aug-20		EA	1	25	150 to 25m	Foraging		
57	Breeding 2020	24-Aug-20		EA	2	100	25 to 100m	Foraging		
58	Breeding 2020	24-Aug-20	1255	EA	2	220	150 to 220m	Flying		
59	Breeding 2020	24-Aug-20		EA	1	50	150 to 50m	Flying		
60	Breeding 2020	24-Aug-20		EA	1	20	50 to 5m	Flying		
61	Breeding 2020	19-Aug-20	1415	EA	2	100	50 to 100m	Circling		Adult
62	Breeding 2020	19-Aug-20	1413	EA	1	100	20 to 100m	Circling		Adult

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
63	Breeding 2020	19-Aug-20	1541	EA	1	50	20 to 50m	Circling		Adult
64	Breeding 2020	19-Aug-20	1553	EA	1	50	20 to 50m	Circling		Adult
65	Breeding 2020	13-Aug-20	1403	EA	1					
66	Breeding 2020	24-Aug-20		EA	1	100	25 to 100m	Foraging		

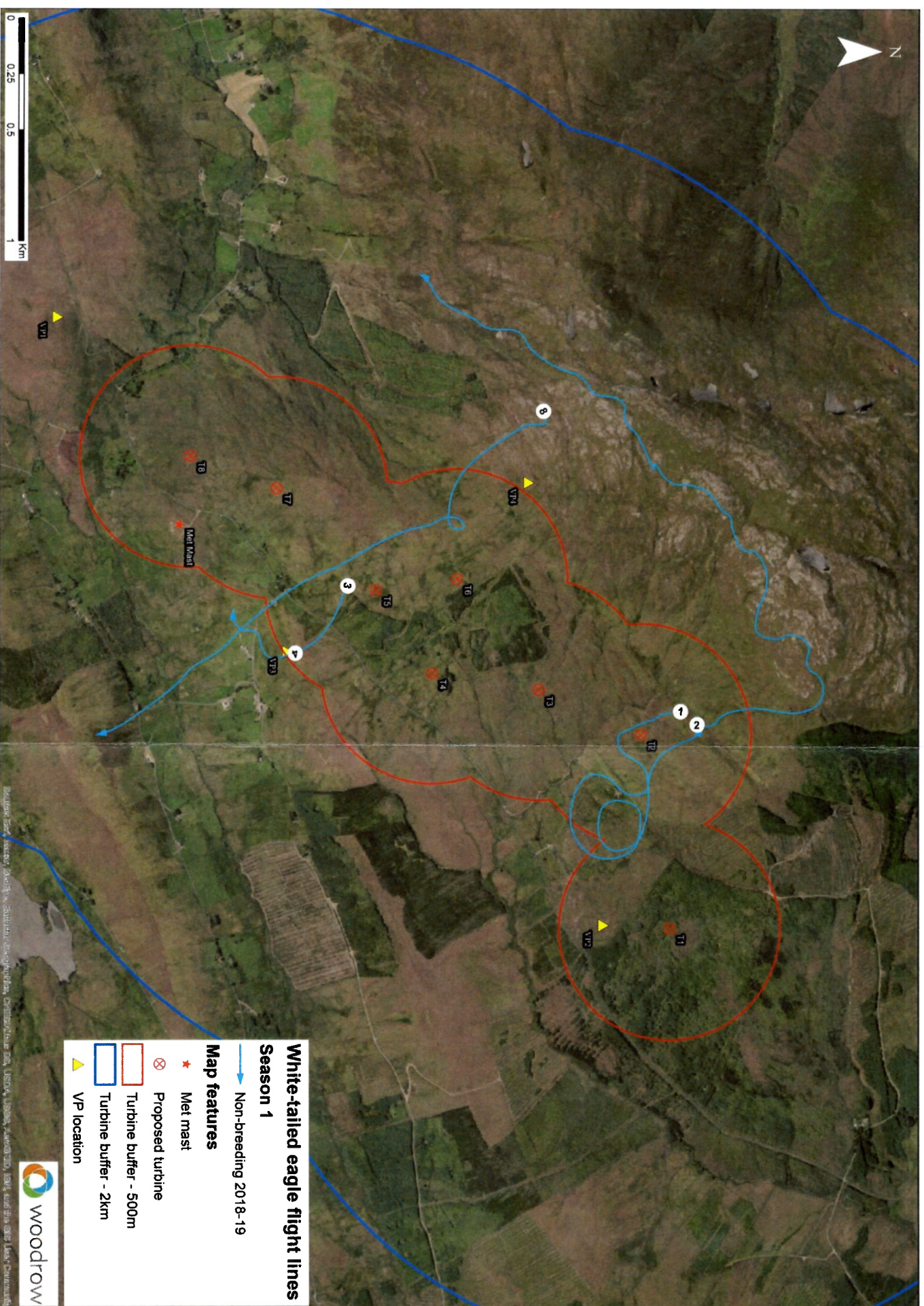


Figure 11 Flight-lines for white-tailed eagle: Season 1 – non-breeding 2018-19

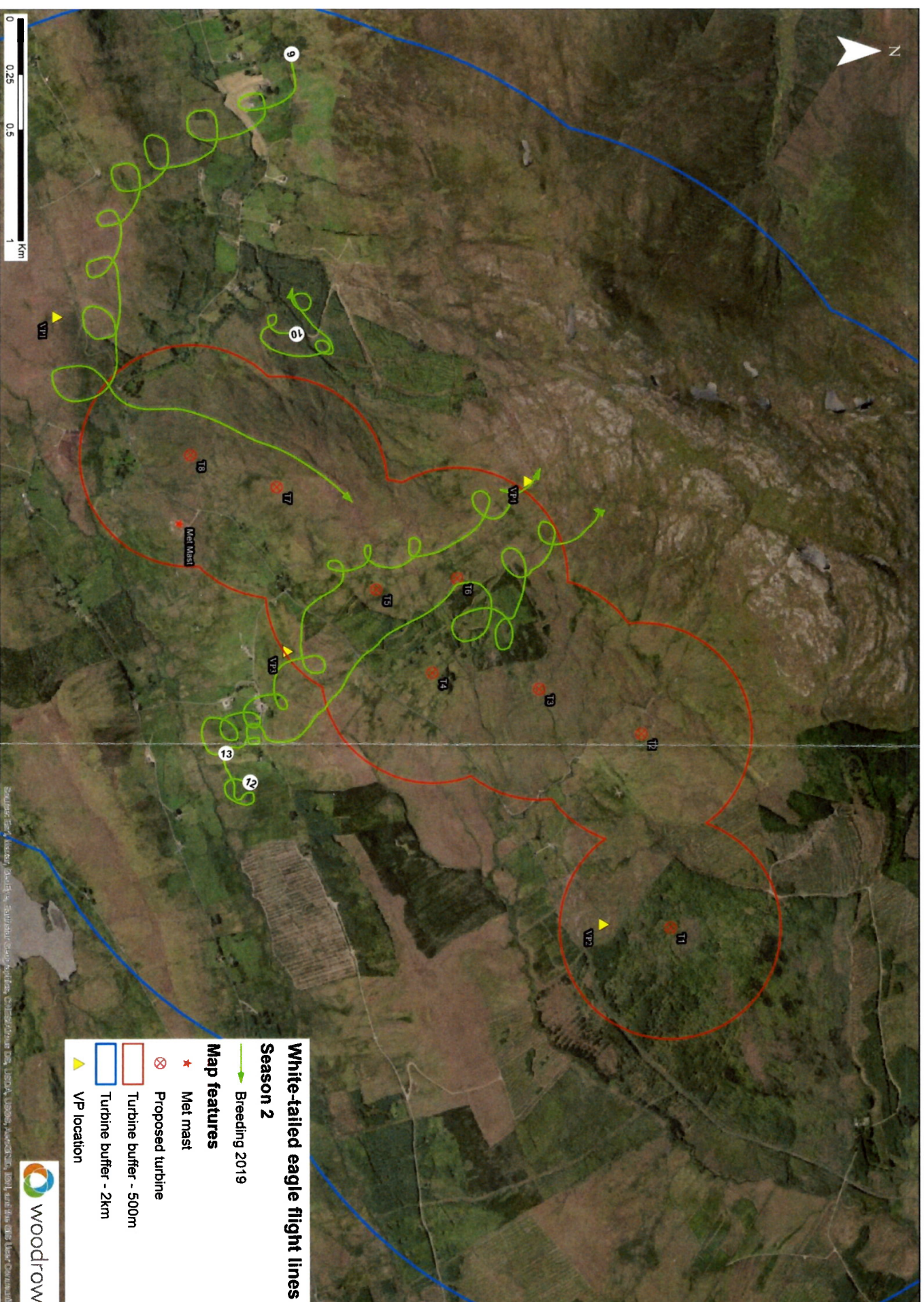


Figure 12 Flight-lines for white-tailed eagle: Season 2 – breeding 2019

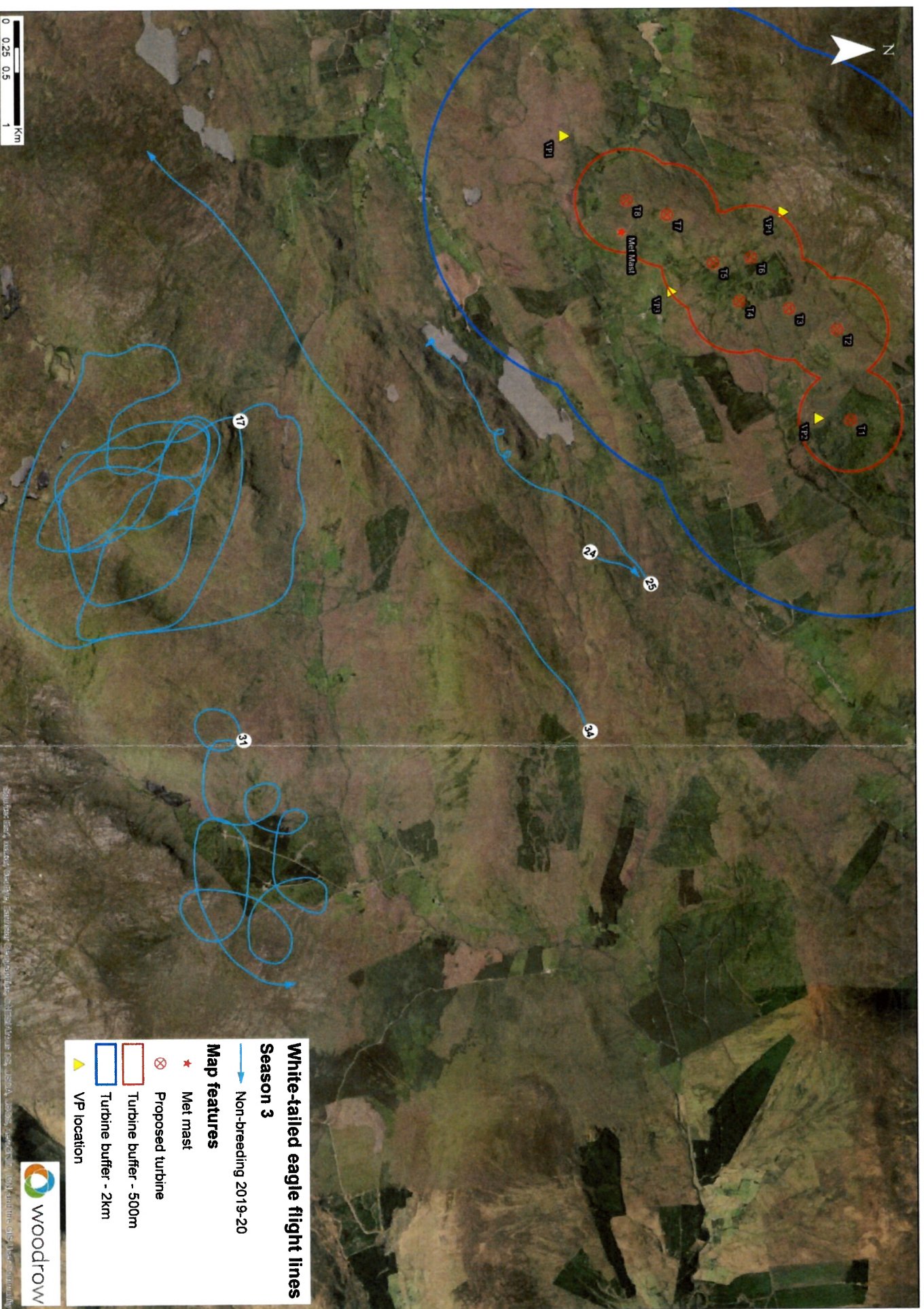


Figure 13 Flight-lines for white-tailed eagle: Season 3 – non-breeding 2019-20

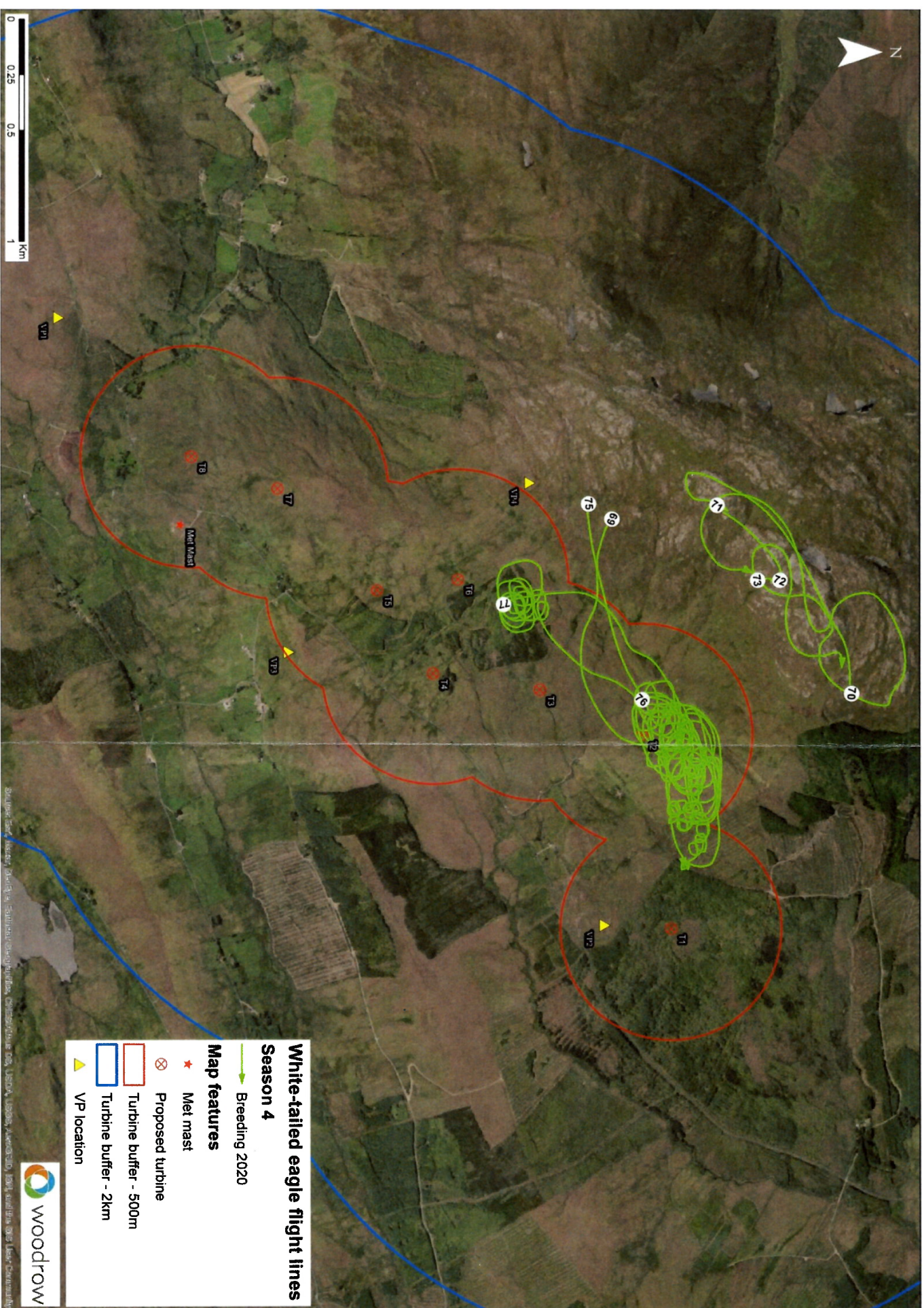


Figure 14 Flight-lines for white-tailed eagle: Season 4 – breeding 2020

Table 6 Flight line data for white-tailed eagle

WE – white-tailed eagle NOTE: Includes records of eagles observed beyond the 500m turbine buffer

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	30-Oct-18	1218	WE	1	80	40 to 80m	Flying		
2	Non-breeding 2018-19	30-Oct-18	1219	WE	1	100	30 to 100m	Flying		
3	Non-breeding 2018-19	20-Mar-19	1255	WE	1	200	200 to 150m	Commute	F	Adult - Aidibheall
4	Non-breeding 2018-19	20-Mar-19	1255	WE	1	100	150 to 100m	Commute	F	Adult - Aidibheall
8	Non-breeding 2018-19	21-Mar-19	1656	WE	1	120	120-100-70-50-80m	Flying		
9	Breeding 2019	18-May-19	1145	WE	1	50	40 to 50m	Hunting/ commute		
10	Breeding 2019	27-Mar-19	1035	WE	1	20	c. 20m	Flying		
12	Breeding 2019	10-Apr-19	1449	WE	1	300	300 to 200m	Commute - circling		
13	Breeding 2019	10-Apr-19	1516	WE	1	300	150 to 300m	Commute - circling		Sub-adult
17	Non-breeding 2019-20	27-Feb-20	1535	WE	2	200	10 to 300m	Soaring		Sub-adult + Adult
24	Non-breeding 2019-20	13-Feb-20	1417	WE	1	100	100 to 0m	Fly-land		Adult – tagged bird
25	Non-breeding 2019-20	13-Feb-20	1426	WE	1	100	0-100-20m	Flying		Adult
31	Non-breeding 2019-20	13-Feb-20	1513	WE	1	300	300 to 0m	Flying		Adult
34	Non-breeding 2019-20	27-Feb-20	1257	WE	1	30	100 to 15m	Flying		Adult
66*	Breeding 2020	22-Apr-20	1352	WE	1		not rec	Flying		
69	Breeding 2020	28-Apr-20	1341	WE	1	100	50 to 100m	Fly-land		Immature
70	Breeding 2020	21-May-20	1557	WE	1	80	c. 80m	Flying		Sub-adult
71	Breeding 2020	21-May-20	1558	WE	1	80	c. 80m	Flying		Sub-adult
72	Breeding 2020	21-May-20	1600	WE	1	100	100 to 150m	Flying		Sub-adult
73	Breeding 2020	21-May-20	1625	WE	1	100	c. 100m	Flying		Sub-adult
75	Breeding 2020	29-Apr-20	920	WE	1	100	50 to 180m	Fly-land	F?	Immature
76	Breeding 2020	29-Apr-20	954	WE	1	100	50 to 180m	Fly-land	F?	Immature
77	Breeding 2020	29-Apr-20	959	WE	1	100	50 to 180m	Fly-land	F?	Immature

*Obs. 66 not shown on map – recorded beyond the 2 km turbine buffer over Lavagh More (Blue Stacks) 54.756, -8.081

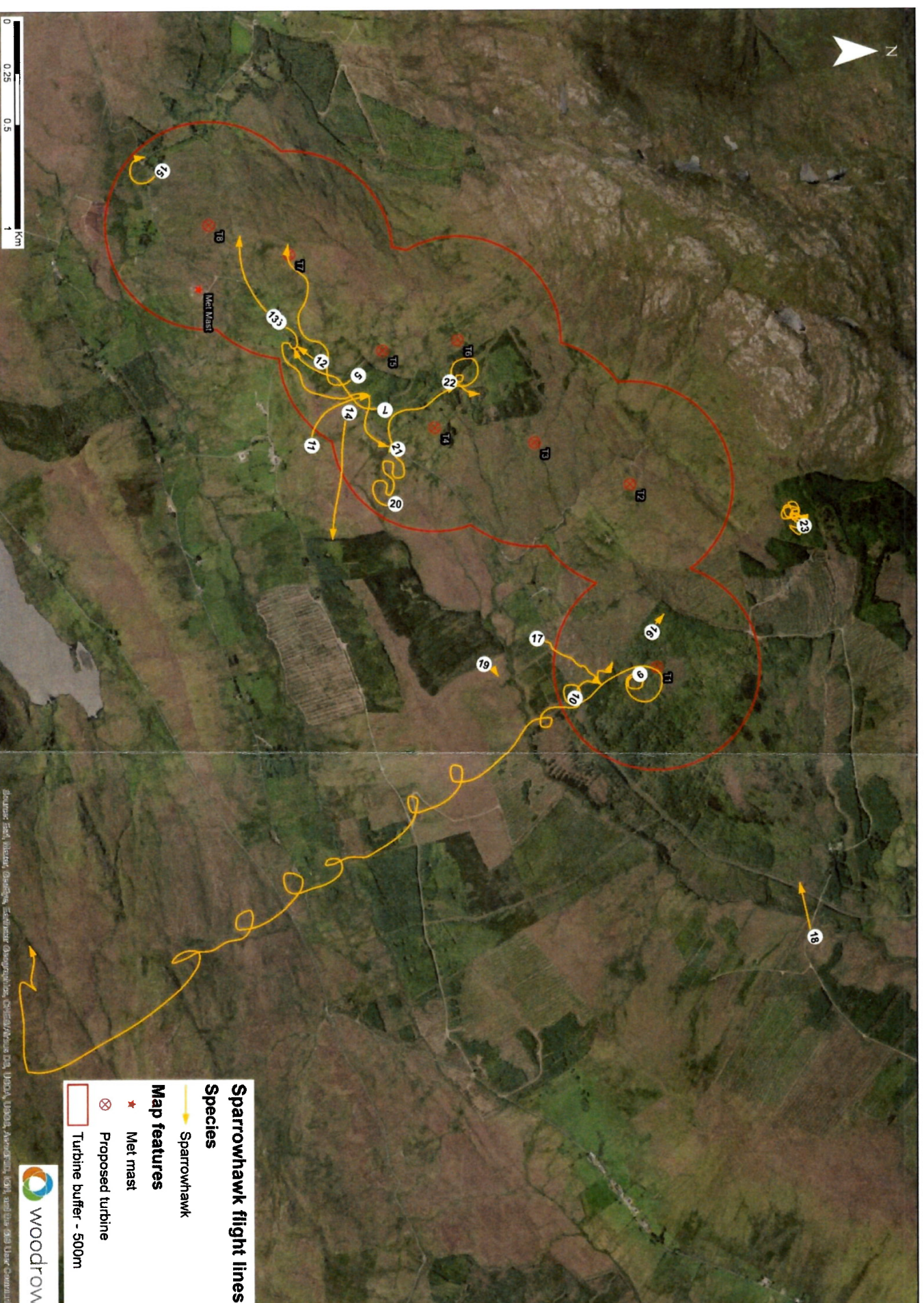


Figure 15 Flight-lines for sparrowhawk: Oct-2018 to Aug-2020

Table 7 Flight line data for sparrowhawk

SH – sparrow hawk

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
5	Breeding 2019	27-Mar-19	1149	SH	1	20	c. 20m	Hunting	F	
6	Breeding 2019	02-Jul-19	1446	SH	1	5	1 to 5m	Flying		
7	Breeding 2019	03-Sep-19	1238	SH	1	3	1 to 3m	Hunting	F	
9	Non-breeding 2019-20	27-Feb-20	1125	SH	1	100	20 to 200m	Display flight	M	Adult
10	Non-breeding 2019-20	03-Mar-20	1412	SH	1		not rec	Hunting		
11	Non-breeding 2019-20	29-Oct-19	1332	SH	1	10	>10m	Flying	M	Adult
12	Non-breeding 2019-20	17-Dec-19	1347	SH	1	3	1 to 3m	Flying	F	Juvenile
13	Non-breeding 2019-20	17-Dec-19	1354	SH	1	3	3 to 1m	Hunting	F	Juvenile
14	Non-breeding 2019-20	06-Feb-20	1345	SH	1	30	30 to 5m	Flying	M	Adult
15	Breeding 2020	08-Jul-20	1828	SH	1	20	10 to 20m	Hunting	M	Adult
16	Breeding 2020	21-Apr-20	1003	SH	1	8	c. 8m	Aggressive	M	Adult
17	Breeding 2020	21-Apr-20	805	SH	1		na	Flying		
18	Breeding 2020	04-Jun-20	1215	SH	1		na	Flying		
19	Breeding 2020	23-Jun-20	1006	SH	1	10	0 to 10m	Fly-land	M	Adult
20	Breeding 2020	21-May-20	1125	SH	1	40	30 to 50m	Hunting	F	Adult
21	Breeding 2020	21-May-20		SH	1	20	50 to 20m	Hunting	F	Adult
22	Breeding 2020	21-May-20		SH	1	200	20 to 200m	Ascending	F	Adult
23	Breeding 2020	24-Jul-20	757	SH	1	30	20 to 40m	Mobbing		

Table 8 Flight line data for kestrel

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	19-Nov-18	1416	K	1	10	c. 10m	Flying		
2	Non-breeding 2018-19	19-Nov-18	1418	K	2	5	c. 5m	Flying		
3	Non-breeding 2018-19	30-Oct-18	1539	K	1	60	30 to 60m	Hunting		
4	Non-breeding 2018-19	01-Nov-18	1247	K	1	30	20 to 30m	Flying		
5	Non-breeding 2018-19	19-Dec-18	1141	K	1	30	c. 30m	Hunting		
6	Breeding 2019	10-Apr-19	1242	K	1	40	c. 40m	Foraging		
7	Breeding 2019	08-Aug-19	1239	K	1	40	20 to 40m	Hunting	F	
8	Breeding 2019	08-Aug-19	1244	K	1	30	20 to 30m	Hunting	M	
9	Breeding 2019	08-Aug-19	1414	K	1	15	c. 15m	Hunting		
10	Non-breeding 2019-20	07-Dec-19	1328	K	1	15	15-0	Fly-land	M	Adult
11	Non-breeding 2019-20	07-Dec-19	1330	K	1	15	c. 15m	Flying	M	Adult
12	Non-breeding 2019-20	27-Feb-20	1620	K	1	25	25 to 0m	Flying	M	Adult
13	Non-breeding 2019-20	03-Mar-20	1007	K	1	100	100 to 50m	Hunting	F	
14	Non-breeding 2019-20	03-Mar-20	1011	K	1	30	10 to 30m	Hunting	F	
15	Non-breeding 2019-20	27-Oct-19	1420	K	1	50	5 to 30m	Hunting	M	
16	Non-breeding 2019-20	15-Dec-19	1016	K/SH	1	90	90 to 60m	Flying		
17	Non-breeding 2019-20	31-Dec-19	1253	K	1	30	30 to 15m	Flying	M	Adult
18	Non-breeding 2019-20	09-Jan-20	1409	K	1	20	c. 20m	Flying		
19	Non-breeding 2019-20	09-Jan-20	1412	K	1	4	4 to 3m	Fly-land		
20	Non-breeding 2019-20	09-Jan-20	1414	K	1	4	4 to 0m	Fly-land		
21	Non-breeding 2019-20	29-Oct-19	1522	K	1	30	10 to 30m	Hunting	M	Adult
22	Non-breeding 2019-20	31-Oct-19	1100	K	1	10	0 to 10m	Fly-land		
23	Non-breeding 2019-20	27-Nov-19	1438	K	1	50	50 to 5m	Flying		
24	Non-breeding 2019-20	09-Dec-19	1449	K	1	35	30 to 10m	Hunting		
25	Non-breeding 2019-20	09-Dec-19	1450	K	1	30	30 to 10m	Hunting		
26	Non-breeding 2019-20	17-Jan-20	1350	K/SH	1	100	140-80-80-15m	Display flight		
27	Non-breeding 2019-20	06-Feb-20	1355	K	1	100	100 to 5m	Hunting		
28	Non-breeding 2019-20	06-Feb-20	1453	K	1	40	40 to 200m	Hunting		
29	Non-breeding 2019-20	06-Feb-20	1454	K	1	200	200 to 150m	Hunting		
30	Non-breeding 2019-20	29-Oct-19	904	K	1	30	10 to 40m	Hunting	M	Adult

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
31	Non-breeding 2019-20	31-Oct-19	1432	K	1	40	10 to 50m	Hunting	F	
32	Non-breeding 2019-20	23-Feb-20	1456	K	1	100	c. 100m	Flying		
33	Breeding 2020	24-Apr-20	1529	K	1	2	c. 2m	Flying		
34	Breeding 2020	24-Apr-20	1532	K	1	2	c. 2m	Fly-land		
35	Breeding 2020	24-Apr-20	1536	K	1	40	5 to 50m	Flying		
36	Breeding 2020	24-Apr-20	1558	K	1	150	10 to 300m	Flying		
37	Breeding 2020	13-May-20	1223	K	1	80	c. 80m	Hunting		
38	Breeding 2020	13-May-20	1232	K	1	100	c. 100m	Hunting		
39	Breeding 2020	13-May-20	1313	K	1		na	Nest		
40	Breeding 2020	16-May-20	811	K	1	30	30 to 40m	Flying		
41	Breeding 2020	27-May-20	1449	K	1	140	c. 140m	Flying		
42	Breeding 2020	27-May-20		K	1	50	50 to 10m	Hunting		
43	Breeding 2020	27-May-20		K	1	90	90 to 120m	Hunting		
44	Breeding 2020	27-May-20		K	1	120	c. 120m	Flying		
45	Breeding 2020	27-May-20		K	1	200	200+-m	Circling		
46	Breeding 2020	27-May-20	1531	K	1	40	40 to 25m	Flying		
47	Breeding 2020	27-May-20	1610	K	1	40	c. 40m	Flying		
48	Breeding 2020	27-May-20		K	1	40	c. 40m	Hunting		
49	Breeding 2020	27-May-20		K	1	50	50 to 80m	Hunting		
50	Breeding 2020	27-May-20		K	1	150	80 to 150m	Hunting		
51	Breeding 2020	27-May-20		K	1	150	c. 150m	Hunting		
52	Breeding 2020	04-Jun-20	1624	K	1	4	c. 4m	Fly-land		
53	Breeding 2020	29-Apr-20	950	K	1	50	50 to 75m	Hunting	M	Adult
54	Breeding 2020	13-May-20	1618	K	1	250	c. 250m	Circling		
55	Breeding 2020	13-Aug-20	1209	K	1	20	c. 20m	Hunting	M	Adult
56	Breeding 2020	13-Aug-20	1210	K	1	50	50 to 40m	Circling	M	Adult
57	Breeding 2020	21-May-20	1628	K	1	30	c. 30m	Hunting		
58	Breeding 2020	21-May-20	1630	K	1	40	c. 40m	Hunting		
59	Breeding 2020	21-May-20	1636	K	1	60	c. 60m	Flying		
60	Breeding 2020	12-Aug-20	1156	K	2	120	20 to 50m	Hunting		Juvenile
61	Breeding 2020	12-Aug-20		K	2	200	150 to 200m	Circling		Juvenile
62	Breeding 2020	12-Aug-20		K	2	40	150 to 40m	Flying		

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
63	Breeding 2020	24-Aug-20	1032	K	1	30	c. 30m	Flying		
64	Breeding 2020	24-Aug-20	1152	K	1	80	70 to 80m	Circling		
65	Breeding 2020	24-Aug-20	1213	K	2	10	4 to 10m	Flying		
66	Breeding 2020	24-Aug-20	1213	K	1	20	4 to 20m	Hunting		

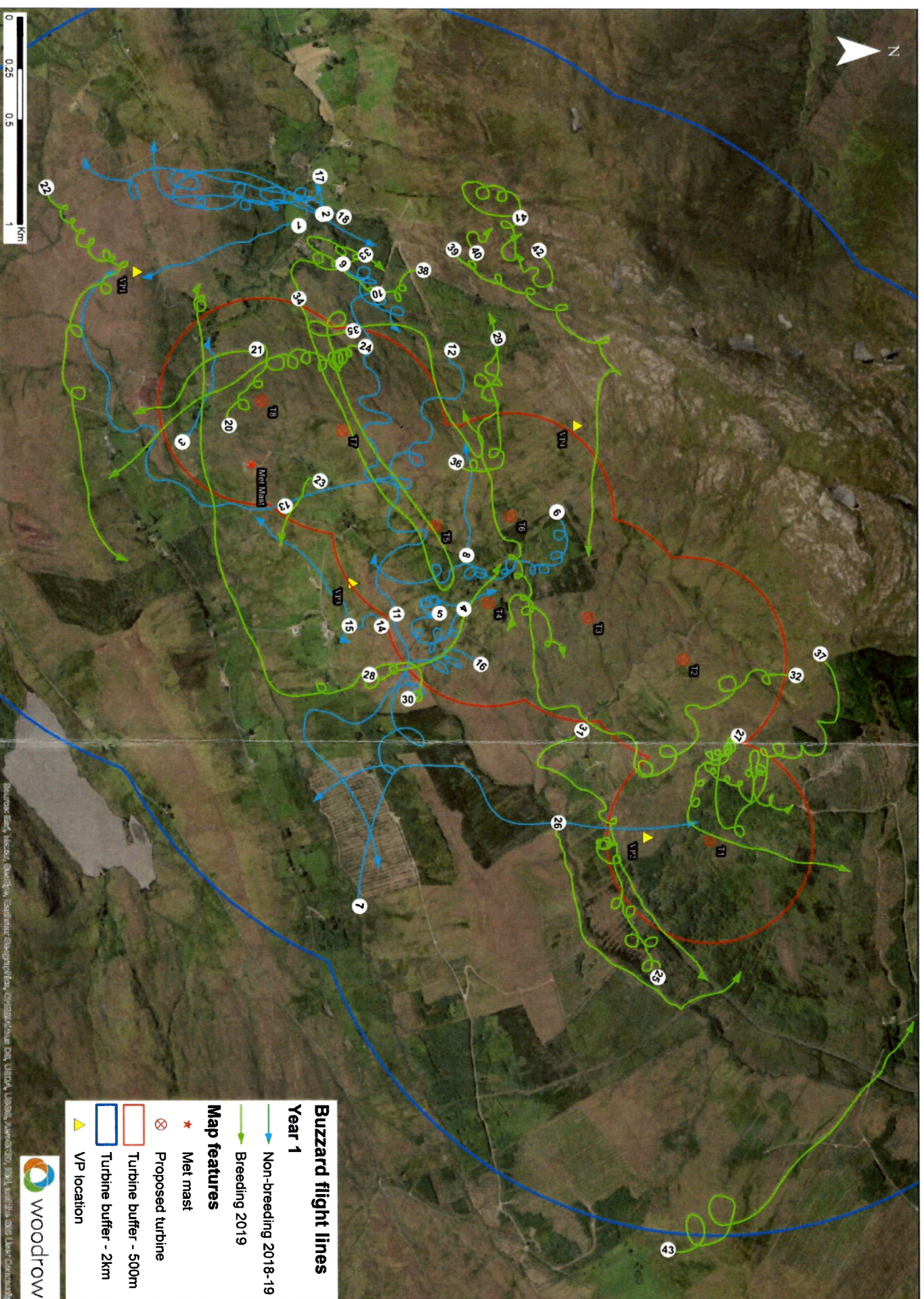


Figure 18 Flight-lines for buzzard: Year 1 - Oct-2018 to Aug-2019

Table 9 Flight data for buzzard
BZ – buzzard

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	23-Nov-18	843	BZ	1	10	c. 10m	Flying		
2	Non-breeding 2018-19	10-Jan-19	1341	BZ	1	10	c. 10m	Flying		
3	Non-breeding 2018-19	05-Feb-19	1000	BZ	1	40	c. 40m	Hunting		
4	Non-breeding 2018-19	19-Nov-18	824	BZ	1	30	c. 30m	Flying		
5	Non-breeding 2018-19	19-Nov-18	1021	BZ	1	20	20 to 10m	Flying		
6	Non-breeding 2018-19	19-Nov-18	1521	BZ	1	40	10-40-10m	Flying		
7	Non-breeding 2018-19	20-Nov-18	859	BZ	1	40	40-30-10m	Flying		
8	Non-breeding 2018-19	18-Dec-18	1311	BZ	1	2	c. 2m	Fly-land		
9	Non-breeding 2018-19	01-Mar-19	1039	BZ	1	30	c. 30m	Soaring		
10	Non-breeding 2018-19	01-Mar-19	1121	BZ	1	100	80 to 100m	Soaring		
11	Non-breeding 2018-19	01-Mar-19	1122	BZ	1	120	100 to 120m	Soaring		
12	Non-breeding 2018-19	01-Mar-19	1057	BZ	1	80	c. 80m	Soaring/ flying	M	
13	Non-breeding 2018-19	01-Mar-19	1100	BZ	2	70	c. 70m	Flying	M+F	
14	Non-breeding 2018-19	20-Mar-19	1028	BZ	1	40	c. 40m	Hunting		
15	Non-breeding 2018-19	20-Mar-19	1207	BZ	2	125	c. 125m	Flying	Pair	
16	Non-breeding 2018-19	21-Mar-19	1617	BZ	1	120	100-120-80-30m	Soaring		
17	Non-breeding 2018-19	21-Mar-19	1633	BZ	1	100	100 to 30m	Soaring		
18	Non-breeding 2018-19	21-Mar-19	1641	BZ	1	120	30 to 120m	Soaring		
19	Non-breeding 2018-19	21-Mar-19	1642	BZ	1	120	30 to 120m	Soaring		
20	Breeding 2019	20-Mar-19	1443	BZ	1	80	80 to 150m	Flying		
21	Breeding 2019	20-Mar-19	1443	BZ	1	150	c. 150m	Flying		
22	Breeding 2019	17-Apr-19	1542	BZ	2	20	10 to 20m	Soaring/ hunting	Pair	
23	Breeding 2019	09-May-19	1240	BZ	1	20	c. 20m	Flushed		
24	Breeding 2019	16-Jul-19	1043	BZ	1	120	50 to 120m	Soaring		
25	Breeding 2019	27-Mar-19	1615	BZ	1	20	c. 20m	Hunting		
26	Breeding 2019	17-May-19	1056	BZ	1	2	c. 2m	Fly-calling		
27	Breeding 2019	07-Jun-19	901	BZ	1	70	40-70-20m	Hunting		
28	Breeding 2019	27-Mar-19	1045	BZ	1	10	c. 10m	Flying		
29	Breeding 2019	10-Apr-19	1139	BZ	1	120	c. 120m	Foraging		
30	Breeding 2019	10-Apr-19	1244	BZ	1	80	80-20-80-40m	Foraging		

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
31	Breeding 2019	10-Apr-19	1253	BZ	1	120	120 to 50m	Foraging		
32	Breeding 2019	10-Apr-19	1341	BZ	1	40	40 to 20m	Foraging		
33	Breeding 2019	10-Apr-19	1420	BZ	1	80	80 to 30m	Foraging		
34	Breeding 2019	10-Apr-19	1420	BZ	1	80	80 to 30m	Foraging		
35	Breeding 2019	10-Apr-19	1442	BZ	1	120	30 to 120m	Foraging		
36	Breeding 2019	10-Apr-19	1514	BZ	1	80	c. 80m	Foraging		
37	Breeding 2019	07-Jun-19	1100	BZ	1	200	20-50-200	Flying		
38	Breeding 2019	07-Jun-19	1114	BZ	1	20	5 to 20m	Flying		
39	Breeding 2019	07-Jun-19	1226	BZ	2	50	40 to 50m	Flying		
40	Breeding 2019	11-Apr-19	1348	BZ	1	40	c. 40m	Foraging		
41	Breeding 2019	11-Apr-19	1333	BZ	1	50	c. 50m	Foraging		
42	Breeding 2019	14-Jun-19	1351	BZ	1	25	c. 25m	Circling		
43	Breeding 2019	25-Jun-19	1711	BZ	1	100	c. 100m	Soaring		
44	Non-breeding 2019-20	07-Dec-19	1307	BZ	1	30	30 to 15m	Flying		
45	Non-breeding 2019-20	05-Jan-20	1032	BZ	1		na	Calling		
46	Non-breeding 2019-20	13-Feb-20	1240	BZ	1		na	Flying		
47	Non-breeding 2019-20	31-Oct-19	904	BZ	1	40	30 to 40m	Circling		
48	Non-breeding 2019-20	05-Jan-20	1409	BZ	1	4	4 to 0m	Fly-land		
49	Non-breeding 2019-20	05-Jan-20	1412	BZ	1	50	0-20-50-100-40-3m	Foraging		
50	Non-breeding 2019-20	05-Jan-20	1434	BZ	1	50	15 to 50m	Flying		
51	Non-breeding 2019-20	17-Jan-20	1504	BZ	1	20	c. 20m	Flying		
52	Non-breeding 2019-20	17-Jan-20	1524	BZ	1		not rec	Flying		
53	Non-breeding 2019-20	06-Feb-20	1308	BZ	1	200	180 to 200m	Circling		
54	Non-breeding 2019-20	17-Oct-19	815	BZ	1		na	Flying		
55	Non-breeding 2019-20	23-Feb-20	1121	BZ	1	60	c. 60m	Hunting		
56	Non-breeding 2019-20	23-Feb-20	1131	BZ	2	100	60-50-2-100m	Display flight	Pair	
57	Non-breeding 2019-20	23-Feb-20	1139	BZ	2	200	100 to 200m	Flying	Pair	
58	Breeding 2020	22-Apr-20	1033	BZ	1	30	30 to 20m	Flying		
59	Breeding 2020	24-Apr-20	1623	BZ	1	80	30-80-150m	Flying		
60	Breeding 2020	13-May-20	1014	BZ	2		not rec	Hunting		
61	Breeding 2020	13-May-20	1108	BZ	1	80	c. 80m	Hunting		
62	Breeding 2020	13-May-20	1136	BZ	1	60	c. 60m	Hunting		

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
63	Breeding 2020	27-May-20	1537	BZ	1		not rec	Flying		
64	Breeding 2020	08-Jul-20	1806	BZ	1	50	50 to 100m	Circling		Adult
65	Breeding 2020	21-Apr-20	1205	BZ	1	200	c. 200m	Flying		
66	Breeding 2020	21-Apr-20	1410	BZ	1		not rec	Flying		
67	Breeding 2020	21-Apr-20	1430	BZ	1	120	200-120-120m	Foraging		
68	Breeding 2020	29-Apr-20	1034	BZ	1	100	50 to 100m	Hunting		Adult
69	Breeding 2020	13-May-20	1452	BZ	1	200	not rec	Hunting		
70	Breeding 2020	13-May-20	1500	BZ	1		not rec	Hunting		
71	Breeding 2020	13-May-20	1724	BZ	1	60	60 to 20m	Hunting		
72	Breeding 2020	21-May-20	1133	BZ	2	20	20-4-30m	Hunting		
73	Breeding 2020	21-May-20	1134	BZ	1	50	30-50-70m	Hunting		
74	Breeding 2020	21-May-20	1134	BZ	1		not rec	Flying		
75	Breeding 2020	21-May-20	1227	BZ	1	60	60 to 25m	Flying		
76	Breeding 2020	11-Jul-20	1002	BZ	1	150	c. 150m	Circling		
77	Breeding 2020	11-Jul-20	1152	BZ	2		not rec	Circling		
78	Breeding 2020	22-Apr-20	1255	BZ	1	80	80 to 40m	Hunting		
79	Breeding 2020	21-May-20	1644	BZ	1	100	100 to 150m	Hunting		
80	Breeding 2020	24-Aug-20	1217	BZ	1		na	Calling		
81	Breeding 2020	19-Aug-20	829	BZ	1	50	20 to 50m	circling		Adult

Table 10 Flight data for other raptors – hen harriers and peregrines
HH – hen harrier and PE - peregrine

Flight ID	Season	Date	Time	BTO Code	No. of birds	Height (m)	Range – Flight height	Behaviour	Sex	Age
1	Non-breeding 2018-19	11-Dec-18	1054	HH	1	5	c. 5m	Hunting	F	Ringtail
2	Non-breeding 2018-19	11-Dec-18	1152	HH	1	50	20-50-10m	Hunting	F	Ringtail
3	Non-breeding 2018-19	11-Dec-18	1200	HH	1	20	20 to 10m	Hunting	F	Ringtail
4	Breeding 2019	02-Jul-19	904	PE	1	2	1 to 2m	Fly-land		
5	Non-breeding 2019-20	13-Feb-20	1352	PE	1	12	c. 12m	Flying	M	Adult
6	Breeding 2020	24-Aug-20	1202	HH	1	8	10 to 6m	Flying	M	
7	Breeding 2020	24-Aug-20	1236	HH	1	3	4 to 1m	Hunting	M	
8	Breeding 2020	24-Aug-20	950	HH	1		na		M	
9	Breeding 2020	19-Aug-20	1213	HH	1	20	5 to 20m	Commute	M	Sub-adult

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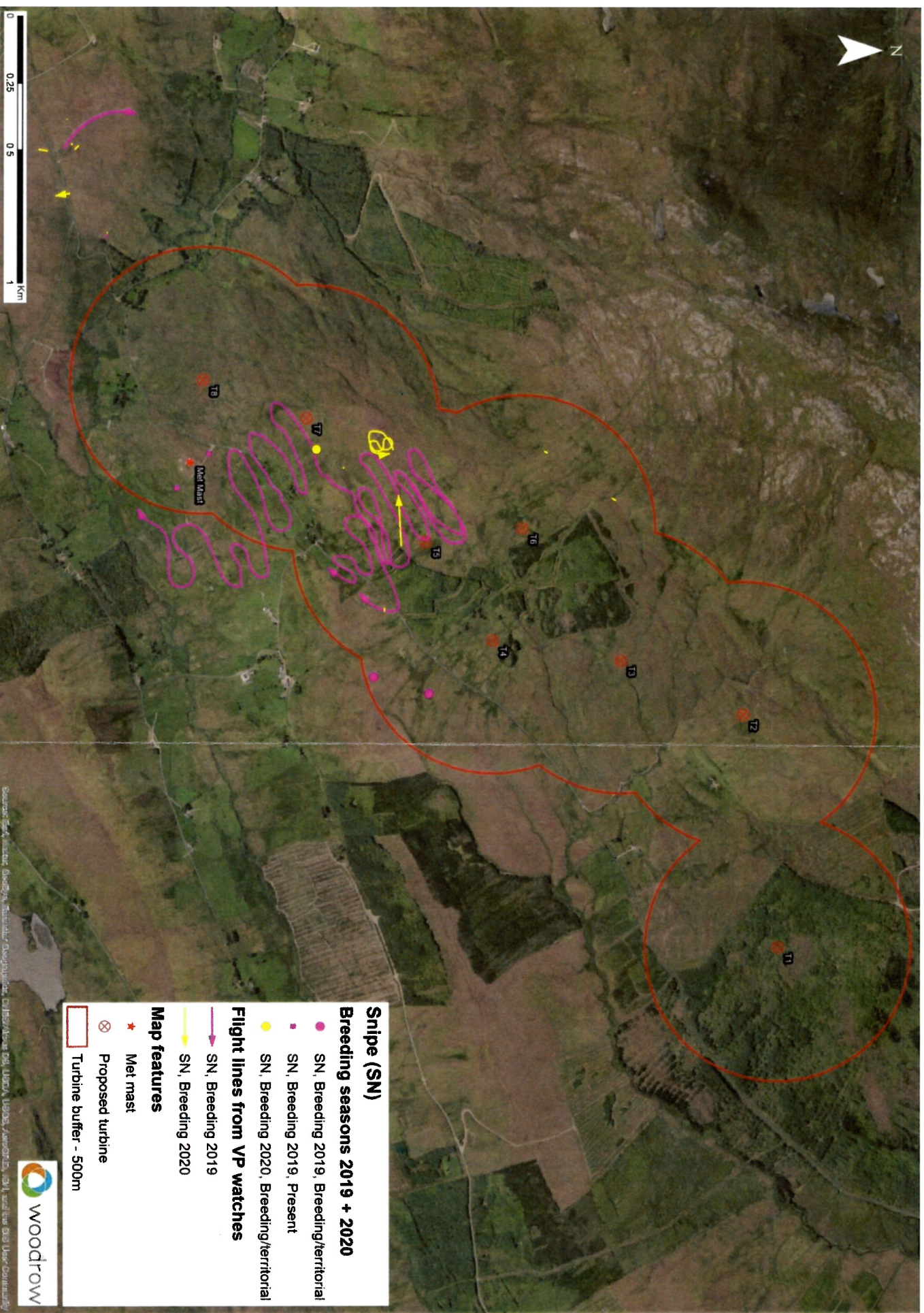


Figure 2. Snipe breeding season records (2019 and 2020), including data from VP watches

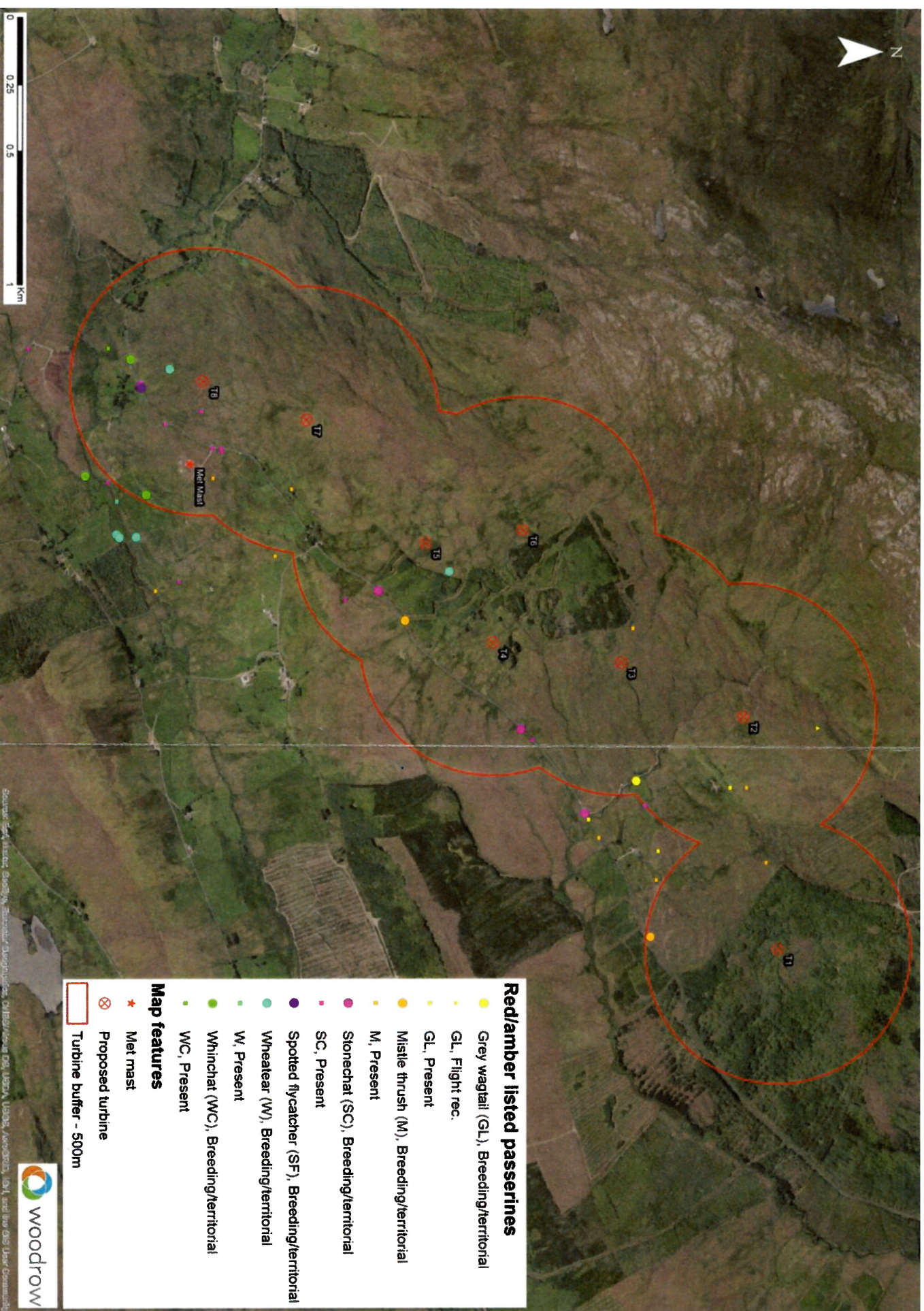


Figure 4. Composite map of selected (red & amber) breeding species (2018 & 2019) – chats, thrushes & grey wagtail

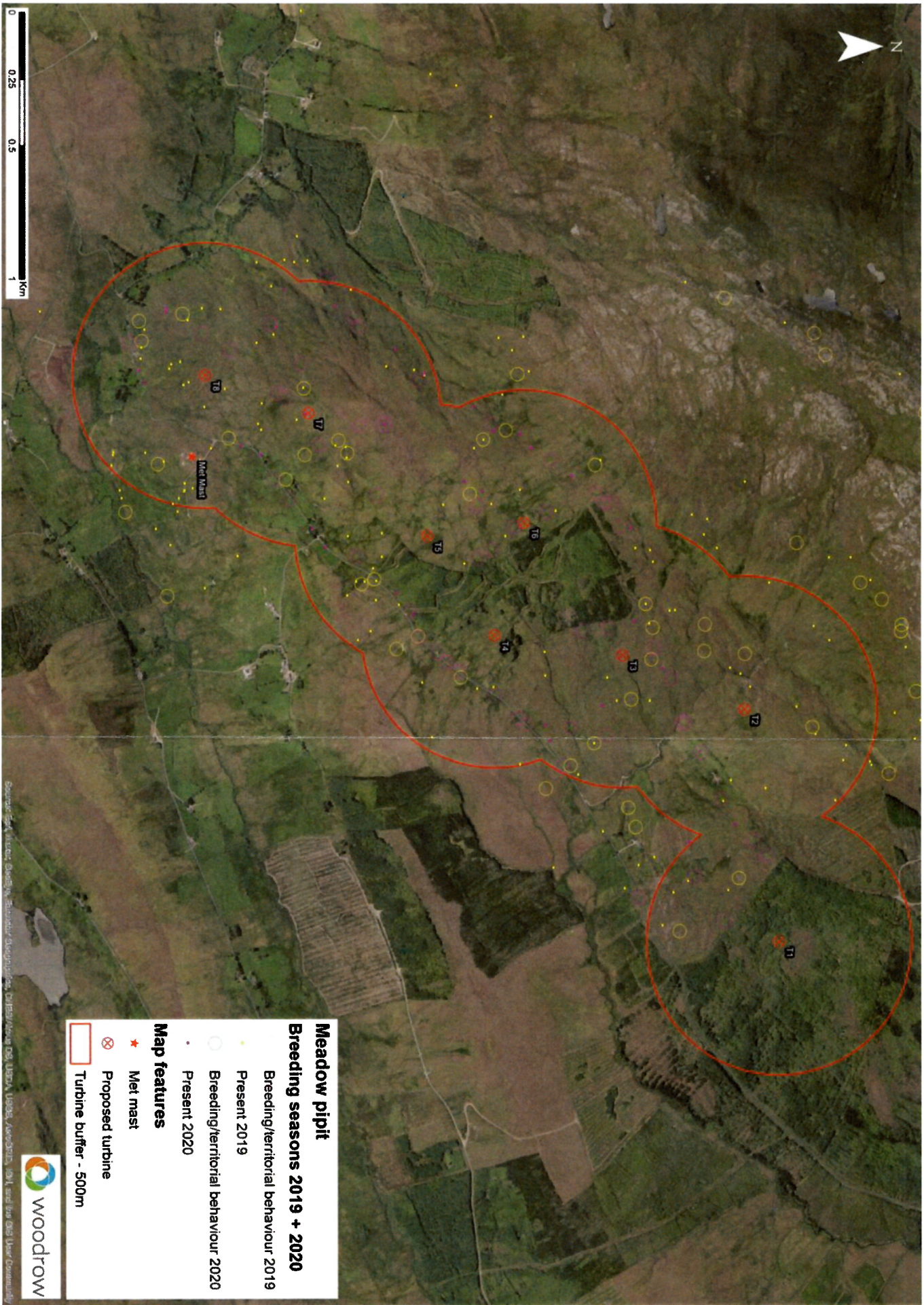


Figure 5. Composite map of breeding season meadow pipit records (2019 and 2020)

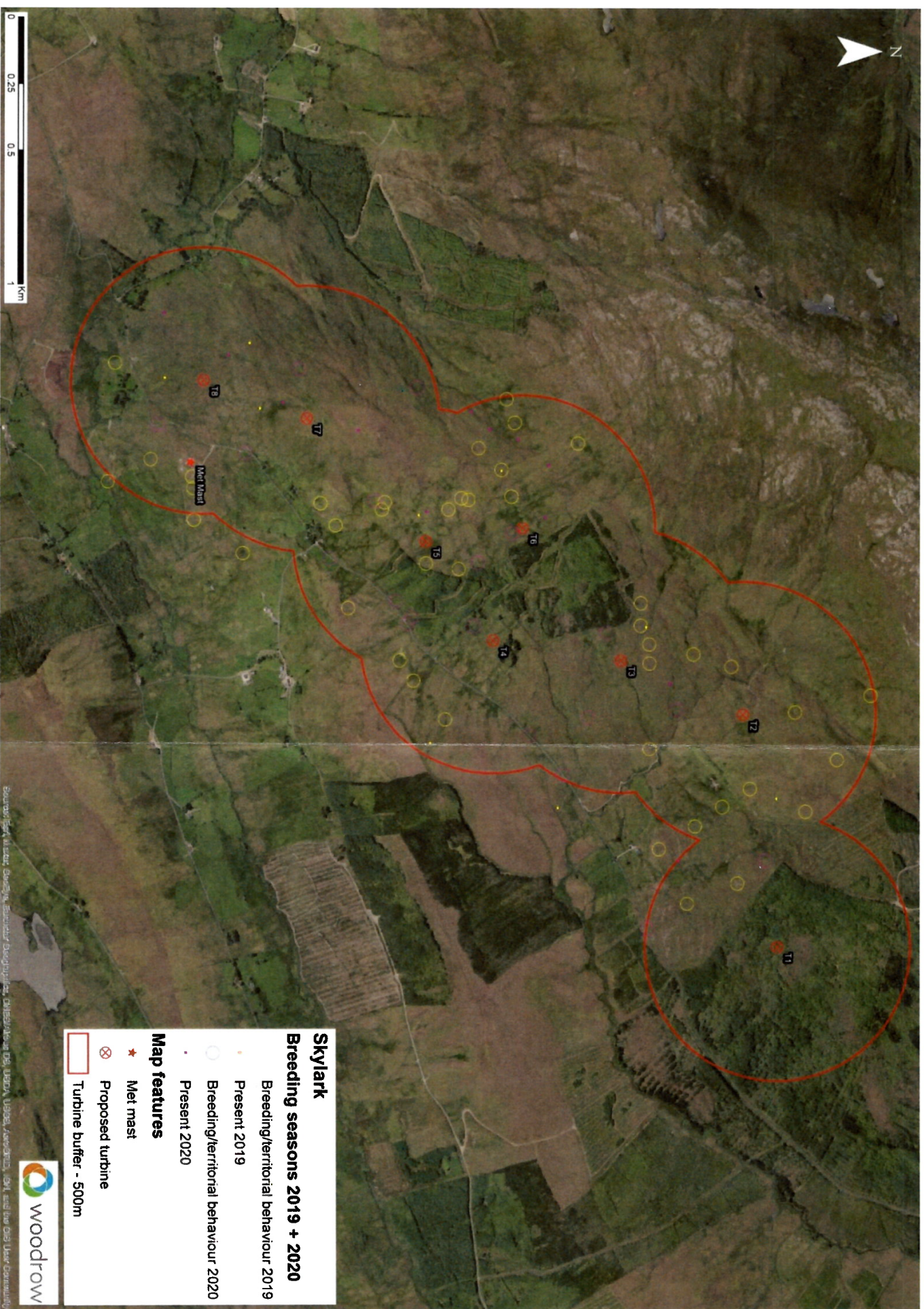


Figure 6. Composite map of breeding season skylark records (2019 and 2020)

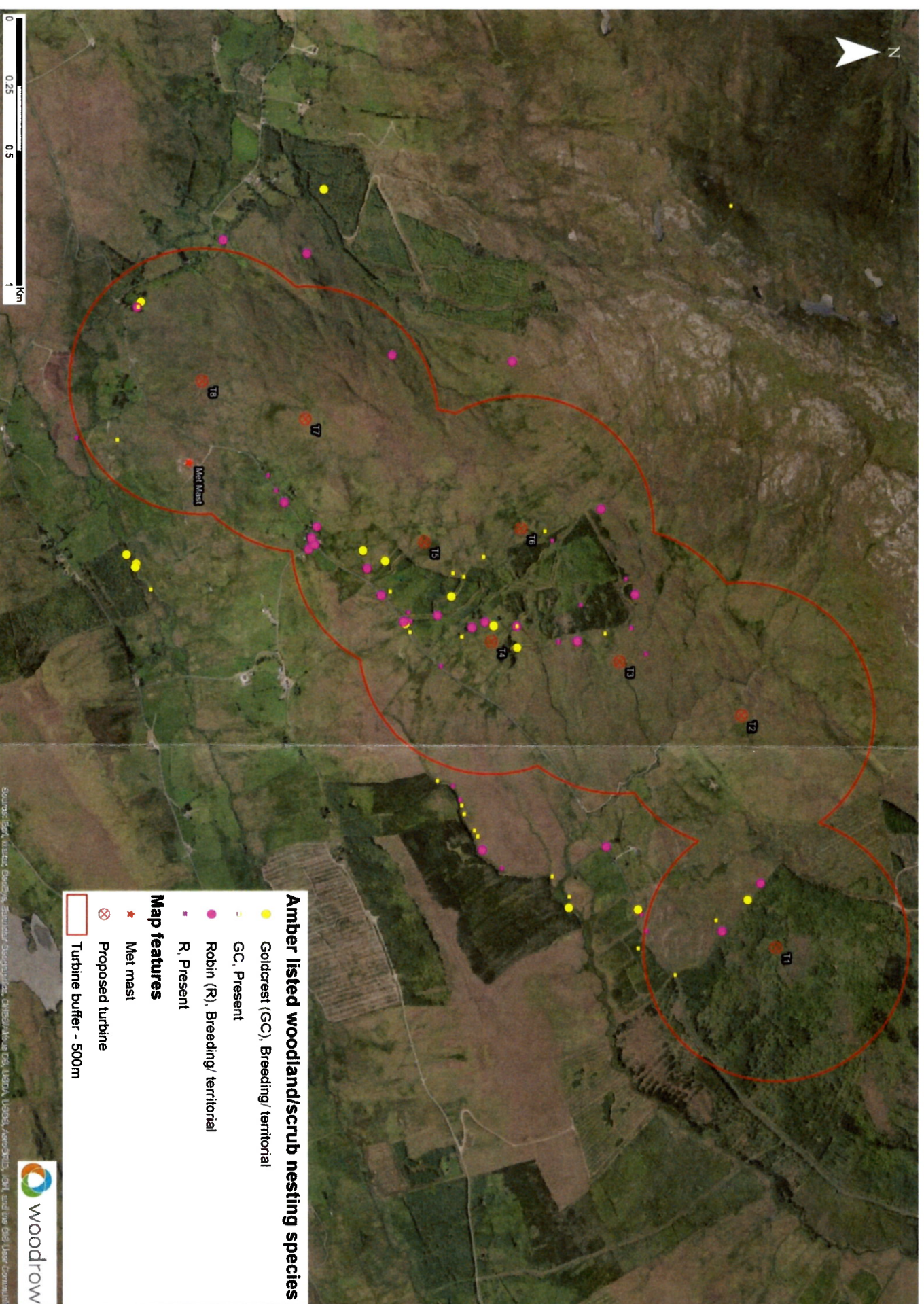


Figure 7. Composite map of selected amber listed breeding species (2018 & 2019) – scrub/woodland nesting

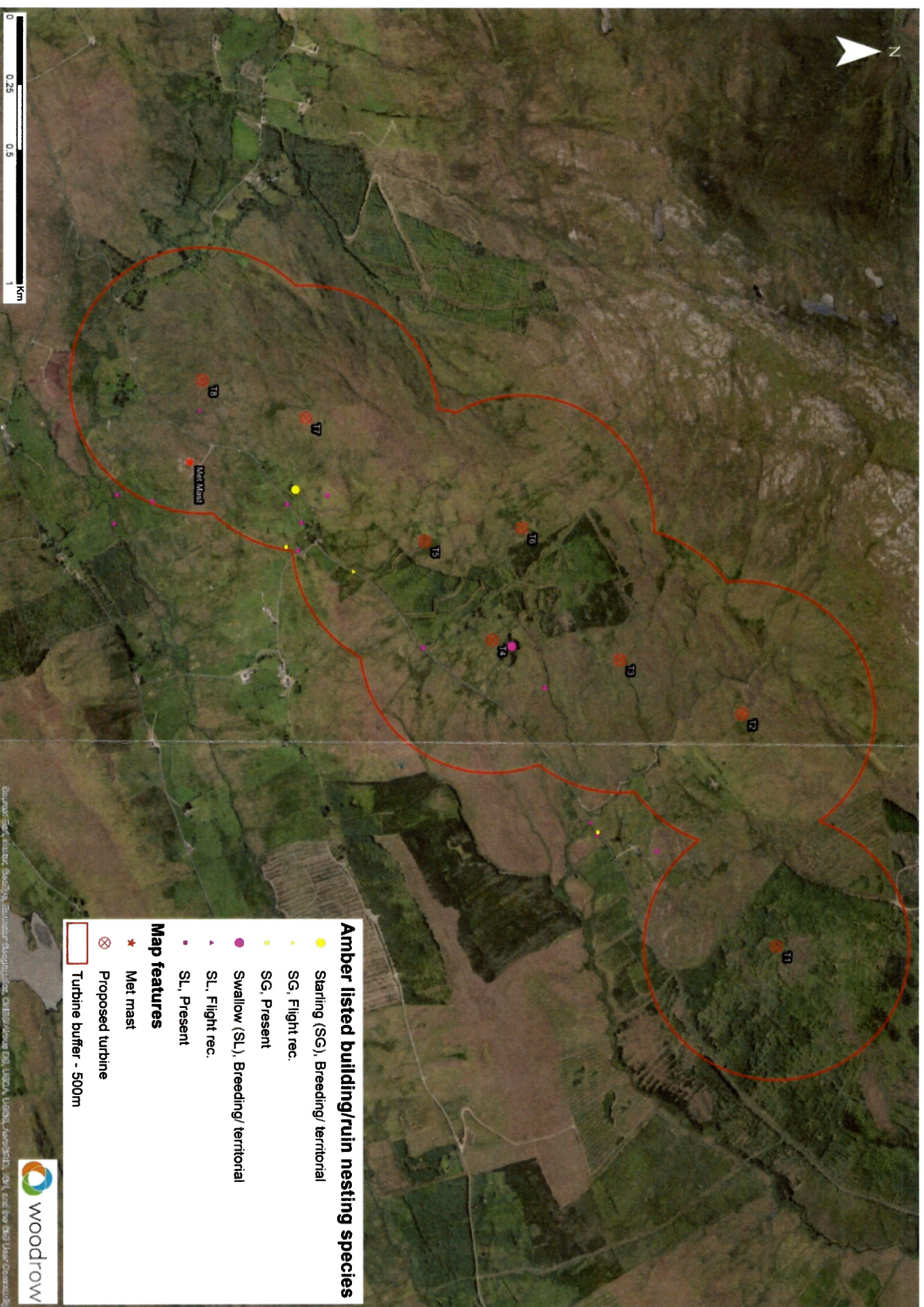


Figure 8. Composite map of selected amber listed breeding species (2018 & 2019) – building nesting species

Appendix 5: Avi-fauna – Results: Wider area maps

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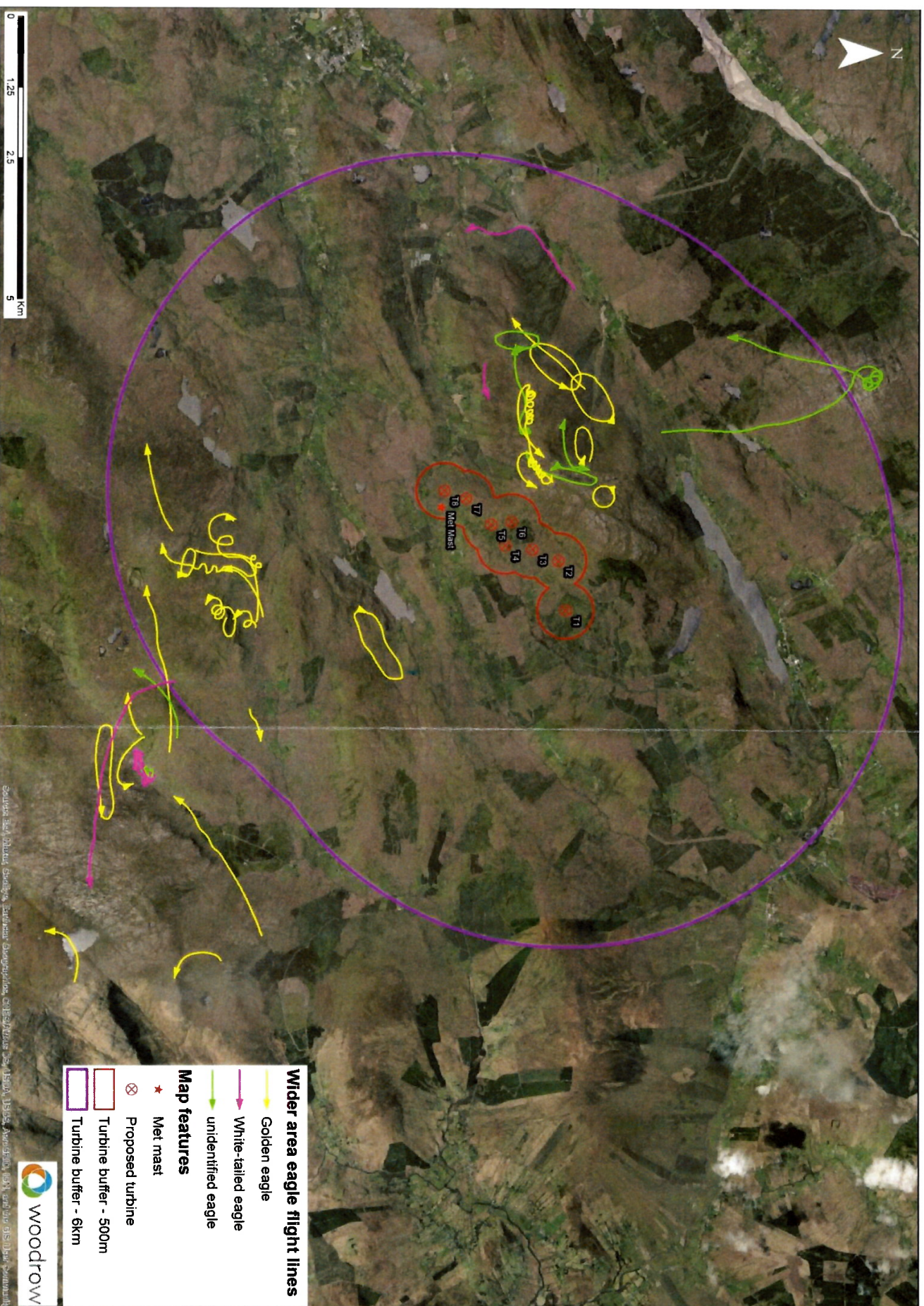


Figure 1 Wider area eagle observations
Table 1 Year 1: Non-breeding season 2018-19 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	MT	30/10/2018	815	2.00	RZ, WS	Wind: F3-2, S-E Oktas:7 Temp: 4-5°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	MT	01/11/2018	1004	2.00	No target sp.	Wind: F2-3, W/NW-NW Oktas:6-4 Temp: 5-6°C Ground cond: wet damp Rainfall: nil Visibility: good Factors affect vis: none
1	KW	09/11/2018	800	3.00	No target sp.	Wind: F6, SE Oktas:8 Temp: not rec. °C Ground cond: dry Rainfall: showers Visibility: good Factors affect vis: none
1	KW	23/11/2018	840	3.00	BZ, HG	Wind: F3-4, E-NE Oktas:5-8 Temp: 3-6°C Ground cond: wet Rainfall: light passing showers Visibility: good Factors affect vis: none
1	KW	23/11/2018	1200	2.00	No target sp.	Wind: F3-4, E-NE Oktas:5-7 Temp: 6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	11/12/2018	950	3.00	H	Wind: F3-4, SE Oktas:7-8 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good-mod Factors affect vis: low cloud covering highest hills & ridges (1130-1300)
1	HPD	11/12/2018	1315	3.00	No target sp.	Wind: F4-5, SE Oktas:8 Temp: 8°C Ground cond: dry Rainfall: mostly dry, single passing shower Visibility: mod Factors affect vis: low cloud on highest hills and some mist lower later
1	KW	10/01/2019	845	3.00	No target sp.	Wind: F1, W Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	10/01/2019	1315	3.00	BZ	Wind: F1, W Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	05/02/2019	900	3.00	BZ	Wind: F4-5, S Oktas:8 Temp: 8°C Ground cond: damp Rainfall: light, occ heavy showers Visibility: mod Factors affect vis: low cloud base over hilltops
1	HPD	05/02/2019	1225	3.00	H	Wind: F4-5, S Oktas:8 Temp: 8°C Ground cond: damp Rainfall: rain from 1420 Visibility: mod-poor Factors affect vis: low cloud - showers at times
1	KW	22/02/2019	825	3.00	No target sp.	Wind: F3-5, S Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	22/02/2019	1150	3.00	SN	Wind: F5-6, S Oktas:8 Temp: 12°C Ground cond: wet Rainfall: mostly dry, occ. Showers Visibility: good-mod Factors affect vis: misty at times
2	MT	30/10/2018	1049	3.00	H, WE	Wind: F3, S Oktas:7-8 Temp: 4°C Ground cond: wet Rainfall: mostly dry, occ. spots Visibility: good Factors affect vis: none
2	KW	19/11/2018	815	4.00	BZ	Wind: F1-2, E Oktas:4-7 Temp: 6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud covering mountain to west
2	KW	19/11/2018	1245	4.00	BZ, K	Wind: F1-2, E Oktas:5-8 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud covering mountain to west
2	KW	11/12/2018	1015	3.00	HH, ML	Wind: F3-4, ESE-SE Oktas:7-8 Temp: 9-10°C Ground cond: wet Rainfall: nil Visibility: good-mod Factors affect vis: cloud covering mountain top
2	KW	11/12/2018	1335	3.00	No target sp.	Wind: F3-2, SE Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good-mod Factors affect vis: mist - light
2	HPD	10/01/2019	845	3.00	GP	Wind: F1-2, W Oktas:8 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	HPD	10/01/2019	1215	3.00	No target sp.	Wind: F2, NW Oktas:8 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: mist/low cloud - occasional pockets
2	KW	05/02/2019	900	3.00	No target sp.	Wind: F4, ESE-SE Oktas:8 Temp: 5-10°C Ground cond: wet Rainfall: showers Visibility: mod-good Factors affect vis: low cloud, with passing showers
2	KW	05/02/2019	1230	3.00	No target sp.	Wind: F4, SE Oktas:8 Temp: 10°C Ground cond: wet Rainfall: showers Visibility: mod-good Factors affect vis: low cloud, with passing showers
2	HPD	22/02/2019	830	3.00	No target sp.	Wind: F4-5, S Oktas:8 Temp: 12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: good vis, low cloud covering hilltops above Graffy
2	HPD	22/02/2019	1155	3.00	No target sp.	Wind: F5-6, S Oktas:8 Temp: 12°C Ground cond: dry Rainfall: showers Visibility: mod-good Factors affect vis: mod vis during showers, otherwise good

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
2	KW	20/03/2019	1635	1.00	No target sp.	Wind: F4, SW Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to SW
3	MT	30/10/2018	1524	2.00	K, RG	Wind: F3-2, S Oktas:8-5 Temp: 5-3°C Ground cond: wet Rainfall: mostly dry, occ. light passing shower Visibility: good Factors affect vis: low cloud over high ground until 1630, low light - dusk at 1738
3	MT	09/11/2018	710	4.00	No target sp.	Wind: F5-6, SE-SSE Oktas:7-8 Temp: 7°C Ground cond: wet/damp Rainfall: mostly dry, occ. light drizzle Visibility: good Factors affect vis: low light, occ. moderate vis due to passing showers
3	KW	20/11/2018	815	3.00	BZ	Wind: F2-4, NE Oktas:2-5 Temp: 6°C Ground cond: wet Rainfall: not rec. Visibility: good Factors affect vis: low cloud base over hilltops
3	MT	01/12/2018	923	3.00	No target sp.	Wind: F1-3, E-NE Oktas:7-8 Temp: 5-9°C Ground cond: wet Rainfall: periods of light drizzle Visibility: good-mod. Factors affect vis: low cloud on top of mountain, vis mod during periods of drizzle, cloud base drops, slightly misty
3	KW	18/12/2018	845	3.00	No target sp.	Wind: F3-4, S Oktas:4-8 Temp: 8-10°C Ground cond: wet Rainfall: showers Visibility: good, occ. mod. Factors affect vis: low cloud
3	KW	18/12/2018	1205	3.00	ML, BZ	Wind: F3-4, S Oktas:4-8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	23/01/2019	920	3.00	No target sp.	Wind: F1, W Oktas:8 Temp: 1.5-3°C Ground cond: snow/ wet Rainfall: showers rain & sleet Visibility: mod. Factors affect vis: low cloud
3	KW	23/01/2019	1245	3.00	No target sp.	Wind: F1-3, W Oktas:8 Temp: 3°C Ground cond: wet-snow Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops
3	KW	12/02/2019	1025	3.00	No target sp.	Wind: F3-4, SSW-S Oktas:8-5 Temp: 9°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: low cloud & mist
3	KW	12/02/2019	1355	3.00	No target sp.	Wind: F4-5, S Oktas:7-3 Temp: 9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hilltops periodically
3	KW	01/03/2019	930	3.00	BZ	Wind: F2-4, S-SSE Oktas:4-8 Temp: 8-9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	HPD	20/03/2019	945	3.00	BZ, LB, WE	Wind: F5, SW Oktas:8 Temp: 11°C Ground cond: dry Rainfall: showers Visibility: mod.-good Factors affect vis: fog on hills, clear lower down around VP
4	MT	01/11/2018	1258	4.50	K, EA	Wind: F3-2, NW-W Oktas:5-8 Temp: 6°C Ground cond: wet/damp Rainfall: mostly dry, occ. passing shower Visibility: good, occ. mod. Factors affect vis: glare - occasionally intense glare & showers
4	KW	18/11/2018	915	3.00	No target sp.	Wind: F4-5, E Oktas:4-1 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: glare to E, intermittent low cloud
4	KW	18/11/2018	1245	3.00	No target sp.	Wind: F4-5, E Oktas:3-1 Temp: 7-6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to E
4	KW	19/12/2018	905	3.00	EA	Wind: F4, S Oktas:8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: good Factors affect vis: low cloud base over hilltops
4	KW	19/12/2018	1235	3.00	K	Wind: F4-5, S Oktas:8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: good Factors affect vis: low cloud base over hilltops
4	KW	24/01/2019	915	3.00	No target sp.	Wind: F3-4, WNW Oktas:8 Temp: 5-9°C Ground cond: wet Rainfall: misty drizzle Visibility: mod.-poor Factors affect vis: low cloud & mist
4	KW	24/01/2019	1240	3.00	No target sp.	Wind: F2-4, WNW Oktas:8 Temp: 9-10°C Ground cond: wet Rainfall: showers Visibility: poor Factors affect vis: fog, low cloud, mist
4	KW	29/01/2019	900	3.00	No target sp.	Wind: F4-2, NW Oktas:4-8 Temp: 1.5°C Ground cond: snow Rainfall: snow showers Visibility: mod.-good Factors affect vis: snow showers
4	KW	29/01/2019	1220	3.50	No target sp.	Wind: F2-1, NW Oktas:8-5 Temp: 1-3°C Ground cond: snow Rainfall: snow showers Visibility: mod.-good Factors affect vis: snow showers - low cloud - glare
4	KW	14/02/2019	1315	4.50	No target sp.	Wind: F3-5, S Oktas:8 Temp: 9-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: murky light beyond 2km
4	KW	21/03/2019	1415	3.00	BZ, LB, RG, WE, WS	Wind: F4, SW Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hilltops

Table 2 Year 1: Breeding season 2019 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
1	HPD	20/03/2019	1630	1.00	BZ	Wind: F4, SW Oktas:7-8 Temp: 12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: good vis, low cloud covering hilltops above Grafty
1	KW	21/03/2019	930	3.00	LB	Wind: F2, SW Oktas:8 Temp: 12°C Ground cond: wet Rainfall: mist Visibility: poor Factors affect vis: low cloud
1	KW	28/03/2019	1200	3.00	ML	Wind: F3-5, SW Oktas:2-4 Temp: 13-14°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	17/04/2019	1400	3.00	BZ	Wind: F1-5, SE-E Oktas:3-7 Temp: 10-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	09/05/2019	900	3.00	BZ, LB, RG, SN, WC, WM	Wind: F1-2, NE Oktas:8 Temp: 8°C Ground cond: dry Rainfall: showers Visibility: mod-good Factors affect vis: mod vis during showers, otherwise good
1	KW	18/05/2019	815	3.00	No target sp.	Wind: F5, NW Oktas:7-8 Temp: 12-14°C Ground cond: dry Rainfall: mostly dry, v. light shower at end Visibility: good Factors affect vis: none
1	KW	18/05/2019	1145	3.00	WE	Wind: F3-5, NW Oktas:7-8 Temp: 14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	14/06/2019	800	2.00	LB	Wind: F2, W Oktas:4-6 Temp: 12-13°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	25/06/2019	1100	3.00	SN	Wind: F2-5, NE Oktas:8 Temp: 18°C Ground cond: not rec. Rainfall: mist Visibility: good Factors affect vis: low cloud base over hilltops
1	KW	16/07/2019	915	3.00	BZ	Wind: F3-4, SW Oktas:4-7 Temp: 16-18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	23/07/2019	1300	3.00	LB	Wind: F4-5, S Oktas:2-4 Temp: 22°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	16/08/2019	815	3.00	LB, MA	Wind: F4-5, S-SW Oktas:3-8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: mod-good Factors affect vis: low cloud & passing showers
1	KW	03/09/2019	900	3.00	RK *	Wind: F2-3, SW Oktas:8 Temp: 16-17°C Ground cond: wet Rainfall: passing showers Visibility: poor-good Factors affect vis: low cloud & passing showers
2	HPD	21/03/2019	930	3.00	JS, LB, WS	Wind: F3, SW Oktas:8 Temp: 12°C Ground cond: damp Rainfall: light shower Visibility: mod-poor Factors affect vis: fog thick, vis 500-800m average, occ better, also some light drizzle
2	KW	27/03/2019	1330	3.00	BZ	Wind: F5, SW Oktas:5-8 Temp: 8-9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	KW	17/04/2019	1000	3.00	ML	Wind: F1-4, E-ESE-SE Oktas:4-6 Temp: 9-10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	HD	09/05/2019	930	3.00	ML	Wind: F2, E Oktas:7-8 Temp: 7°C Ground cond: wet Rainfall: persistent light rain Visibility: mod Factors affect vis: low cloud
2	KW	17/05/2019	915	3.00	BZ	Wind: F3-4, SE-E Oktas:2-8 Temp: 1-4°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	17/05/2019	1245	3.00	ML	Wind: F2-1, E Oktas:8 Temp: 4°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	07/06/2019	745	3.00	BZ, MA, ML	Wind: F2-3, SE Oktas:5-8 Temp: 11-13°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	19/06/2019	1800	3.00	ML(on nest)	Wind: F2-3, SW Oktas:6-8 Temp: not rec. °C Ground cond: wet Rainfall: showers Visibility: mod-good Factors affect vis: low cloud
2	KW	02/07/2019	915	3.00	ML & PE before start	Wind: F2, NW Oktas:7-8 Temp: 13-14°C Ground cond: dry Rainfall: mostly dry, occ. v light misty drizzle Visibility: good Factors affect vis: occ. misty drizzle
2	KW	17/07/2019	1000	3.00	ML, H	Wind: F3-4, S Oktas:8 Temp: 16°C Ground cond: wet Rainfall: showers, light rain & mist Visibility: good Factors affect vis: low cloud base over hilltops
2	KW	08/08/2019	900	3.00	No target sp.	Wind: F1, NE-E NE Oktas:6-8 Temp: 14-18°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	KW	21/08/2019	830	3.00	No target sp.	Wind: F4, S Oktas:7-8 Temp: 12-13°C Ground cond: wet Rainfall: passing showers - occ. heavy Visibility: mod-good Factors affect vis: low cloud over mountain top, with passing showers

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
3	KW	27/03/2019	930	3.00	BH, BZ, LB, SH, WE	Wind: F3, SW Oktas:8 Temp: 7.8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	10/04/2019	1045	3.00	BZ, EA, K	Wind: F3-4, E-SE Oktas:3-6 Temp: 10-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	10/04/2019	1405	3.00	BZ, WE	Wind: F4-3, SE Oktas:4-2 Temp: 11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	HPD	09/05/2019	1330	3.00	ML	Wind: F1, E Oktas:7-8 Temp: 17°C Ground cond: damp Rainfall: passing showers Visibility: good Factors affect vis: none
3	HPD	18/05/2019	845	3.00	ML	Wind: F4-5, NW Oktas:8 Temp: 14°C Ground cond: dry Rainfall: showers Visibility: good Factors affect vis: occ. showers
3	HPD	18/05/2019	1200	3.00	No target sp.	Wind: F4-5, NW Oktas:7-8 Temp: 13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: fog covering hill tops above Grafty, otherwise good lower down
3	KW	07/06/2019	1100	3.00	BZ, LB	Wind: F2-4, SE-S Oktas:7-8 Temp: 12-13°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	19/06/2019	1500	3.00	SN	Wind: F3-5, SW Oktas:8 Temp: 14°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: low cloud
3	KW	02/07/2019	1300	3.00	SH	Wind: F2-4, NW Oktas:7-8 Temp: 17-18°C Ground cond: dry Rainfall: not rec. Visibility: good Factors affect vis: none
3	KW	17/07/2019	1700	3.00	ML	Wind: F2-4, SW Oktas:3-6 Temp: 16-17°C Ground cond: wet Rainfall: not rec. Visibility: good Factors affect vis: none
3	KW	08/08/2019	1230	3.00	K	Wind: F1, ENE-E Oktas:5-8 Temp: 18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	KW	21/08/2019	1200	1.00	No target sp.	Wind: F4-5, S Oktas:8 Temp: 13°C Ground cond: wet Rainfall: light drizzle becomes heavy & persistent Visibility: mod.-poor Factors affect vis: rain
3	KW	03/09/2019	1230	2.00	SH	Wind: F3, SW Oktas:8 Temp: 16-17°C Ground cond: wet Rainfall: misty rain shower Visibility: poor-mod. Factors affect vis: rain & mist
4	KW	11/04/2018	1015	3.00	No target sp.	Wind: F1-2, SE-S Oktas:8 Temp: 9-11°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: low cloud/haze beyond 2k
4	KW	11/04/2018	1340	3.00	BZ	Wind: F1-2, S Oktas:8 Temp: 11°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: low cloud/haze beyond 2k
4	KW	26/03/2019	1015	3.00	RG	Wind: F3-6, SW Oktas:8 Temp: 7.8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hillsops periodically
4	KW	26/03/2019	1335	3.00	No target sp.	Wind: F3, SW Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hillsops periodically
4	KW	29/05/2019	850	3.00	No target sp.	Wind: F1-2, SE Oktas:8 Temp: 10-11°C Ground cond: wet Rainfall: mostly dry, occ. light showers Visibility: good Factors affect vis: low cloud base over hillsops
4	KW	29/05/2019	1215	3.00	No target sp.	Wind: F2, S Oktas:8 Temp: 11°C Ground cond: wet Rainfall: light passing showers, becoming persistent at end Visibility: good-mod. Factors affect vis: low cloud dropping over lower slopes towards end
4	KW	14/06/2019	1045	3.00	BZ	Wind: F2, W Oktas:4-8 Temp: 13°C Ground cond: wet Rainfall: showers Visibility: good Factors affect vis: occ. showers
4	KW	25/06/2019	1445	3.00	BZ	Wind: F3, NE Oktas:6-8 Temp: 16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	16/07/2019	1300	3.00	No target sp.	Wind: F4-5, SW Oktas:6-8 Temp: 19-20°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	23/07/2019	1645	3.00	No target sp.	Wind: F3, S Oktas:2-4 Temp: 22°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	16/08/2019	1200	3.00	No target sp.	Wind: F3-6 (gusting 7), SW Oktas:8-6 Temp: 15°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	KW	04/09/2019	1315	3.00	No target sp.	Wind: F3-6, NW Oktas:8 Temp: 12-13°C Ground cond: wet Rainfall: passing showers Visibility: good-mod. Factors affect vis: showers

Table 3 Year 2: Non-breeding season 2019-20 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	KW	10/10/2019	930	3.00	ML, RG	Wind: F3, S Oktas:8 Temp: 12-13°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: none
1	RV	27/10/2019	935	3.00	RG	Wind: F1-2, NE Oktas:1-2 Temp: 5-6°C Ground cond: damp Rainfall: single prolonged shower Visibility: good Factors affect vis: shower
1	RV	30/10/2019	1125	3.00	RG	Wind: F3, N-NW Oktas:2-3 Temp: 8-10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	18/11/2019	1245	3.00	No target sp.	Wind: F2-3, SE Oktas:6 Temp: 2 °C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	07/12/2019	1225	3.00	BZ, K	Wind: F4-5, SSW-Oktas:7-8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	JB	31/12/2019	905	3.00	No target sp.	Wind: F2-3, E Oktas:0 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
1	JB	05/01/2020	830	3.00	BZ, EA, GB, RG	Wind: F2-4, S Oktas:8 Temp: 8°C Ground cond: wet Rainfall: mostly dry, occ. drizzle Visibility: good Factors affect vis: low cloud, occasional drizzle
1	JB	12/01/2020	940	3.00	GB	Wind: F3-4, SW Oktas:5 Temp: 3°C Ground cond: wet Rainfall: short rain showers Visibility: good Factors affect vis: none
1	JB	28/01/2020	1200	3.00	H	Wind: F2-4, W Oktas:8 Temp: 3°C Ground cond: snow - patchy/ wet Rainfall: mostly dry, occ. shower hail Visibility: good-mnd. Factors affect vis: rain/hail
1	JB	13/02/2020	1015	3.00	BZ	Wind: F3-4, ENE-NE Oktas:6-8 Temp: 4°C Ground cond: wet Rainfall: mostly dry, occ. light rain, drizzle Visibility: mostly good Factors affect vis: rain/drizzle
1	JB	27/02/2020	1330	3.17	ML, K, GB, WE	Wind: F3, WNW-W Oktas:7-4 Temp: 6°C Ground cond: snow: 10mm Rainfall: nil Visibility: good Factors affect vis: none
1	RV	03/03/2020	730	3.00	LB, K, LB	Wind: F4, W-WNW Oktas:2-4 Temp: 4°C Ground cond: damp Rainfall: mostly dry occ. light drizzle, some sleet & snow Visibility: good Factors affect vis: occ. sleet/ snow showers
2	KW	17/10/2019	1200	3.00	No target sp.	Wind: F2-4, SSE-S Oktas:5-8 Temp: 7-8°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: low cloud
2	RV	27/10/2019	1320	3.00	K	Wind: F1, N Oktas:1-4 Temp: 6-7°C Ground cond: wet Rainfall: showers Visibility: mod. Factors affect vis: glare - intense at times, with single heavy shower
2	RV	30/10/2019	745	3.00	No target sp.	Wind: F2-3, N Oktas:1-3 Temp: 6-9°C Ground cond: damp Rainfall: light drizzle Visibility: good Factors affect vis: none
2	JB	18/11/2019	915	3.00	No target sp.	Wind: F1-3, SW-S Oktas:1-7 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
2	JB	07/12/2019	855	3.00	No target sp.	Wind: F4, SW Oktas:8 Temp: 8°C Ground cond: wet Rainfall: drizzle/light rain Visibility: mod.-poor Factors affect vis: low cloud - vis down to 1km at times, high points obscured for most of watch
2	JB	15/12/2019	900	3.00	K/SH?, ML, RG	Wind: F2-3, SW Oktas:2-5 Temp: 0°C Ground cond: snow - light Rainfall: nil Visibility: good Factors affect vis: none
2	JB	31/12/2019	1230	3.00	K, EA	Wind: F2-3, E-SE-S Oktas:0-1 Temp: 2°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: haze - slight during last hour
2	JB	09/01/2020	1235	3.00	K, EA	Wind: F2, SW Oktas:4 Temp: 4°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	JB	28/01/2020	830	3.00	No target sp.	Wind: F2-4, W Oktas:8 Temp: 1°C Ground cond: snow: 40mm Rainfall: rain, hail, sleet Visibility: good Factors affect vis: short hail/select showers
2	JB	13/02/2020	1345	3.00	EA, PF, RG, WE	Wind: F3-2, NE-NNE-E Oktas:6-2 Temp: 5°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to W - occ over last hour
2	JB	27/02/2020	1000	3.00	EA, SH, WE	Wind: F3-4, NW Oktas:3-8 Temp: 3°C Ground cond: snow: 30mm Rainfall: mostly dry - passing snow showers Visibility: good Factors affect vis: snow showers
2	RV	03/03/2020	1430	3.00	ML, SH	Wind: F4-3, WNW-W Oktas:2-4 Temp: 5°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: glare - mild caused by evening sun
3	KW	10/10/2019	1300	3.00	LB	Wind: F3-5, S Oktas:7-8 Temp: 11-12°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: none

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
3	RV	29/10/2019	1245	3.00	K, SH	Wind: F3-4, E Oktas:1-3 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	RV	31/10/2019	815	3.00	BZ, EA, K	Wind: F3, SE Oktas:7 Temp: 8°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: low cloud base over hillslopes periodically
3	JB	27/11/2019	1230	3.00	K, EA	Wind: F2-3, NE Oktas:4-7 Temp: 6°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	09/12/2019	1210	3.00	K	Wind: F2, W Oktas:5-8 Temp: 6°C Ground cond: dry Rainfall: v. light drizzle Visibility: good Factors affect vis: none
3	JB	17/12/2019	1215	3.00	SH	Wind: F2, W Oktas:4-8 Temp: 2°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	JB	05/01/2020	1155	3.00	BZ, EA, GB	Wind: F4-5, SW Oktas:8 Temp: 9°C Ground cond: wet Rainfall: drizzle Visibility: mod.-good Factors affect vis: low cloud on top of site, drizzle at times
3	JB	17/01/2020	1245	3.00	BZ, K, SH	Wind: F2-3, W Oktas:5-7 Temp: 3°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	JB	06/02/2020	1245	3.17	BZ, CA, EA, K, SH	Wind: F3-5, SW Oktas:5-6 Temp: 5°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	JB	24/02/2020	1000	3.00	No target sp.	Wind: F4-5, W Oktas:7-8 Temp: 3°C Ground cond: snow: 50mm Rainfall: light drizzle Visibility: mod.-good Factors affect vis: drizzle
3	JB	24/02/2020	1330	3.00	No target sp.	Wind: F5-6, W Oktas:7-8 Temp: 3°C Ground cond: snow: 20mm Rainfall: light to heavy showers Visibility: good-mod. Factors affect vis: showers
3	RV	03/03/2020	1100	3.00	No target sp.	Wind: F4-5, WNW Oktas:1-8 Temp: 5°C Ground cond: wet Rainfall: snow & sleet for 20mins Visibility: good Factors affect vis: sleet snow shower
4	KW	17/10/2019	830	3.00	BZ	Wind: F4-5, SE SSE Oktas:4-8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	RV	29/10/2019	904	3.00	K, WS	Wind: F3-4, NE-E Oktas:1 Temp: 3-5°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	31/10/2019	1208	3.00	K	Wind: F3-4, SE Oktas:1-3 Temp: 9°C Ground cond: damp Rainfall: nil Visibility: not rec. Factors affect vis: low cloud base over hillslopes
4	JB	27/11/2019	840	3.00	RG	Wind: F2-3, NE Oktas:8-6 Temp: 5°C Ground cond: wet Rainfall: mostly dry, occ. light passing shower Visibility: mod.-good Factors affect vis: low cloud patches clearing, then occ. glare
4	JB	09/12/2019	840	3.00	No target sp.	Wind: F1-2, NW Oktas:1-4 Temp: 4°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: glare - some at sunrise
4	JB	17/12/2019	845	3.00	EA	Wind: F1-2, W Oktas:5-8 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
4	JB	09/01/2020	900	3.00	No target sp.	Wind: F1, S Oktas:4-7 Temp: 4°C Ground cond: frost wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	17/01/2020	900	3.25	RG	Wind: F4-1, SW-W Oktas:7-8 Temp: 1°C Ground cond: wet-snow Rainfall: passing showers - occ. snow Visibility: mod. Factors affect vis: low cloud, slight mist (15m)
4	JB	06/02/2020	915	3.00	No target sp.	Wind: F3-6, SSW-SW Oktas:6-7 Temp: 2°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	JB	23/02/2020	900	3.00	BZ, EA, RG	Wind: F3-5, W Oktas:5-6 Temp: 2-3°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	23/02/2020	1230	3.00	EA, K	Wind: F4-3, W Oktas:5-6 Temp: 2-4°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	RV	07/03/2020	920	3.00	WK	Wind: F5, W-S Oktas:8 Temp: 3°C Ground cond: wet Rainfall: rain until 1100, heavy at times Visibility: mod. Factors affect vis: cloud base above VP

Table 4							Year 2: Breeding season 2020 – Vantage point (VP) survey effort	
VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary		
1	JB	21/04/2020	1515	3.00	GB, HG, LB	Wind: F4-3, E Oktas:1 Temp: 13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
1	JB	22/04/2020	800	3.00	BZ, RG	Wind: F3-2, E Oktas:2-5 Temp: 7-12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
1	JB	24/04/2020	1415	3.00	K, RG	Wind: F1-3, E-SW-W Oktas:2-4 Temp: 20-18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
1	JB	13/05/2020	1000	3.00	BZ, K, RG	Wind: F3-4, NNE Oktas:7-8 Temp: 7-11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
1	RV	16/05/2020	645	3.00	K, LB, SN	Wind: F3, SW Oktas:8 Temp: 7°C Ground cond: dry Rainfall: Drizzle Visibility: mod. Factors affect vis: low cloud, drizzle & some mist		
1	JB	27/05/2020	1330	3.00	BZ, EA, K	Wind: F2, SW Oktas:3-8 Temp: 18°C Ground cond: dry Rainfall: nil Visibility: Good Factors affect vis: none		
1	JB	04/06/2020	1600	3.00	K, SN	Wind: F3, NNW Oktas:8 Temp: 11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
1	RV	23/06/2020	520	3.00	H, LB	Wind: F1-F2, S Oktas:1 Temp: 10°C Ground cond: damp Rainfall: nil Visibility: good-mod. Factors affect vis: misty, overcast & dull at start - quickly cleared, occ. low cloud along top of mountain		
1	RV	08/07/2020	1715	3.00	BZ, SH	Wind: F3, NE Oktas:1 Temp: 13°C Ground cond: damp Rainfall: drizzle Visibility: Good Factors affect vis: drizzle - light spells, some patches of low cloud but generally clear		
1	JB	11/07/2020	1315	3.00	H, HG, SN	Wind: F3, W Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none		
1	RV	12/08/2020	630	3.00	ML	Wind: F2-3, NNE Oktas:8-2 Temp: 13°C Ground cond: damp Rainfall: nil Visibility: poor-mod. Factors affect vis: low cloud over hill top, also localised mist		
1	RV	19/08/2020	1320	3.00	EA	Wind: F4-5, E Oktas:7-8 Temp: 18°C Ground cond: damp Rainfall: light drizzle from 15:40 Visibility: good-mod. Factors affect vis: drizzle - light for last 40 mins		
2	JB	21/04/2020	815	3.00	MA, ML, SH	Wind: F2-3, ESE Oktas:0 Temp: 6-10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
2	RV	22/04/2020	645	3.00	ML	Wind: F3, E Oktas:2 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
2	JB	24/04/2020	1045	3.00	EA, GB, ML, RG	Wind: F1-2, E Oktas:2-3 Temp: 15-20°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none		
2	RV	10/05/2020	1130	3.00	ML	Wind: F6, NE Oktas:8 Temp: 7°C Ground cond: dry Rainfall: mostly dry, occ. passing drizzle Visibility: good Factors affect vis: none		
2	JB	14/05/2020	930	3.00	ML	Wind: F2-3, N-NNW Oktas:1-7 Temp: 9-14°C Ground cond: dry Rainfall: nil Visibility: Good Factors affect vis: heat haze		
2	RV	28/05/2020	635	3.17	EA, ML	Wind: F2, S Oktas:4 Temp: 14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: haze - slight during last 30 mins.		
2	JB	04/06/2020	1230	3.00	ML	Wind: F3, N Oktas:7-8 Temp: 10-13°C Ground cond: dry Rainfall: mostly dry, occ. v light to light showers Visibility: good Factors affect vis: none		
2	RV	15/06/2020	555	1.25	ML(chicks)	Wind: F1, N Oktas:0 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good (poor at end) Factors affect vis: perfect conditions at start - thick fog rolled up valley, stopped watch		
2	RV	23/06/2020	855	1.75	EA, ML, SH	Wind: F3-4, S Oktas:1 Temp: 13°C Ground cond: damp Rainfall: nil Visibility: Good Factors affect vis: good vis, occ. low cloud over hilltops above Graffy		
2	RV	08/07/2020	1345	3.00	ML	Wind: F3, E Oktas:1 Temp: 13°C Ground cond: damp Rainfall: Drizzle Visibility: good Factors affect vis: drizzle - light drizzle for last hour		
2	JB	11/07/2020	615	3.00	ML	Wind: F2, W Oktas:8 Temp: 10°C Ground cond: wet Rainfall: mostly dry, single brief, v. light shower Visibility: good Factors affect vis: none		
2	RV	19/08/2020	620	3.00	BZ	Wind: F2-3, E Oktas:7-8 Temp: 14°C Ground cond: damp Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops		
2	RV	19/08/2020	950	3.00	HH	Wind: F3-4, E Oktas:8 Temp: 15°C Ground cond: damp Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops		
3	JB	21/04/2020	1145	3.00	BZ, GB	Wind: F4, ESE Oktas:0-1 Temp: 10-13°C Ground cond: dry Rainfall: nil		

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
						Visibility: good Factors affect vis: none
3	RV	29/04/2020	850	3.00	BZ, K, LB, SN, WE	Wind: F4, W-NW Oktas:7 Temp: 7°C Ground cond: damp Rainfall: nil Visibility: Good Factors affect vis: none
3	RV	30/04/2020	645	3.00	SN	Wind: F1-2, N Oktas:1 Temp: 5°C Ground cond: damp Rainfall: drizzle Visibility: poor-mod. Factors affect vis: low cloud, with some fog & showers
3	JB	13/05/2020	1445	3.00	BZ, EA, K, Larus gull sp.	Wind: F3-4, NE-NNE Oktas:8-1 Temp: 11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	21/05/2020	1100	3.00	BZ, EA, SH	Wind: F2-3, SW Oktas:3-4 Temp: 15-17°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	17/06/2020	1015	3.00	No target sp.	Wind: F3, NW Oktas:8 Temp: 12°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	RV	30/06/2020	520	3.00	No target sp.	Wind: F3, W-SW Oktas:1 Temp: 10°C Ground cond: damp Rainfall: Drizzle Visibility: poor-mod. Factors affect vis: fog rolling in with persistent ligh drizzle
3	JB	11/07/2020	945	3.00	BZ, EA, SN	Wind: F3, W Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	RV	24/07/2020	540	3.00	EA, SH	Wind: F3, S Oktas:1 Temp: 12°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	KW	13/08/2020	815	3.00	No target sp.	Wind: F2, NE Oktas:8 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: poor-mod. Factors affect vis: Low cloud
3	KW	13/08/2020	1140	3.00	EA, K	Wind: F2-1, NE Oktas:8-3 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: mod-good Factors affect vis: low cloud lifting
3	JB	24/08/2020	1000	3.00	BZ, EA, HH, K	Wind: F2-3, S Oktas:6-7 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	22/04/2020	1130	3.00	BZ, EA, WE	Wind: F3, E Oktas:4-6 Temp: 14-16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	JB	22/04/2020	1500	3.00	EA, Falcon sp.	Wind: F3-2, E Oktas:6-8 Temp: 15-17°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	28/04/2020	1320	3.00	EA, ML, RG, WE, CU*, GP*	Wind: F2, E Oktas:2 Temp: 9°C Ground cond: dry Rainfall: showers Visibility: Good Factors affect vis: none
4	RV	10/05/2020	740	3.00	GP, HG, LB, SN	Wind: F6, NE Oktas:8 Temp: 6°C Ground cond: damp Rainfall: Drizzle Visibility: good Factors affect vis: mist on far side of valley
4	JB	21/05/2020	1445	3.00	BZ, GB, K, ML, WE	Wind: F2-4, SW Oktas:5-7 Temp: 16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	26/05/2020	640	3.00	RG	Wind: F3, W Oktas:4 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	JB	17/06/2020	1345	1.00	SN	Wind: F3, NW Oktas:8 Temp: 12-11°C Ground cond: damp Rainfall: nil Visibility: good-mod. Factors affect vis: cloud base drops - stopped VP watch
4	JB	25/06/2020	1530	2.00	No target sp.	Wind: F2, NNW Oktas:6-8 Temp: 18°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	RV	30/06/2020	855	3.00	RG*	Wind: F2-3, W-SW Oktas:1 Temp: 11°C Ground cond: Wet Rainfall: Drizzle Visibility: poor-mod. Factors affect vis: fog rolling in with drizzle, began to clear from 10-45 - dry & clear for last hour
4	JB	20/07/2020	1530	3.00	EA, SH	Wind: F3-2, W Oktas:5-3 Temp: 16°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
4	RV	29/07/2020	650	3.00	No target sp.	Wind: F2, W-SW Oktas:1 Temp: 11°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	KW	12/08/2020	900	3.00	K	Wind: F1-2, N Oktas:8-3 Temp: 17-20°C Ground cond: dry Rainfall: nil rolling through vis ranging poor to good
4	KW	12/08/2020	1225	3.00	No target sp.	Wind: F2, N Oktas:2 Temp: 20-19°C Ground cond: dry Rainfall: nil Visibility: mod-good Factors affect vis: cloud lifts, only covering tops of hill

Appendix VI: Avi-fauna Collision Risk Modelling Report

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1 Statement of Authority

This report was compiled Aoife Moroney (BSc, MSc) and Mike Trewby (BSc, Post grad. dip., CIEEM), with guidance and input from Will Woodrow (MSc., MSc. (Arch), CIEEM, CEcol) throughout the analysis and assessment.

Will is a Director and Principal Ecologist at Woodrow Sustainable Solutions Ltd (Woodrow). He has been studying and working in ecology, including avian ecology, since 1985 and has worked as an ecological consultant since 2004. Will has worked on numerous wind farm projects, including over 20 impact assessments and has undertaken collision risk modelling on over 8 wind farm proposals to date.

Mike is a Senior Ecologist at Woodrow and from 1997 has worked on a range of ecology projects and since 2011 has been an ecological consultant specialising in avian ecology on wind farms in Ireland, including undertaking of impact assessments and collision risk modelling.

Aoife is an Assistant Ecologist with Woodrow. She has completed a B.Sc. in Engineering at University College Dublin and M.Sc. in Environmental Engineering (specialising in Environmental Management) at the Technical University of Denmark and the Royal Institute of Technology, Sweden. Aoife is highly proficient in data analysis and management. She regularly assists in the compilation of environmental reports (including for Appropriate Assessment and Ecological Impact Assessment) as part of larger and smaller scale infrastructure projects.

2 Overview

The proposed Application is for an eight-turbine wind farm on Graffy Hill, Co. Donegal, which is located along the lower southern slopes of An Eachla (Aghla Mountain), c. 8 km east of Na Gleannta (Glenties). The central grid reference for the site is IGG 90603-97329 [Lat. 54.8238, Long. -8.1469]. The proposed wind turbines (WT) are located within the following townlands: An Dearachán Mór - Dalraghan More (WT01, WT02), Min na Manrach - Meenamalragh (WT03, WT04, WT05, WT06) and An Ghrafaidh - Graffy (WT07, WT08).

The intention of this report is to display modelled data, based on observed bird usage of the area, to provide an indication of the likely collision risk imposed by the proposed wind farm on potentially sensitive avian populations. The report uses bird usage data derived from vantage point (VP) watches conducted by appropriately experience ornithological surveyors from Woodrow Sustainable Solutions Ltd (Woodrow) over two years between October 2018 and August 2020 inclusive.

As shown in Figure 1 in Appendix I, flight data for selected target species was collected from four vantage points (VPs) over two years. Appendix II provides details of timings for VP watches and demonstrates that the minimum requirement of 36 hours per VP per season was achieved across the

two year, amounting to a total of 577.26 hours of VP watch data. Conducting of VP watches simultaneous by two surveyors was largely avoided over the two-year study. Simultaneous VP watches were only undertaken on 10 out of 98 survey days. When simultaneous VP watches did occur, care was taken to ensure that the viewsheds of the VPs did not overlap, i.e. only VP1 and VP2 covering opposite ends of the site could be done at the same time to avoid overlap. Therefore, no correction factor to account for simultaneous observer effort was required.

The flight risk volume applied in this analysis is based on a buffer extending 500 m from turbine towers (as shown in Figure 2 in Appendix I), which equates to area of 412 Ha. Two turbine models have been specified, the Enercon E-126 and Nordex 133, and the model has been run for both scenarios. The collision risk zone was defined as 18 to 150 m. This was based on the lowest minimum swept height and highest maximum swept height of the two turbine models, as detailed in **Table 1**.

CRM was undertaken for those species with > 200 flight seconds occurring with the potential collision risk zone (CRZ) over the two years (i.e. at collision risk height and within the turbine envelope = 500 m turbine buffer). Therefore, CRMs were run for 12 species including:

- Whooper swan 7,148 flight seconds in CRZ
- White-tailed eagle 3,144 flight seconds in CRZ
- Hen harrier 212 flight seconds in CRZ
- Sparrowhawk 386 flight seconds in CRZ
- Buzzard 7,383 flight seconds in CRZ
- Golden eagle 3,657 flight seconds in CRZ
- Kestrel 3,014 flight seconds in CRZ
- Merlin 1,058 flight seconds in CRZ
- Snipe 1,327 flight seconds in CRZ
- Lesser black-backed gull 2,402 flight seconds in CRZ
- Herring gull 19,500 flight seconds in CRZ
- Great black-backed gull 1,018 flight seconds in CRZ

CRM was not undertaken for black-headed gull or peregrine, as records of these target species were limited to one and two observations (single birds) respectively within the 500m turbine buffer (BH 124 sec. / PE 18 sec. & 13 sec.); and in the case of the peregrine observations, both flight-lines were below the CRZ (judged to be at 10 to 15m). Similarly, no CRM was undertaken for woodcock, as records were of wintering birds that were flushed by surveyors.

3 Collision Risk Model – Approach

Flight data for selected target species was run through a collision risk model (CRM), as detailed in SNH (2000)¹ and Band *et al.* (2007)². This model uses two approaches for different situations. The first approach is for birds that take regular flights through a wind farm area; and the second is for birds that may occupy an area, including a wind farm, as a regular territory. The model approach used in this case is the second approach, relating to birds occupying a given area.

3.1 Stage 1 - Number of birds flying through rotors

This stage involved a number of sequential steps:

1. Identify a 'flight risk volume' V_w which is the area of the windfarm multiplied by the height of the rotors, as shown in Equation 1.

$$V_w = Area_{windfarm} * rotor\ diameter \quad (1)$$

2. Calculate the combined volume swept out by the windfarm rotors using Equation 2:

$$V_r = X\pi R^2(d + l) \quad (2)$$

where X is the number of wind turbines, d is the depth of the rotor back to front, and l is the length of the bird.

3. Estimate the bird occupancy n within the flight risk volume. This is the number of birds present, multiplied by the time spent flying in the flight risk volume, within the period (usually one year) for which the collision estimate is being made.
4. The bird occupancy, in bird-seconds, of the volume swept by the rotors b is then calculated using Equation 3.

$$b = n \left(\frac{V_r}{V_w} \right) \quad (3)$$

5. Calculate the time taken for a bird to make a transit through the rotor and completely clear the rotors t , see Equation 4:

$$t = \frac{d + l}{v} \quad (4)$$

where v m/sec is the speed of the bird through the rotor.

6. To calculate the number of bird transits through the rotors N , divide the total occupancy of the volume swept by the rotors in bird-secs by the transit time t , as shown in Equation 5:

$$N = \frac{n \left(\frac{V_r}{V_w} \right)}{t} \quad (5)$$

Note in this calculation that the factor $(d + l)$ cancels itself out, so only assumed values need be used - it is used above to help visualise the calculation.

¹ Scottish Natural Heritage (2000). Windfarms and Birds - Calculating a theoretical collision risk assuming no avoiding action. SNH Guidance Note.

² Band, W., Madders, M., and Whitfield, DP., (2007). Developing Field and Analytical Methods to Assess Avian Collision Risk at Wind Farm Sites. In: de Lucas, M., Janss, G. & Ferrer, M. (Eds) 2007. Birds and Wind Farms – Risk Assessment and Mitigation. Quercus Editions, Madrid, 259-279

Within this stage, a weighting system is also applied to the value for bird occupancy n , which is intended to take account of the fact that the observations arise from different Vantage Points (VPs), that different vantage points cover varying area extents (in terms of total hectareage), and that the combination of the areas seen from all VPs may not always incorporate the entire site being assessed. The weighting factor for each VP is worked out by the percentage cover of the 15 m viewshed, as well as the combined percentage cover of all the VPs.

3.2 Stage 2 - Probability of bird being hit when flying through the rotors

This stage uses data relating to bird and rotor characteristics in order to compute the likelihood of a bird being hit when flying through the rotor. The turbine and operational model inputs are shown in **Table 1** and **Table 2** provides the model input for dimensions/attributes of target species. This, together with the output from Stage 1, allows for a model output of the likely number of collisions per year.

Data relating to the likelihood of a bird being hit when flying through the rotor is derived from a spreadsheet available from NatureScot (formerly Scottish Natural Heritage). The outputs from this spreadsheet are provided for each target species in **Table 3**.

Following the above steps, the number of bird transits per year through the rotors can be combined with the probability of a bird being hit when flying through the rotor to give a likely collision risk per year (assuming no avoidance). An avoidance figure is then applied in order to get a predicted likely collision rate, and thus a likely mortality rate. This stage also considers the proportion of time that turbines are likely to be operational. Avoidance rate are given in SNH (2016, 2018) and Furness (2019), which are used to provide estimates of the number of collisions per annum and for the life of the project (30 years).

Table 1. Turbine and operational inputs for the Enercon E-126 and Nordex 133

Turbine parameter	Unit	E-126	N133
Number of blades		3	3
Hub height	meters	85.94	83
Rotor diameter	meters	127	133.2
Minimum swept height	meters	24.85	18.6
Maximum swept height	meters	147.03	147.4
Maximum rotor depth d	meters	4	4
Maximum rotor chord	meters	4	4
Blade pitch ³	degrees	25	25
Dynamic operating range	rpm	5-12.1	6.9-13
Rotation period ⁴	seconds	6	5
Turbine operation time	percentage	0.85	0.85

³ Pitch varies between -5° and 90° depending on windspeed. The value of 25° is based on Band (2012) which suggests a pitch of 25° to 30°. This, however, is based on large off-shore turbines and is therefore considered a precautionary value for onshore turbines.

⁴ The values chosen for rotation period are slightly higher than the average rotation period calculated using the dynamic operating range. This is due to the site being an upland site and likely experiencing relatively high wind speeds.

Table 2. Avian biometrics⁵ and flight speeds^{6 7 8} model inputs

Species	Length (cm)	Average (cm)	Wing-span (cm)	Average (cm)	Flight speed (m/s)
Whooper swan	145-160	153	218-243	231	17.3
White-tailed eagle	70-90	80	200-240	220	13.6
Hen harrier	44-52	48	100-120	110	9.1
Sparrowhawk	28-38	33	55-70	63	10.0
Buzzard	51-57	54	113-128	121	11.6
Golden eagle	75-88	82	204-220	212	11.9
Kestrel	32-35	34	71-80	76	10.1
Merlin	25-30	28	52-62	57	10.1*
Snipe	25-27	26	44-47	46	17.1
Lesser black-backed gull	52-64	58	135-150	143	11.9
Herring gull	55-64	60	138-150	144	12.8
Great black-backed gull	64-78	71	150-165	158	13.7

*No flight speeds were found for merlin and the same flight speed as for kestrel was therefore employed in the CRM

Table 3: Average collision probability (Band 2007)

Species	E-126	N133	Avoidance Rate
Whooper swan	8.79%	9.77%	99.5 ⁹
White-tailed eagle	8.04%	8.87%	95.0
Hen harrier	8.52%	9.87%	99.0
Sparrowhawk	7.02%	8.09%	98.0
Buzzard	7.36%	8.36%	98.0
Golden eagle	8.72%	9.83%	99.0
Kestrel	7.07%	8.13%	95.0
Merlin	6.72%	7.73%	98.0
Snipe	4.73%	5.10%	98.0
Lesser black-backed gull	7.50%	8.47%	99.5 ¹⁰
Herring gull	7.23%	8.09%	99.5 ¹⁰
Great black-backed gull	7.33%	8.18%	99.5 ¹⁰

As would be expected, given the longer blade diameter, collision probability is higher for of the Nordex N133 turbine when compared with the smaller rotor swept area of the Enercon E-126. Therefore, the Nordex N133 turbine represents the worst-case scenario.

⁵ Snow, D. & Perrins, C.M. 1998. The Birds of the Western Palearctic: 2 Volume Set: Volume 1, Non-passerines; Volume 2, Passerines.

⁶ Alerstam, T., Rosen M., Backman J., G P., Ericson P & Hellgren O. 2007. Flight Speeds among Bird Species: Allometric and Phylogenetic Effects. *PLoS Biol*, 5, 1656-1662.

⁷ Bruderer, B & Boldt, A. (2001). Flight characteristics of birds: I. radar measurements of speeds. *Ibis* 143, pp 178-204.

⁸ Provan, S. & Whitfield, D. P. (2006). *Avian flight speeds and biometrics for use in collision risk modelling*. Report from Natural Research to Scottish Natural Heritage. Natural Research Ltd, Banchory

⁹ SNH (2018) Avoidance Rates for the onshore SNH Wind Farm Collision Model v2. Scottish Natural Heritage

¹⁰ 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.

3.3 Viewshed spatial coverage

Vantage point (VP) locations used were the same during all survey periods. Viewshed spatial coverages for each VP were calculated using ArcGIS Pro. Spatial coverage of these VPs, both in relation to the spatial area of the viewshed (at 15 m) within the study area and proportion of the study area, is given **Figure 3** and **Figure 4** of **Appendix I: Avi-fauna..** The locations of these vantage points in relation to the site and study area (500m buffer from the turbines) and the spatial coverage of each viewshed are mapped in **Figure 3** and **Figure 4** of **Appendix I: Avi-fauna.**

Table 4: Spatial visual coverage of 500 m buffer (area = 389 ha) and collision risk zone (CRZ)

Vantage Point (VP)	Turbines locations visible from VP (ground level to tip)	Additional turbine locations where majority of rotor swept area visible (within 2km of VP)	Area of CRZ visible within 500m turbine buffer (Ha)	% Coverage	VP survey effort non-breeding season (hrs)	VP survey effort breeding season (hrs)	Total VP survey effort (hours)
VP1	T8	T7	66	16 %	72.17	72.00	144.17
VP2	T2, T3, T4	T5, T6	210	51 %	72.00	72.17	144.17
VP3	T4, T5, T6, T7	T1, T2, T3, T8	304	74 %	72.17	72.00	144.17
VP4	T1, T2, T5, T6, T7	T3, T4, T8	321	78 %	72.75	72.00	144.75

3.4 Recorded Flight Activity

Surveys were undertaken for four seasons between October 2018 and August 2020. Flight times within the study area and at risk height are provided in **Table 5** for the 12 target species included in the model.

Table 5. Flight seconds in CRZ for target species from each vantage point (VP): Oct-2018 to Aug-2020

Species	VP1	VP2	VP3	VP4	Total (flight seconds)
Whooper swan	175	10		6,963	7,148
White-tailed eagle	117	47	2,670	310	3,144
Hen harrier		212			212
Sparrowhawk	15	70	301		386
Buzzard	594	1,396	3,813	1,580	7,383
Golden eagle	520	212	2,183	742	3,657
Kestrel	982	18	1,228	786	3,014
Merlin		866	192		1,058
Snipe			1,327		1,327
Lesser black-backed gull	1,847	0	555	0	2,402
Herring gull	19,500				19,500
Great black-backed gull	390	137	371	120	1,018

4 Collision risk assessment

As detailed above, the collision risk assessment is undertaken in two stages, with Stage 1 being to ascertain the number of bird flights through the rotors and Stage 2 being to ascertain the probability of a bird being hit by the rotors as it passes through.

Table 1 to **Table 5** show the model inputs for both turbine and bird parameters, as well as the basis of weighting for observational effort.

4.1 STAGE 1 - Number of birds flying through rotors

As detailed in the preceding section, the first part of Stage 1 is defining the 'flight risk volume' V_w . This is derived from the wind farm area (4,115,425.31 m²) multiplied by the rotor diameter (rotor swept area). This is shown below as 522,659,014 m³ for the E-126 and 548,174,651 m³ for the N133 and calculated using Equation 1. The 'rotor swept volume' V_r is then worked out based on the rotor swept area multiplied by the number of turbines, the depth of the rotor and the length of the bird. This is shown for both turbine models in **Table 6** and calculated using Equation 2.

E-126

$$\begin{aligned} V_w &= Area_{windfarm} * rotor\ diameter \\ &= 3888829 * (127) = 522659014m^3 \\ V_r &= X\pi R^2(d + l) = 8\pi \left(\frac{127}{2}\right)^2 (4 + l) \end{aligned}$$

N133

$$\begin{aligned} V_w &= Area_{windfarm} * rotor\ diameter \\ &= 3888829 * (133.2) = 548174651m^3 \\ V_r &= X\pi R^2(d + l) = 8\pi \left(\frac{133.2}{2}\right)^2 (4 + l) \end{aligned}$$

Table 6. Risk Volume V_r and rotor transit time t for each species using both turbine dimensions

Species	E-126		N133	
	V_r (m ³)	t (s)	V_r (m ³)	t (s)
Whooper swan	560418.472	0.31965	616472.133	0.31965
White-tailed eagle	486439.180	0.35294	535093.352	0.35294
Hen harrier	454009.901	0.49231	499420.462	0.49231
Sparrowhawk	438808.677	0.43300	482698.795	0.43300
Buzzard	460090.391	0.39138	506109.129	0.39138
Golden eagle	488466.010	0.40504	537322.908	0.40504
Kestrel	439822.092	0.42970	483813.573	0.42970
Merlin	433741.602	0.42376	477124.906	0.42376
Snipe	431714.772	0.24912	474895.350	0.24912
Lesser black-backed gull	464144.051	0.38487	510568.240	0.38487
Herring gull	466170.881	0.35938	512797.796	0.35938
Great black-backed gull	477318.445	0.34380	525060.352	0.34380

The next stage of the calculations is to determine the bird occupancy n within the flight risk volume. This is worked out individually for each VP and then averaged to find the mean occupancy across the site. The observation effort (see Equation 6) of each VP (in hectare hours) is first calculated by

multiplying the area viewed from the VP (see **Table 4**~~Error! Reference source not found.~~) by the number of VP hours undertaken (recommended 36 hours per VP per season by SNH). Occupancy n is then calculated, using Equation 7, by dividing the flight time at risk height (in hours) by the observation effort and then multiplying that value by the study area (500m turbine buffer) and the total hours the birds are active across the site. The time the birds are active is defined as the product of the number of days in the season/year and the mean day length. This is assumed to be an average of 12 days daylight for 365 days in the year for species that were present throughout the year (i.e. 4,380 hours). For wintering species 1,704 hours was used and for species that were only present during the breeding season 2,400 hours was applied. For snipe, a species known to fly at night a correction of 25% was applied to account for potential nocturnal flight time. The figures calculated for occupancy, in bird-seconds, are shown in **Table 7**.

$$\text{Observation effort} = \text{Area}_{\text{viewshed}} * \text{Survey effort} \quad (6)$$

$$n = \frac{\text{Flight time at risk height (hrs)}}{\text{Observation effort}} * \text{Area}_{500\text{m turbine buffer}} * \text{Daylight hours} \quad (7)$$

Table 7. Occupancy n (bird-secs) values calculated for each Vantage Point

Species	VP1	VP2	VP3	VP4
Whooper swan	7.11369	0.12883	0.00000	58.08181
White-tailed eagle	6.11969	0.77730	30.50346	3.34060
Hen harrier	0.00000	2.73128	0.00000	0.00000
Sparrowhawk	0.78458	1.15768	3.43878	0.00000
Buzzard	31.06918	23.08753	43.56168	17.02628
Golden eagle	27.19861	3.50613	24.93972	7.99589
Kestrel	51.36353	0.29769	14.02931	8.47004
Merlin	0.00000	15.67709	2.40668	0.00000
Snipe	0.00000	0.00000	20.79210	0.00000
Lesser black-backed gull	105.99608	0.00000	6.95681	0.00000
Herring gull	1019.94785	0.00000	0.00000	0.00000
Great black-backed gull	20.39896	2.26575	4.23850	1.29314

As previously described, a weighting factor was used to account for the varying extents of cover of each VP as well as the combined cover of each VP not accounting for the entire site. Weighted values for n were calculated using the values for percentage cover described in **Table 4**. In this case, the combined VPs do not cover the entirety of the site and therefore the total cover is 0.98.

$$n_{\text{weighted}} = \frac{n_{VP} (0.16) + n_{VP} (0.51) + n_{VP} (0.74) + n_{VP} (0.78)}{0.97}$$

Once a value for n and n_{weighted} has been calculated for each VP, this is then used to generate the mean activity for the site as a percentage of time (i.e. a percentage occupancy) within the risk

zone, n_{avg} . This is calculated by adding the values for n calculated for each VP then dividing by the number of VPs. In this case, both weighted and unweighted values for n_{avg} were obtained, as shown in **Table 8**.

Table 8. Values obtained for n_{avg} and $n_{weightedavg}$ (bird-secs)

Species	n_{avg}	$n_{weightedavg}$
Whooper swan	16.3311	11.9648
White-tailed eagle	10.1853	6.8219
Hen harrier	0.6828	0.3585
Sparrowhawk	1.3453	0.8379
Buzzard	28.6862	16.0122
Golden eagle	15.9101	7.9316
Kestrel	18.5401	6.5355
Merlin	4.5209	2.5149
Snipe	5.1980	3.9505
Lesser black-backed gull	28.2382	5.7206
Herring gull	254.9870	42.3278
Great black-backed gull	7.0491	2.2087

The bird occupancy of the rotor swept volume b is then worked out using Equation 3 by multiplying n_{avg} by $\frac{V_r}{V_w}$.

The bird occupancy of the swept volume b is used to ascertain the number of bird transits through the rotors N by dividing b by the rotor transit time t , see Equation 4-5. **Error! Reference source not found.** The number of transits through the rotors N is then adjusted by a factor of 0.85¹¹ to obtain Tn , which takes into account likely wind turbine down time. Calculations for the number of transits through the rotors are shown in **Table 9** for the E-126 and **Table 10** for the N133.

¹¹ This operational period of 85% is referenced from a report by the British Wind Energy Association (BWEA) (2007) which identifies the standard operational period of the wind turbines in the UK to be roughly 85%.

Table 9. Values obtained for number of transits through the rotors T_n for the E-126

Species	Weighted			Unweighted		
	b	N	T_n	b	N	T_n
Whooper swan	63.0393	197.2116	167.6299	46.1851	144.4850	122.8122
White-tailed eagle	34.1260	96.6902	82.1867	22.8568	64.7609	55.0467
Hen harrier	2.1353	4.3373	3.6867	1.1210	2.2771	1.9355
Sparrowhawk	4.0660	9.3903	7.9817	2.5324	5.8486	4.9713
Buzzard	90.9075	232.2747	197.4335	50.7433	129.6526	110.2047
Golden eagle	53.5292	132.1572	112.3336	26.6859	65.8842	56.0016
Kestrel	56.1661	130.7091	111.1027	19.7989	46.0759	39.1645
Merlin	13.5065	31.8729	27.0920	7.5134	17.7301	15.0706
Snipe	15.4568	62.0449	52.7381	11.7472	47.1541	40.0810
Lesser black-backed gull	90.2764	234.5609	199.3768	18.2886	47.5185	40.3907
Herring gull	818.7422	2278.2392	1936.5033	135.9112	378.1877	321.4595
Great black-backed gull	23.1753	67.4101	57.2986	7.2615	21.1216	17.9533

Table 10. Values obtained for number of transits th_{rough} the rotors T_n for the N133

Species	Weighted			Unweighted		
	b	N	T_n	b	N	T_n
Whooper swan	66.1168	206.8393	175.8134	48.4398	151.5385	128.8078
White-tailed eagle	35.7919	101.4105	86.1989	23.9726	67.9224	57.7341
Hen harrier	2.2395	4.5490	3.8667	1.1758	2.3882	2.0300
Sparrowhawk	4.2645	9.8487	8.3714	2.6561	6.1341	5.2140
Buzzard	95.3455	243.6141	207.0720	53.2206	135.9821	115.5848
Golden eagle	56.1425	138.6090	117.8176	27.9887	69.1006	58.7355
Kestrel	58.9080	137.0902	116.5266	20.7655	48.3252	41.0764
Merlin	14.1659	33.4289	28.4146	7.8801	18.5957	15.8063
Snipe	16.2114	65.0738	55.3127	12.3206	49.4561	42.0377
Lesser black-backed gull	94.6836	246.0119	209.1101	19.1814	49.8383	42.3625
Herring gull	858.7123	2389.4603	2031.0412	142.5462	396.6504	337.1528
Great black-backed gull	24.3067	70.7009	60.0958	7.6160	22.1527	18.8298

4.2 Stage 2 - Probability of bird being hit when flying through the rotors

Table 3 provides the collision probability of the selected target species passing through the rotors. The average collision probability is applied within the CRM and is based the collision probability of a bird travelling upwind and one travelling downwind. All collision probability calculations were undertaken using the setting for birds flapping, as opposed to the setting for gliding birds. This is appropriate for birds, like golden plover and snipe that predominately employ a flapping mode of flight. The flapping setting generates higher values for collision probability in species that incorporate gliding in their flight behaviour, in particular larger raptors, like buzzards. The higher (flapping) value has been retained for these species and will generate a more precautionary estimate for collision risk.

The model was also run for different rotation periods to examine the relationship between varying dynamic operation ranges and collision risk. The results of the varying collision probabilities for each species and each turbine model are shown in **Table 11**.

Table 11. Variation in collision risk probability for low and high rotation periods

Species	High rotation period		Low rotation period	
	E-126 (5s)	N133 (4s)	E-126 (12s)	N133 (9s)
Whooper swan	9.90%	11.61%	6.89%	7.08%
White-tailed eagle	8.99%	10.49%	6.64%	6.61%
Hen harrier	9.93%	12.09%	5.54%	6.27%
Sparrowhawk	8.15%	9.88%	4.70%	5.23%
Buzzard	8.44%	10.10%	5.34%	5.69%
Golden eagle	9.93%	11.81%	6.58%	6.86%
Kestrel	8.18%	9.90%	4.82%	5.31%
Merlin	7.78%	9.42%	4.56%	5.04%
Snipe	5.20%	5.94%	4.11%	4.03%
Lesser black-backed gull	8.55%	10.18%	5.60%	5.88%
Herring gull	8.19%	9.68%	5.58%	5.75%
Great black-backed gull	8.27%	9.75%	5.76%	5.89%

Table 12. Collision risk model results for the Enercon E-126

Species	Unweighted					Weighted				
	Collisions/year		Stats			Collisions/year		Stats		
	No avoid	Avoid	Per 10 years	Per 30 years	1 bird every x years	No avoid	Avoid	Per 10 years	Per 30 years	1 bird every x years
Whooper swan	14.74	0.03	0.29	0.88	33.92	10.80	0.02	0.22	0.65	46.30
White-tailed eagle	7.29	0.36	3.64	10.93	2.74	4.88	0.24	2.44	7.32	4.10
Hen harrier	0.36	0.01	0.07	0.22	137.42	0.19	0.00	0.04	0.11	261.76
Sparrowhawk	0.65	0.01	0.13	0.39	77.39	0.40	0.01	0.08	0.24	124.26
Buzzard	16.51	0.33	3.30	9.91	3.03	9.22	0.18	1.84	5.53	5.43
Golden eagle	11.04	0.11	1.10	3.31	9.06	5.50	0.06	0.55	1.65	18.17
Kestrel	9.03	0.45	4.51	13.54	2.22	3.18	0.16	1.59	4.77	6.28
Merlin	2.09	0.04	0.42	1.26	23.88	1.16	0.02	0.23	0.70	42.92
Snipe	2.69	0.05	0.54	1.61	18.58	2.05	0.04	0.41	1.23	24.45
Lesser black-backed gull	16.88	0.08	0.84	2.53	11.85	3.42	0.02	0.17	0.51	58.49
Herring gull	156.64	0.78	7.83	23.50	1.28	26.00	0.13	1.30	3.90	7.69
Great black-backed gull	4.68	0.02	0.23	0.70	42.69	1.47	0.01	0.07	0.22	136.25

Table 13. Collision risk model results for the Nordex 133

Species	Unweighted					Weighted				
	Collisions/year		Stats			Collisions/year		Stats		
	No avoidance	With avoidance	Per 10 years	Per 30 years	1 bird every x years	No avoidance	With avoidance	Per 10 years	Per 30 years	1 bird every x years
Whooper swan	17.18	0.03	0.34	1.03	29.11	12.59	0.03	0.25	0.76	39.73
White-tailed eagle	7.65	0.38	3.82	11.47	2.62	5.12	0.26	2.56	7.68	3.91
Hen harrier	0.38	0.01	0.08	0.23	131.03	0.20	0.00	0.04	0.12	249.58
Sparrowhawk	0.68	0.01	0.14	0.41	73.79	0.42	0.01	0.08	0.25	118.48
Buzzard	17.32	0.35	3.46	10.39	2.89	9.67	0.19	1.93	5.80	5.17
Golden eagle	11.58	0.12	1.16	3.47	8.63	5.77	0.06	0.58	1.73	17.32
Kestrel	9.47	0.47	4.73	14.20	2.11	3.34	0.17	1.67	5.01	5.99
Merlin	2.20	0.04	0.44	1.32	22.76	1.22	0.02	0.24	0.73	40.92
Snipe	2.82	0.06	0.56	1.69	17.72	2.14	0.04	0.43	1.29	23.31
Lesser black-backed gull	17.70	0.09	0.89	2.66	11.30	3.59	0.02	0.18	0.54	55.76
Herring gull	164.28	0.82	8.21	24.64	1.22	27.27	0.14	1.36	4.09	7.33
Great black-backed gull	4.91	0.02	0.25	0.74	40.70	1.54	0.01	0.08	0.23	129.91

5 Results and observations

The output figures from stage 1 (bird transits through the rotors per year) and stage 2 (probability of a bird being hit while passing through the rotors) are multiplied to get an estimated collision/mortality rate per year in the absence of any avoidance. An avoidance rate is then applied to this value – see **Table 3**. These results are detailed in **Error! Reference source not found.** for the Enercon E-126 and **Table 13** for the Nordex N133.

The results generated by running this version of the CRM are considered to represent high levels of theoretical collision risk posed to the target species recorded within the turbine envelope based on the flight data collected from October 2018 to August 2020, due to the parameters entered into the model being notably precautionary, including turbine dimensions, higher than average rotational period and selecting flapping flight behaviour for each species. It is also important to note that, as is always the case with a modelled approach, the collision risk model outputs are only considered to be indicative of the level of risk of fatalities resulting from the proposed wind farm site and should be considered in conjunction with other discussions within the Avi-fauna section in the Biodiversity Chapter of the EIS. For instance, the outputs from the model do not take account of potential displacement of birds from the wind farm envelope, which for species breeding within or directly adjacent to the site may be more of a cause for concern, e.g. sparrowhawk, merlin and snipe. It is also acknowledged that the application of CRMs to smaller, evasive species like sparrowhawk, merlin and snipe may not provide an accurate estimate of collision risk, as these species can be difficult to detect over the full extent of the viewsheds for VPs, due to diminutive size, cryptic nature and/or flight behaviour.

The worst-case CRM for Graffy Wind Farm (N133 turbines) generated notably low levels of theoretical collision risk for eight of the target species recorded. Less than 1.5 collisions (weighted) were predicted over the 30-year life span of the project for the following species:

- Whooper swan 0.76 collisions per 30 years (weighted)
- Hen harrier 0.12 collisions per 30 years (weighted)
- Sparrowhawk 0.25 collisions per 30 years (weighted)
- Merlin 0.73 collisions per 30 years (weighted)
- Snipe 1.29 collisions per 30 years (weighted)
- Lesser black-backed gull 0.54 collisions per 30 years (weighted)
- Great black-backed gull 0.23 collisions per 30 years (weighted)

The low levels of collision risk generated for some of these species were driven by low recorded usage within the turbine envelope, in particular for hen harriers (four observations of single birds over the two-years). This was also the case for *Larus* gulls, with relatively low numbers and observation recorded for lesser black-backed gulls (11 observations of 1 to 4 birds over the two-years) and great black-backed gulls (6 observations of 1 to 2 birds over the two-years). The predicted collision risk for

herring gulls although higher at 4.09 collisions per 30 years (weighted), was the result of a single observations of *c.* 150 birds circling through the site for *c.* 2 minutes, and overall, there were only three observations of herring gulls within the turbine envelope over the two years and the other observations were of only one and two birds. There were no regular gull flight paths identified through the turbine envelope and the occasional gull flocks recorded during VP watches were birds linked to the mink farm, *c.* 3.5 km to the west of the wind farm site, where several hundred gulls were regularly recorded, presumably attracted by the food feed to the captive mink. Therefore, based on recorded usage the proposed Graffy Wind Farm poses a negligible impact in terms of predicted collision risk for gulls and hen harrier.

As mentioned above, the accuracy of predicted collision rates generated for some target species may be less certain due to lower detection rates resulting from cryptic plumage, smaller size and evasive flight behaviour. Sparrowhawk, merlin and snipe all provide examples of species where collision rates may need further interpretation. It is all acknowledged that the application of CRMs to smaller, evasive species like sparrowhawk, merlin and snipe may not provide an accurate estimate of collision risk, as these species can be difficult to detect over the full extent of the viewsheds for VPs, due diminutive size and/or flight behaviour.

Higher collision rates were registered for four raptor species, which given the low fecundity of some larger raptors could potentially result in effects at the population level:

- White-tailed eagle 7.68 collisions per 30 years (weighted)
- Buzzard 5.80 collisions per 30 years (weighted)
- Kestrel 5.01 collisions per 30 years (weighted)
- Golden eagle 1.73 collisions per 30 years (weighted)

The population-level consequences of predicted collision risks can be assessed by considering the additional mortality that would be caused (assuming that the collision risk is non-additive) relative to background mortality rates in the population, with a threshold level of a 1% increase in annual mortality used to determine whether the impact will be significant (Percival, 2003). Estimates of the potential increase in annual mortality rates for target species are discussed within the impact assessment, where relevant.

In relation to CRM for white-tailed eagle, the model applies an avoidance rate of 95% to generate predicted collision for the proposed development, as per SNH (2018), which is based on the findings of May *et al.* (2010)¹². Applying a higher avoidance rate of 98% for this species can be justified based

¹² May, R., Hoel, P.L., Langston, R., Dahl, E.L., Bevanger, K., Reitan, O., Nygård, T., Pedersen, H.C., Røskoft, E. & Stokke, B.G. (2010). *Collision risk in white-tailed eagles. Modelling collision risk using vantage point observations in Smøla wind-power plant*. Norwegian Institute for Nature Research NINA Report 639. Trondheim, Norway

on the updated assessment for this research project, as described in May *et al.* (2011)¹³ which details the collision risk study using radio tagged birds and actual mortality rates for white-tailed eagles at a wind farm site in Norway. Applying a 98% avoidance rate generates a lower predicted value for collision related mortality, with a worst-cased scenario (Nordex N133) of 3.07 collisions predicted over 30 years, equivalent to 1 bird every *c.* 9.5 years (weighted and based on realistic operating conditions). The predicted risk is lowered further when the model is run using the specifications of the smaller alternative turbine (Enercon E-126) of 2.79 collisions predicted over 30 years, equivalent to 1 bird every *c.* 10.5 years (weighted and based on realistic operating conditions).

¹³ May R, Nygård T, Dahl EL, Reitan O, Bevanger K. (2011). *Collision risk in white-tailed eagles. Modelling kernel-based collision risk using satellite telemetry data in Smola wind-power plant.* Norwegian Institute for Nature Research 2011: 22. Trondheim, Norway.

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Table 14. Seasonal breakdown for target species flight lines recorded within 500 m turbine buffer

Target species*	Total flight secs	Season 1: Non-breeding 2018-19				Season 3: Non-breeding 2019-20			
		Mean No. of birds (range) No. of flight observations	Flight seconds in height bands			Mean No. of birds (range) No. of flight observations	Flight seconds in height bands		
			0 to 18m	18 to 150m	> 150m		0 to 18m	18 to 150m	> 150m
Grey heron	136	1.00 (range: na) 1 observation		75					
Whooper swan	7,148	14.00 (range: 5 to 23) 2 observations		7,075		3.00 (range: na) 1 observation		63	
Mallard	126								
White-tailed eagle	3,694	1.00 (range: na) 3 observations		247	40				
Hen harrier	296	1.00 (range: na) 3 observations	39	167					
<u>Sparrowhawk</u>	757					1.00 (range: na) 4 observations	56	75	
Buzzard	8,011	1.11 (range: 1 to 2) 9 observations	17	2,128		1.25 (range: 1 to 2) 4 observations	4	1,289	
Golden eagle	4,729	1.00 (range: na) 2 observations		702		1.00 (range: na) 5 observations		907	38
<u>Kestrel</u>	3,811	1.00 (range: na) 2 observations	0	347		1.00 (range: na) 11 observations	109	940	476
Merlin	2,102	1.00 (range: na) 1 observation	5			1.00 (range: na) 2 observations	10	143	
Peregrine	31					1.00 (range: na) 1 observation	18		
Red grouse	22	1.00 (range: na) 1 observation	22						
<u>Jack snipe</u>	6								
<u>Snipe</u>	1,339								
Black-headed gull	124								
<u>Lesser black-backed gull</u>	3,002	2.00 (range: na) 1 observation		368		3.00 (range: na) 1 observation		90	
Herring gull	20,005	1.00 (range: na) 1 observation	105						
<u>Great black-backed gull</u>	1,130					1.50 (range: 1 to 2) 2 observations		376	
Mixed gull flocks	7,500								

Target species	Season 2: Breeding 2019				Season 4: Breeding 2020			
	Mean No. of birds (range) No. of flight observations	Flight seconds in height bands			Mean No. of birds (range) No. of flight observations	Flight seconds in height bands		
		0 to 18m	18 to 150m	> 150m		0 to 18m	18 to 150m	> 150m
Grey heron	1.00 (range: na) 1 observation	9			1.00 (range: na) 2 observations	27	25	
Whooper swan	1.00 (range: na) 1 observation		10					
Mallard	2.50 (range: 2 to 3) 2 observations	126						
White-tailed eagle	1.00 (range: na) 3 observations		117	510	1.00 (range: na) 2 observations		2,780	
Hen harrier					1.00 (range: na) 3 observations	45	45	
<u>Sparrowhawk</u>	1.00 (range: na) 3 observations	83	171		1.00 (range: na) 4 observations	45	140	187
Buzzard	1.09 (range: 1 to 2) 11 observations	20	2,565	587	1.11 (range: 1 to 2) 10 observations		1,401	
Golden eagle	1.00 (range: na) 1 observation			201	1.18 (range: 1 to 2) 11 observations		2,048	833
<u>Kestrel</u>	1.00 (range: na) 3 observations		359		1.2 (range: 1 to 2) 5 observations		1,368	212
Merlin	1.31 (range: 1 to 3) 13 observations	201	199	681	1.07 (range: 1 to 2) 15 observations	147	716	
Peregrine	1.00 (range: na) 1 observation	13						
Red grouse								
<u>Jack snipe</u>	1.00 (range: na) 1 observation		6					
<u>Snipe</u>	1.33 (range: 1 to 2) 1 observation		787		1.00 (range: na) 2 observations	12	540	
Black-headed gull	1.00 (range: na) 1 observation		124					
<u>Lesser black-backed gull</u>	1.00 (range: na) 4 observations		271		2.20 (range: 1 to 4) 5 observations		1,673	600
Herring gull					76.00 (range: 2 to 150) 2 observations		19,500	400
<u>Great black-backed gull</u>					1.00 (range: na) 4 observations		642	112
Mixed gull flocks					50.00 (range: na) 1 observation			7,500

*Primary target species are highlight in **Bold** (Annex I/ BoCCI red listed), secondary target species indicted by underline (BoCCI amber listed) and BoCCI green listed target species are displayed in plain text.

Appendix 7: Confidential Appendix: Merlin flight-lines and nesting information

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Rationale for Confidential Appendix

Ornithological survey for the proposed Development followed SNH (2017)¹ guidelines and Section 5: Recording, reporting & presentation of data covers the requirement for confidential annexes to protect sensitive bird species. SNH(2017) defers to SNH (2015)² which is a list of sensitive species, where the term 'sensitive' refers to:

species that are vulnerable to persecution or over-exploitation. To safeguard them from deliberate harm, known locations of such species should only be made public at an imprecise resolution.

Breeding merlin are considered a sensitive breeding species on the SNH (2015) list, and the locations of nest sites should not be identified below the 2x2km resolution. The main threat of revealing nesting location was identified as egg collectors and taking of chicks for falconry.

However, in an Irish context, the legal situation in terms of freedom of information and potentially sensitive ecological information is less clear. The National Parks & Wildlife Service - NPWS has published a Sensitive Species List³ where it does not want to make the precise location of endangered species publicly available – merlin do not currently feature on this list. The Irish Raptor Study Group (IRSG) is currently lobbying Government, and specifically NPWS to consider all raptor species as highly sensitive and are added to the official Sensitive Species List.

In relation to the pair of merlin nesting at Graffy, it is considered that making the exact location of nesting sites publicly available may expose this nest site to unnecessary attention. It is important to note that these nesting locations are very exposed both in terms of limited nesting cover (short treelines) and can be accessed with ease from the adjacent public road. The impact assessment conducted for merlin, in terms of assessing distances from nests to turbines and construction activities was robustly undertaken and is clearly documented in the main text of the Biodiversity Chapter. Therefore, this appendix only holds information (nest locations), which it is considered necessary to keep confidential. Furthermore, it is strongly recommended that this information is only released to interested parties through an official data request to the NPWS.

Buffers shown around nests are taken from review by Ruddock & Whitfield (2007):

- US forestry guidelines maintaining a minimum 91 m no-cut buffer around known merlin nest sites.
- Currie & Elliot (1997) proposed a preliminary 200 – 400 m protective buffer around nest sites for forestry workers.
- The higher (400 m) buffer distance is consistent with the 400 m breeding season buffer recommended by Becker (1984) for Richardson's merlin (*F.c. richardsonii*) and human activities (development, logging, recreation, camping, hiking, or other disturbances), which should not occur within 366 m of active merlin nests during the breeding season according to Becker & Ball (1983).

¹ <https://www.nature.scot/sites/default/files/2018-06/Guidance%20Note%20-%20Recommended%20bird%20survey%20methods%20to%20inform%20impact%20assessment%20of%20onshore%20windfarms.pdf>

² <https://www.nature.scot/sites/default/files/2019-08/Sensitive%20Species%20of%20Scotland%20list.xls>

³ <https://www.npws.ie/sites/default/files/general/npws-sensitive-species.pdf>

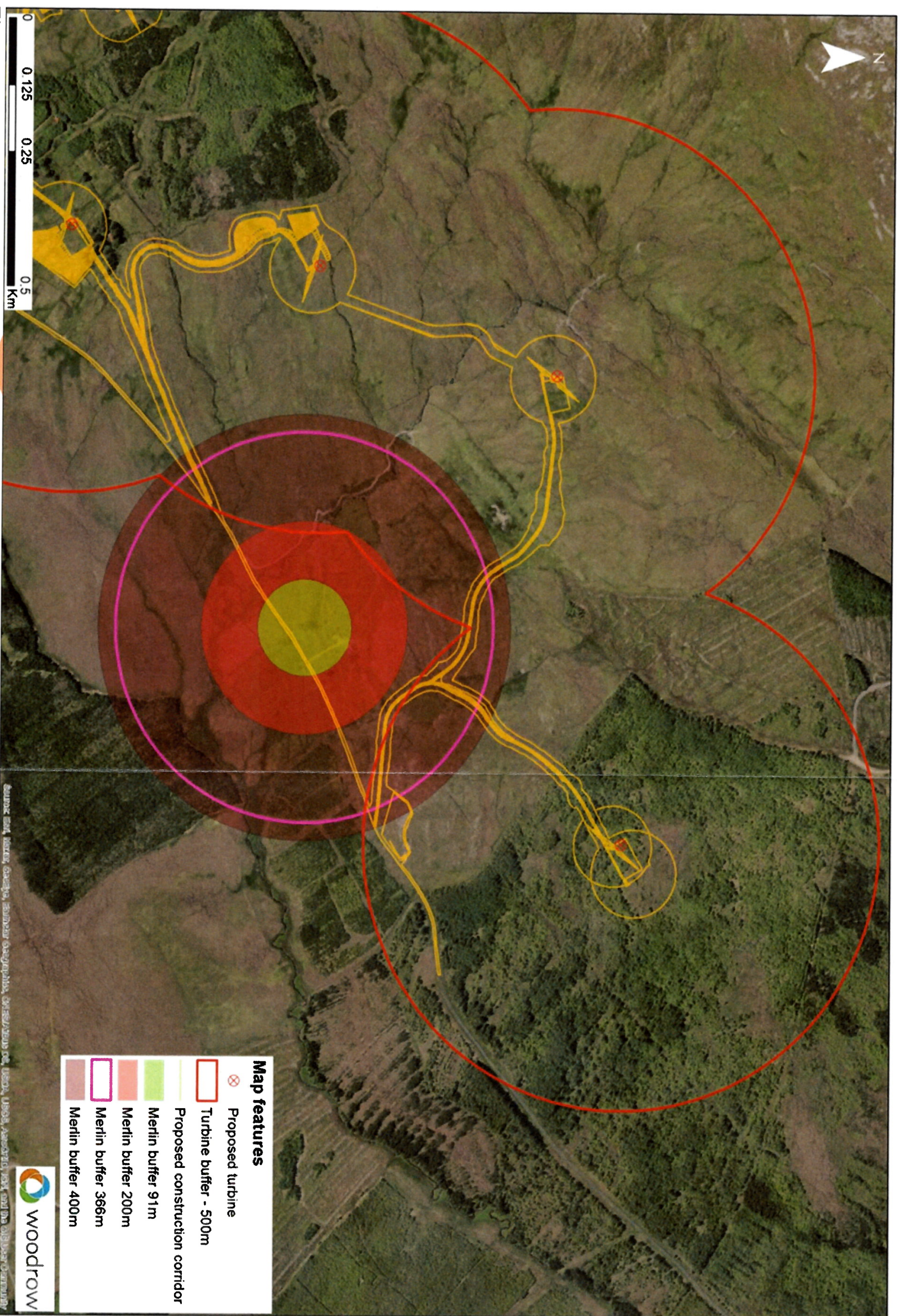


Figure 2. Map showing the location nest location of merlin in 2019 and nest buffers

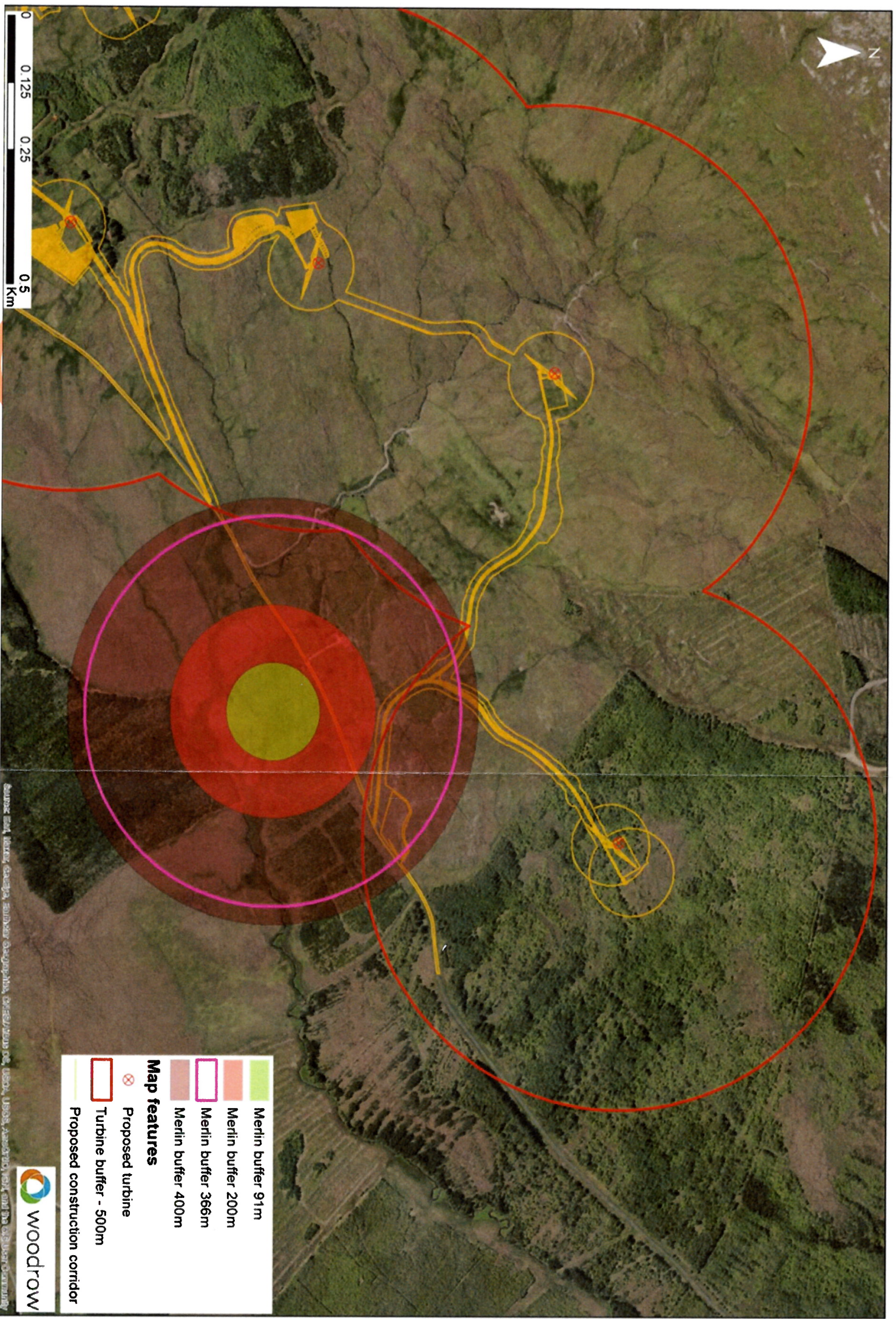


Figure 3. Map showing the location nest location of merlin in 2020 and nest buffers

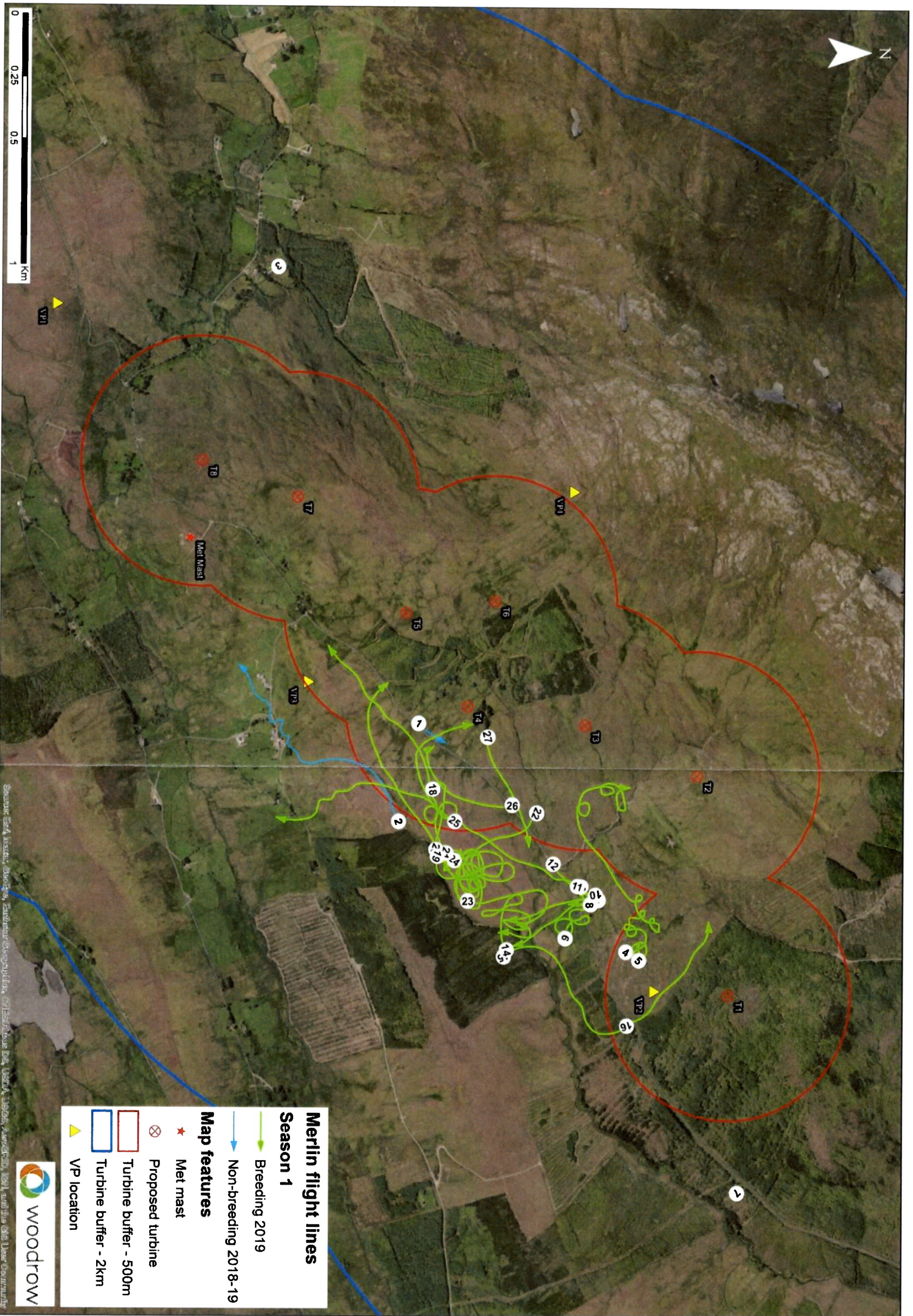


Figure 4. Merlin flight records recorded during VP watches Oct-2018 to Aug-2019

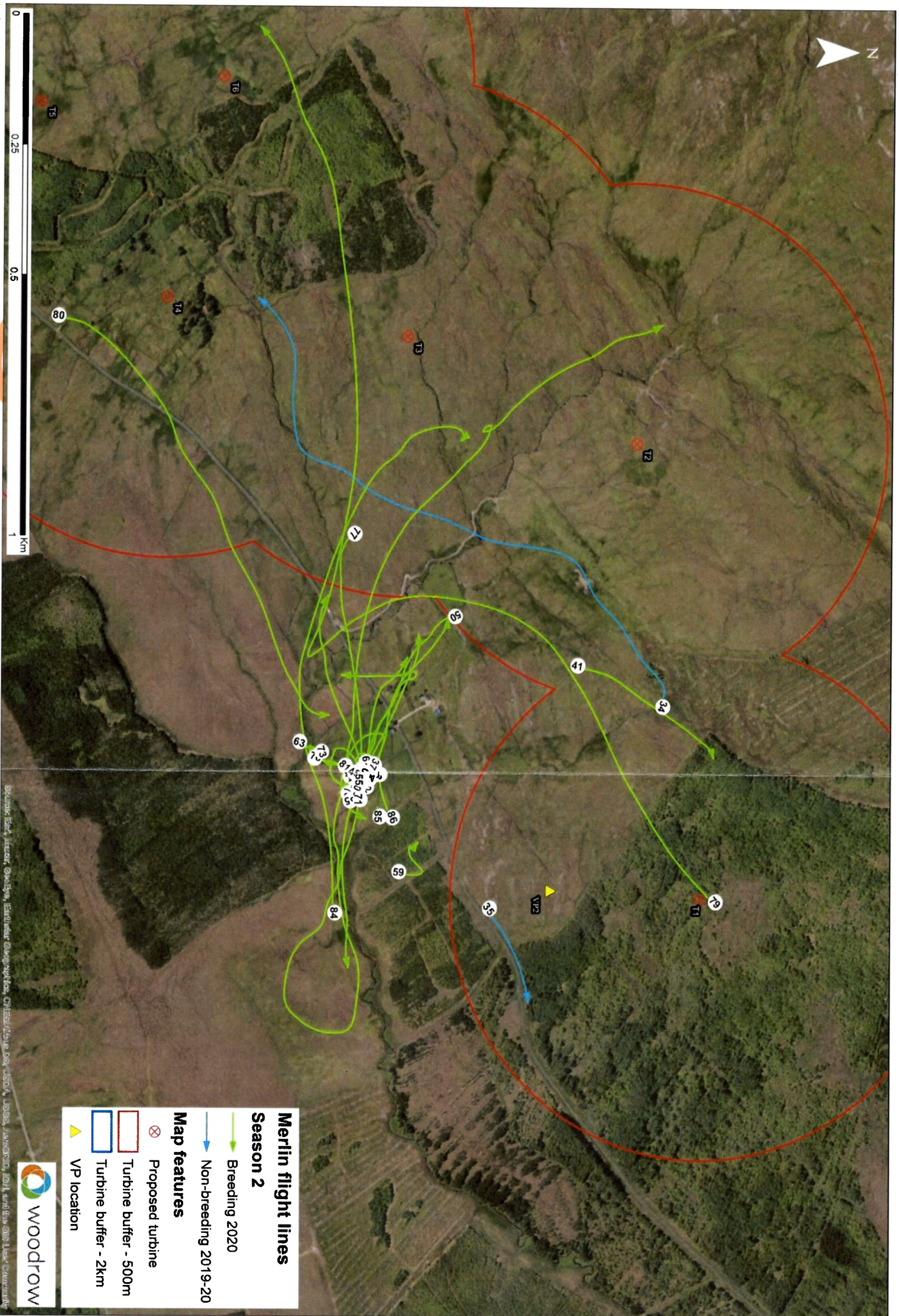


Figure 6. Merlin flight records recorded during VP watches Oct-2019 to Aug-2020 – focused on nest site

Table 1 Year 1: Non-breeding season 2018-19 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	MT	30/10/2018	815	2.00	RZ, WS	Wind: F3-2, S-E Oktas:7 Temp: 4-5°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	MT	01/11/2018	1004	2.00	No target sp.	Wind: F2-3, WNW-NW Oktas:6-4 Temp: 5-6°C Ground cond: wet/ damp Rainfall: nil Visibility: good Factors affect vis: none
1	KW	09/11/2018	800	3.00	No target sp.	Wind: F6, SE Oktas:8 Temp: not rec: °C Ground cond: dry Rainfall: showers Visibility: good Factors affect vis: none
1	KW	23/11/2018	840	3.00	BZ, HG	Wind: F3-4, E-NE Oktas:5-8 Temp: 3-6°C Ground cond: wet Rainfall: light passing showers Visibility: good Factors affect vis: none
1	KW	23/11/2018	1200	2.00	No target sp.	Wind: F3-4, E-NE Oktas:5-7 Temp: 6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	11/12/2018	950	3.00	H	Wind: F3-4, SE Oktas:7-8 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good-mod. Factors affect vis: low cloud covering highest hills & ridges (1130-1300)
1	HPD	11/12/2018	1315	3.00	No target sp.	Wind: F4-5, SE Oktas:8 Temp: 8°C Ground cond: dry Rainfall: mostly dry, single passing shower Visibility: mod. Factors affect vis: low cloud on highest hills and some mist lower later
1	KW	10/01/2019	845	3.00	No target sp.	Wind: F1, W Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	10/01/2019	1315	3.00	BZ	Wind: F1, W Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	05/02/2019	900	3.00	BZ	Wind: F4-5, S Oktas:8 Temp: 8°C Ground cond: damp Rainfall: light, occ heavy showers Visibility: mod. Factors affect vis: low cloud base over hilltops
1	HPD	05/02/2019	1225	3.00	H	Wind: F4-5, S Oktas:8 Temp: 8°C Ground cond: damp Rainfall: rain from 1420 Visibility: mod.-poor Factors affect vis: low cloud - showers at times
1	KW	22/02/2019	825	3.00	No target sp.	Wind: F3-5, S Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	22/02/2019	1150	3.00	SN	Wind: F5-6, S Oktas:8 Temp: 12°C Ground cond: wet Rainfall: mostly dry, occ. Showers Visibility: good-mod. Factors affect vis: misty at times
2	MT	30/10/2018	1049	3.00	H, WE	Wind: F3, S Oktas:7-8 Temp: 4°C Ground cond: wet Rainfall: mostly dry, occ. spots Visibility: good Factors affect vis: none
2	KW	19/11/2018	815	4.00	BZ	Wind: F1-2, E Oktas:4-7 Temp: 6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud covering mountain to west
2	KW	19/11/2018	1245	4.00	BZ, K	Wind: F1-2, E Oktas:5-8 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud covering mountain to west
2	KW	11/12/2018	1015	3.00	HH, ML	Wind: F3-4, ESE-SE Oktas:7-8 Temp: 9-10°C Ground cond: wet Rainfall: nil Visibility: good-mod. Factors affect vis: cloud covering mountain top
2	KW	11/12/2018	1335	3.00	No target sp.	Wind: F3-2, SE Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good-mod. Factors affect vis: mist - light
2	HPD	10/01/2019	845	3.00	GP	Wind: F1-2, W Oktas:8 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	HPD	10/01/2019	1215	3.00	No target sp.	Wind: F2, NW Oktas:8 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: mist/low cloud - occasional pockets
2	KW	05/02/2019	900	3.00	No target sp.	Wind: F4, ESE-SE Oktas:8 Temp: 5-10°C Ground cond: wet Rainfall: showers Visibility: mod.-good Factors affect vis: low cloud, with passing showers
2	KW	05/02/2019	1230	3.00	No target sp.	Wind: F4, SE Oktas:8 Temp: 10°C Ground cond: wet Rainfall: showers Visibility: mod.-good Factors affect vis: low cloud, with passing showers

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
2	HPD	22/02/2019	830	3.00	No target sp.	Wind: F4-5, S Oktas:8 Temp: 12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: good vis. low cloud covering hilltops above Graffy
2	HPD	22/02/2019	1155	3.00	No target sp.	Wind: F3-6, S Oktas:8 Temp: 12°C Ground cond: dry Rainfall: showers Visibility: mod- good Factors affect vis: mod vis during shower, otherwise good
2	KW	20/03/2019	1635	1.00	No target sp.	Wind: F4, SW Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to SW
3	MT	30/10/2018	1524	2.00	K, RG	Wind: F3-5, SE Oktas:8 Temp: 5-3°C Ground cond: wet Rainfall: mostly dry, occ. light passing shower Visibility: good Factors affect vis: low cloud over high ground until 1630, low light - dusk at 1738
3	MT	09/11/2018	710	4.00	No target sp.	Wind: F3-6, SE Oktas:7-8 Temp: 7°C Ground cond: wet/ damp Rainfall: mostly dry, occ. light drizzle Visibility: good Factors affect vis: low light, occ. moderate vis due to passing showers
3	KW	20/11/2018	815	3.00	BZ	Wind: F2-4, NE Oktas:2-5 Temp: 6°C Ground cond: wet Rainfall: not rec. Visibility: good Factors affect vis: low cloud base over hilltops
3	MT	01/12/2018	923	3.00	No target sp.	Wind: F1-3, E-NE Oktas:7-8 Temp: 5-9°C Ground cond: wet Rainfall: periods of light drizzle Visibility: good-mod. Factors affect vis: low cloud on top of mountain, vis mod during periods of drizzle, cloud base d _{tops} slightly misty
3	KW	18/12/2018	845	3.00	No target sp.	Wind: F3-4, S Oktas:4-8 Temp: 8-10°C Ground cond: wet Rainfall: showers Visibility: good, occ. mod. Factors affect vis: low cloud
3	KW	18/12/2018	1205	3.00	ML, BZ	Wind: F3-4, S Oktas:4-8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	23/01/2019	920	3.00	No target sp.	Wind: F1, W Oktas:8 Temp: 1-5-3°C Ground cond: snow/ wet Rainfall: showers rain & sleet Visibility: mod. Factors affect vis: low cloud
3	KW	23/01/2019	1245	3.00	No target sp.	Wind: F1-3, W Oktas:8 Temp: 3°C Ground cond: wet-snow Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops
3	KW	12/02/2019	1025	3.00	No target sp.	Wind: F3-4, SSW-S Oktas:8-5 Temp: 9°C Ground cond: wet Rainfall: nil Visibility: mod- good Factors affect vis: low cloud & mist
3	KW	12/02/2019	1355	3.00	No target sp.	Wind: F4-5, S Oktas:7-3 Temp: 9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hilltops periodically
3	KW	01/03/2019	930	3.00	BZ	Wind: F2-4, S-SSE Oktas:4-8 Temp: 8-9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	HPD	20/03/2019	945	3.00	BZ, LB, WE	Wind: F5, SW Oktas:8 Temp: 11°C Ground cond: dry Rainfall: showers Visibility: mod- good Factors affect vis: fog on hills, clear lower down around VP
4	MT	01/11/2018	1258	4.50	K, EA	Wind: F3-2, NW-W Oktas:5-8 Temp: 6°C Ground cond: wet/ damp Rainfall: mostly dry, occ. passing shower Visibility: good, occ. mod. Factors affect vis: glare - occasionally, intense glare & showers
4	KW	18/11/2018	915	3.00	No target sp.	Wind: F4-5, E Oktas:4-1 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: mod- good Factors affect vis: glare to E, intermittent low cloud
4	KW	18/11/2018	1245	3.00	No target sp.	Wind: F4-5, E Oktas:3-1 Temp: 7-6°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to E
4	KW	19/12/2018	905	3.00	EA	Wind: F4, S Oktas:8 Temp: not rec. Ground cond: wet Rainfall: passing showers Visibility: good Factors affect vis: low cloud base over hilltops
4	KW	19/12/2018	1235	3.00	K	Wind: F4-5, S Oktas:8 Temp: not rec. Ground cond: wet Rainfall: passing showers Visibility: good Factors affect vis: low cloud base over hilltops
4	KW	24/01/2019	915	3.00	No target sp.	Wind: F3-4, WNW Oktas:8 Temp: 5-9°C Ground cond: wet Rainfall: misty drizzle Visibility: mod-poor Factors affect vis: low cloud & mist
4	KW	24/01/2019	1240	3.00	No target sp.	Wind: F2-4, WNW Oktas:8 Temp: 9-10°C Ground cond: wet Rainfall: showers Visibility: poor Factors affect vis: fog, low cloud, mist
4	KW	29/01/2019	900	3.00	No target sp.	Wind: F4-2, NW Oktas:4-8 Temp: 1-5°C Ground cond: snow Rainfall: snow showers Visibility: mod- good Factors affect vis: snow showers
4	KW	29/01/2019	1220	3.50	No target sp.	Wind: F2-1, NW Oktas:8-5 Temp: 1-3°C Ground cond: snow Rainfall: snow showers Visibility: mod- good Factors affect vis: snow showers - low cloud - glare

VP	Surveyor	Date	Start Time	Duration (hr)	Target Sp. (* heard)	Weather summary
4	KW	14/02/2019	1315	4.50	No target sp.	Wind: F3-5, S Oktas:8 Temp: 9-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: murky light beyond 2km
4	KW	21/03/2019	1415	3.00	BZ, LB, RG, WE, WS	Wind: F4, SW Oktas:8 Temp: 10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hilltops

Table 2 Year 1: Breeding season 2019 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
1	HPD	20/03/2019	1630	1.00	BZ	Wind: F4: SW Oktas:7-8 Temp: 12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: good vis, low cloud covering hilltops above Graffy
1	KW	21/03/2019	930	3.00	LB	Wind: F2: SW Oktas:8 Temp: 12°C Ground cond: wet Rainfall: mist Visibility: poor Factors affect vis: low cloud
1	KW	28/03/2019	1200	3.00	ML	Wind: F3-5: SW Oktas:2-4 Temp: 13-14°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	17/04/2019	1400	3.00	BZ	Wind: F1-5: SE-E Oktas:3-7 Temp: 10-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	HPD	09/05/2019	900	3.00	BZ, LB, RG, SN, WC, WM	Wind: F1-2: NE Oktas:8 Temp: 8°C Ground cond: dry Rainfall: showers Visibility: mod-good Factors affect vis: mod vis during showers, otherwise good
1	KW	18/05/2019	815	3.00	No target sp.	Wind: F5: NW Oktas:7-8 Temp: 12-14°C Ground cond: dry Rainfall: mostly dry, v. light shower at end Visibility: good Factors affect vis: none
1	KW	18/05/2019	1145	3.00	WE	Wind: F3-5: NW Oktas:7-8 Temp: 14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	14/06/2019	800	2.00	LB	Wind: F2: W Oktas:4-6 Temp: 12-13°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	KW	25/06/2019	1100	3.00	SN	Wind: F2-3: NE Oktas:8 Temp: 18°C Ground cond: not rec. Rainfall: mist Visibility: good Factors affect vis: low cloud base over hilltops
1	KW	16/07/2019	915	3.00	BZ	Wind: F3-4: SW Oktas:4-7 Temp: 16-18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	23/07/2019	1300	3.00	LB	Wind: F4-5: S Oktas:2-4 Temp: 22°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	KW	16/08/2019	815	3.00	LB, MA	Wind: F4-5: SSW Oktas:3-8 Temp: not rec. °C Ground cond: wet Rainfall: passing showers Visibility: mod-good Factors affect vis: low cloud & passing showers
1	KW	03/09/2019	900	3.00	RK *	Wind: F2-3: SW Oktas:8 Temp: 16-17°C Ground cond: wet Rainfall: passing showers Visibility: poor-good Factors affect vis: low cloud & passing showers
2	HPD	21/03/2019	930	3.00	JS, LB, WS	Wind: F3: SW Oktas:8 Temp: 12°C Ground cond: damp Rainfall: light shower Visibility: mod-poor Factors affect vis: fog thick, vis 500-800m average, occ better, also some light drizzle
2	KW	27/03/2019	1330	3.00	BZ	Wind: F5: SW Oktas:5-8 Temp: 8-9°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	KW	17/04/2019	1000	3.00	ML	Wind: F1-4: E-SE Oktas:4-6 Temp: 9-10°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	HD	09/05/2019	930	3.00	ML	Wind: F2: E Oktas:7-8 Temp: 7°C Ground cond: wet Rainfall: persistent light rain Visibility: mod. Factors affect vis: low cloud
2	KW	17/05/2019	915	3.00	BZ	Wind: F3-4: SE-E Oktas:2-8 Temp: 1-4°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	17/05/2019	1245	3.00	ML	Wind: F2-1: E Oktas:8 Temp: 4°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	07/06/2019	745	3.00	BZ, MA, ML	Wind: F2-3: SE Oktas:5-8 Temp: 11-13°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none
2	KW	19/06/2019	1800	3.00	ML (on nest)	Wind: F2-3: SW Oktas:6-8 Temp: not rec. °C Ground cond: wet Rainfall: showers Visibility: mod-good Factors affect vis: low cloud
2	KW	02/07/2019	915	3.00	ML & PE before start	Wind: F2: NW Oktas:7-8 Temp: 13-14°C Ground cond: dry Rainfall: mostly dry, occ. v light misty drizzle Visibility: good Factors affect vis: occ. misty drizzle
2	KW	17/07/2019	1000	3.00	ML, H	Wind: F3-4: S Oktas:8 Temp: 16°C Ground cond: wet Rainfall: showers, light rain & mist Visibility: good Factors affect vis: low cloud base over hilltops

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
2	KW	08/08/2019	900	3.00	No target sp.	Wind: F1, NE-ENE Oktas:6-8 Temp: 14-18°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
2	KW	21/08/2019	830	3.00	No target sp.	Wind: F4, S Oktas:7-8 Temp: 12-13°C Ground cond: wet Rainfall: passing showers - occ. heavy Visibility: mod.-good Factors affect vis: low cloud over mountain top, with passing showers
3	KW	27/03/2019	930	3.00	BH, BZ, LB, SH, WE	Wind: F5, SW Oktas:8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	10/04/2019	1045	3.00	BZ, EA, K	Wind: F3-4, E-SE Oktas:3-6 Temp: 10-11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	10/04/2019	1405	3.00	BZ, WE	Wind: F4-3, SE Oktas:4-2 Temp: 11°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	HPD	09/05/2019	1330	3.00	ML	Wind: F1, E Oktas:7-8 Temp: 17°C Ground cond: damp Rainfall: passing showers Visibility: good Factors affect vis: occ. showers
3	HPD	18/05/2019	845	3.00	ML	Wind: F4-5, NW Oktas:8 Temp: 14°C Ground cond: dry Rainfall: showers Visibility: good Factors affect vis: fog covering hill tops above Grafly, otherwise good lower down
3	HPD	18/05/2019	1200	3.00	No target sp.	Wind: F4-5, NW Oktas:7-8 Temp: 13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: fog covering hill tops above Grafly, cleared later (1330), light heat haze
3	KW	07/06/2019	1100	3.00	BZ, LB	Wind: F2-4, SE-S Oktas:7-8 Temp: 12-13°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	KW	19/06/2019	1500	3.00	SN	Wind: F3-5, SW Oktas:8 Temp: 14°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: low cloud
3	KW	02/07/2019	1300	3.00	SH	Wind: F2-4, NW Oktas:7-8 Temp: 17-18°C Ground cond: dry Rainfall: not rec. Visibility: good Factors affect vis: none
3	KW	17/07/2019	1700	3.00	ML	Wind: F2-4, SW Oktas:3-6 Temp: 16-17°C Ground cond: wet Rainfall: not rec. Visibility: good Factors affect vis: none
3	KW	08/08/2019	1230	3.00	K	Wind: F1, ENE-E Oktas:5-8 Temp: 18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	KW	21/08/2019	1200	1.00	No target sp.	Wind: F4-5, S Oktas:8 Temp: 13°C Ground cond: wet Rainfall: light drizzle becomes heavy & persistent Visibility: mod.-poor Factors affect vis: rain
3	KW	03/09/2019	1230	2.00	SH	Wind: F3, SW Oktas:8 Temp: 16-17°C Ground cond: wet Rainfall: misty rain shower Visibility: poor-mod. Factors affect vis: rain & mist
4	KW	11/04/2018	1015	3.00	No target sp.	Wind: F1-2, SE-S Oktas:8 Temp: 9-11°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: low cloud/ haze beyond 2k
4	KW	11/04/2018	1340	3.00	BZ	Wind: F1-2, S Oktas:8 Temp: 11°C Ground cond: wet Rainfall: nil Visibility: mod.-good Factors affect vis: low cloud/ haze beyond 2k
4	KW	26/03/2019	1015	3.00	RG	Wind: F5-6, SW Oktas:8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hilltops periodically
4	KW	26/03/2019	1335	3.00	No target sp.	Wind: F5, SW Oktas:8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: low cloud base over hilltops periodically
4	KW	29/05/2019	850	3.00	No target sp.	Wind: F1-2, SE Oktas:8 Temp: 10-11°C Ground cond: wet Rainfall: mostly dry, occ. light showers Visibility: good Factors affect vis: low cloud base over hilltops
4	KW	29/05/2019	1215	3.00	No target sp.	Wind: F2, S Oktas:8 Temp: 11°C Ground cond: wet Rainfall: light passing showers, becoming persistent at end Visibility: good-mod. Factors affect vis: low cloud dropping over lower slopes towards end
4	KW	14/06/2019	1045	3.00	BZ	Wind: F2, W Oktas:4-8 Temp: 13°C Ground cond: wet Rainfall: showers Visibility: good Factors affect vis: occ. showers
4	KW	25/06/2019	1445	3.00	BZ	Wind: F3, NE Oktas:6-8 Temp: 16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	16/07/2019	1300	3.00	No target sp.	Wind: F4-5, SW Oktas:6-8 Temp: 19-20°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather conditions
4	KW	23/07/2019	1645	3:00	No target sp.	Wind: F5, S Oktas:2-4 Temp: 22°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	KW	16/08/2019	1200	3:00	No target sp.	Wind: F5-6 (gusting 7), SW Oktas:8-6 Temp: 15°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	KW	04/09/2019	1315	3:00	No target sp.	Wind: F5-6, NW Oktas:8 Temp: 12-13°C Ground cond: wet Rainfall: passing showers Visibility: good-mod. Factors affect vis: showers

Table 3 Year 2: Non-breeding season 2019-20 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	KW	10/10/2019	930	3.00	ML, RG	Wind: F3, S Oktas:8 Temp: 12-13°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: none
1	RV	27/10/2019	935	3.00	RG	Wind: F1-2, NE Oktas:1-2 Temp: 5-6°C Ground cond: damp Rainfall: single prolonged shower Visibility: good Factors affect vis: shower
1	RV	30/10/2019	1125	3.00	RG	Wind: F3, N-NW Oktas:2-3 Temp: 8-10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	18/11/2019	1245	3.00	No target sp.	Wind: F2-3, SE Oktas:6 Temp: 2°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	07/12/2019	1225	3.00	BZ, K	Wind: F4-5, SSW Oktas:7-8 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	JB	31/12/2019	905	3.00	No target sp.	Wind: F2-3, E Oktas:0 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
1	JB	05/01/2020	830	3.00	BZ, EA, GB, RG	Wind: F2-4, S Oktas:8 Temp: 8°C Ground cond: wet Rainfall: mostly dry, occ. drizzle Visibility: good Factors affect vis: low cloud, occasional drizzle
1	JB	12/01/2020	940	3.00	GB	Wind: F3-4, SW Oktas:5 Temp: 3°C Ground cond: wet Rainfall: short rain showers Visibility: good Factors affect vis: none
1	JB	28/01/2020	1200	3.00	H	Wind: F2-4, W Oktas:8 Temp: 3°C Ground cond: snow - patchy/ wet Rainfall: mostly dry, occ. shower/ hail Visibility: good-mod. Factors affect vis: rain/hail
1	JB	13/02/2020	1015	3.00	BZ	Wind: F3-4, ENE-NE Oktas:6-8 Temp: 4°C Ground cond: wet Rainfall: mostly dry, occ. light rain, drizzle Visibility: mostly good Factors affect vis: rain/drizzle
1	JB	27/02/2020	1330	3.17	ML, K, GB, WE	Wind: F3, WNW-W Oktas:7-4 Temp: 6°C Ground cond: snow: 10mm Rainfall: nil Visibility: good Factors affect vis: none
1	RV	03/03/2020	730	3.00	LB, K, LB	Wind: F4, W-WNW Oktas:2-4 Temp: 4°C Ground cond: damp Rainfall: mostly dry occ. light drizzle, some sleet & snow Visibility: good Factors affect vis: occ. sleet/ snow showers
2	KW	17/10/2019	1200	3.00	No target sp.	Wind: F2-4, SSE-S Oktas:5-8 Temp: 7-8°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: low cloud
2	RV	27/10/2019	1320	3.00	K	Wind: F1, N Oktas:1-4 Temp: 6-7°C Ground cond: wet Rainfall: showers Visibility: mod. Factors affect vis: glare - intense at times, with single heavy shower
2	RV	30/10/2019	745	3.00	No target sp.	Wind: F2-3, N Oktas:1-3 Temp: 6-9°C Ground cond: damp Rainfall: light drizzle Visibility: good Factors affect vis: none
2	JB	18/11/2019	915	3.00	No target sp.	Wind: F1-3, SW-S Oktas:1-7 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
2	JB	07/12/2019	855	3.00	No target sp.	Wind: F4, SW Oktas:8 Temp: 8°C Ground cond: wet Rainfall: drizzle/light rain Visibility: mod.-poor Factors affect vis: low cloud - vis down to 1km at times, high points obscured for most of watch
2	JB	15/12/2019	900	3.00	K/SH?, ML, RG	Wind: F2-3, SW Oktas:2-5 Temp: 0°C Ground cond: snow - light Rainfall: nil Visibility: good Factors affect vis: none
2	JB	31/12/2019	1230	3.00	K, EA	Wind: F2-3, E-SE-S Oktas:0-1 Temp: 2°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: haze - slight during last hour
2	JB	09/01/2020	1235	3.00	K, EA	Wind: F2, SW Oktas:4 Temp: 4°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	JB	28/01/2020	830	3.00	No target sp.	Wind: F2-4, W Oktas:8 Temp: 1°C Ground cond: snow: 40mm Rainfall: rain, hail, sleet Visibility: good Factors affect vis: short hail/select showers
2	JB	13/02/2020	1345	3.00	EA, PE, RG, WE	Wind: F3-2, NE-NNE-E Oktas:6-2 Temp: 5°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: glare to W - occ over last hour
2	JB	27/02/2020	1000	3.00	EA, SH, WE	Wind: F3-4, NW Oktas:3-8 Temp: 3°C Ground cond: snow: 30mm Rainfall: mostly dry - passing snow showers Visibility: good Factors affect vis: snow showers

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
2	RV	03/03/2020	1430	3.00	ML, SH	Wind: F4-3, WNW-W Oktas:2-4 Temp: 5°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: glare - mild caused by evening sun
3	KW	10/10/2019	1300	3.00	LB	Wind: F3-5, S Oktas:7-8 Temp: 11-12°C Ground cond: wet Rainfall: showers Visibility: poor-good Factors affect vis: none
3	RV	29/10/2019	1245	3.00	K, SH	Wind: F3-4, E Oktas:1-3 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	RV	31/10/2019	815	3.00	BZ, EA, K	Wind: F3, SE Oktas:7 Temp: 8°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: low cloud base over hills periodically
3	JB	27/11/2019	1230	3.00	K, EA	Wind: F2-3, NE Oktas:4-7 Temp: 6°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	09/12/2019	1210	3.00	K	Wind: F2, W Oktas:5-8 Temp: 6°C Ground cond: dry Rainfall: v. light drizzle Visibility: good Factors affect vis: none
3	JB	17/12/2019	1215	3.00	SH	Wind: F2, W Oktas:4-8 Temp: 2°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	JB	05/01/2020	1155	3.00	BZ, EA, GB	Wind: F4-5, SW Oktas:8 Temp: 9°C Ground cond: wet Rainfall: drizzle Visibility: mod.-good Factors affect vis: low cloud on top of site, drizzle at times
3	JB	17/01/2020	1245	3.00	BZ, K, SH	Wind: F2-3, W Oktas:5-7 Temp: 3°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	JB	06/02/2020	1245	3.17	BZ, CA, EA, K, SH	Wind: F3-5, SW Oktas:5-6 Temp: 5°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	JB	24/02/2020	1000	3.00	No target sp.	Wind: F4-5, W Oktas:7-8 Temp: 3°C Ground cond: snow: 50mm Rainfall: light drizzle Visibility: mod.-good Factors affect vis: drizzle
3	JB	24/02/2020	1330	3.00	No target sp.	Wind: F5-6, W Oktas:7-8 Temp: 3°C Ground cond: snow: 20mm Rainfall: light to heavy showers Visibility: good-mod. Factors affect vis: showers
3	RV	03/03/2020	1100	3.00	No target sp.	Wind: F4-5, WNW Oktas:1-8 Temp: 5°C Ground cond: wet Rainfall: snow & sleet for 20mins Visibility: good Factors affect vis: sleet snow shower
4	KW	17/10/2019	830	3.00	BZ	Wind: F4-5, SE-SE Oktas:4-8 Temp: 7-8°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	RV	29/10/2019	904	3.00	K, WS	Wind: F3-4, NE-E Oktas:1 Temp: 3-5°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	31/10/2019	1208	3.00	K	Wind: F3-4, SE Oktas:1-3 Temp: 9°C Ground cond: damp Rainfall: nil Visibility: not rec. Factors affect vis: low cloud base over hilltops
4	JB	27/11/2019	840	3.00	RG	Wind: F2-3, NE Oktas:3-6 Temp: 5°C Ground cond: wet Rainfall: mostly dry, occ. light passing shower Visibility: mod.-good Factors affect vis: low cloud patches clearing, then occ. glare
4	JB	09/12/2019	840	3.00	No target sp.	Wind: F1-2, NW Oktas:1-4 Temp: 4°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: glare - some at sunrise
4	JB	17/12/2019	845	3.00	EA	Wind: F1-2, W Oktas:5-8 Temp: 0°C Ground cond: frost Rainfall: nil Visibility: good Factors affect vis: none
4	JB	09/01/2020	900	3.00	No target sp.	Wind: F1, S Oktas:4-7 Temp: 4°C Ground cond: frost/ wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	17/01/2020	900	3.25	RG	Wind: F4-1, SW-W Oktas:7-8 Temp: 1°C Ground cond: wet-snow Rainfall: passing showers - occ. snow Visibility: mod. Factors affect vis: low cloud, slight mist (15m)
4	JB	06/02/2020	915	3.00	No target sp.	Wind: F3-6, SSW-SW Oktas:6-7 Temp: 2°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	JB	23/02/2020	900	3.00	BZ, EA, RG	Wind: F3-5, W Oktas:5-6 Temp: 2-3°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	23/02/2020	1230	3.00	EA, K	Wind: F4-3, W Oktas:5-6 Temp: 2-4°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
4	RV	07/03/2020	920	3.00	WK	Wind: F5, W-S Oktas:8 Temp: 3°C Ground cond: wet Rainfall: rain until 1100, heavy at times Visibility: mod. Factors affect vis: cloud base above VP

Table 4 Year 2: Breeding season 2020 – Vantage point (VP) survey effort

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
1	JB	21/04/2020	1515	3.00	GB, HG, LB	Wind: F4-3, E Oktas:1 Temp: 13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	22/04/2020	800	3.00	BZ, RG	Wind: F3-2, E Oktas:2-5 Temp: 7-12°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	24/04/2020	1415	3.00	K, RG	Wind: F1-3, E-SW Oktas:2-4 Temp: 20-18°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	JB	13/05/2020	1000	3.00	BZ, K, RG	Wind: F3-4, NNE Oktas:7-8 Temp: 7-11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	RV	16/05/2020	645	3.00	K, LB, SN	Wind: F3, SW Oktas:8 Temp: 7°C Ground cond: dry Rainfall: Drizzle Visibility: mod. Factors affect vis: low cloud, drizzle & some mist
1	JB	27/05/2020	1330	3.00	BZ, EA, K	Wind: F2, SW Oktas:3-8 Temp: 18°C Ground cond: dry Rainfall: nil Visibility: Good Factors affect vis: none
1	JB	04/06/2020	1600	3.00	K, SN	Wind: F3, NNW Oktas:8 Temp: 11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
1	RV	23/06/2020	520	3.00	H, LB	Wind: F1-F2, S Oktas:1 Temp: 10°C Ground cond: damp Rainfall: nil Visibility: good-mod. Factors affect vis: misty, overcast & dull at start quickly cleared, occ. low cloud along top of mountain
1	RV	08/07/2020	1715	3.00	BZ, SH	Wind: F3, NE Oktas:1 Temp: 13°C Ground cond: damp Rainfall: drizzle Visibility: Good Factors affect vis: drizzle - light spells, some patches of low cloud but generally clear
1	JB	11/07/2020	1315	3.00	H, HG, SN	Wind: F3, W Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
1	RV	12/08/2020	630	3.00	ML	Wind: F2-3, NNE Oktas:8-2 Temp: 13°C Ground cond: damp Rainfall: nil Visibility: poor-mod. Factors affect vis: low cloud over hill top, also localised mist
1	RV	19/08/2020	1320	3.00	EA	Wind: F4-5, E Oktas:7-8 Temp: 18°C Ground cond: damp Rainfall: light drizzle from 15:40 Visibility: good-mod. Factors affect vis: drizzle - light for last 40 mins
2	JB	21/04/2020	815	3.00	MA, ML, SH	Wind: F2-3, ESE Oktas:0 Temp: 6-10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	RV	22/04/2020	645	3.00	ML	Wind: F3, E Oktas:2 Temp: 9°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	JB	24/04/2020	1045	3.00	EA, GB, ML, RG	Wind: F1-2, E Oktas:2-3 Temp: 15-20°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	RV	10/05/2020	1130	3.00	ML	Wind: F6, NE Oktas:8 Temp: 7°C Ground cond: dry Rainfall: mostly dry, occ. passing drizzle Visibility: good Factors affect vis: none
2	JB	14/05/2020	930	3.00	ML	Wind: F2-3, N-NNW Oktas:1-7 Temp: 9-14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
2	RV	28/05/2020	635	3.17	EA, ML	Wind: F2, S Oktas:4 Temp: 14°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: haze - slight during last 30 mins
2	JB	04/06/2020	1230	3.00	ML	Wind: F3, N Oktas:7-8 Temp: 10-13°C Ground cond: dry Rainfall: mostly dry, occ. v light to light showers Visibility: good Factors affect vis: none
2	RV	15/06/2020	555	1.25	ML(chicks)	Wind: F1, N Oktas:0 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good (poor at end) Factors affect vis: perfect conditions at start - thick fog rolled up valley stopped watch
2	RV	23/06/2020	855	1.75	EA, ML, SH	Wind: F3-4, S Oktas:1 Temp: 13°C Ground cond: damp Rainfall: nil Visibility: Good Factors affect vis: good vis, occ. low cloud over hilltops above Gruffy
2	RV	08/07/2020	1345	3.00	ML	Wind: F3, E Oktas:1 Temp: 13°C Ground cond: damp Rainfall: Drizzle Visibility: good Factors affect vis: drizzle - light drizzle for last hour
2	JB	11/07/2020	615	3.00	ML	Wind: F2, W Oktas:8 Temp: 10°C Ground cond: wet Rainfall: mostly dry, single brief, v. light shower Visibility: good Factors affect vis: none
2	RV	19/08/2020	620	3.00	BZ	Wind: F2-5, E Oktas:7-8 Temp: 14°C Ground cond: damp Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
2	RV	19/08/2020	950	3.00	HH	Wind: F3-4, E Oktas:8 Temp: 15°C Ground cond: damp Rainfall: nil Visibility: mod. Factors affect vis: low cloud base over hilltops
3	JB	21/04/2020	1145	3.00	BZ, GB	Wind: F4, ESE Oktas:0-1 Temp: 10-13°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	RV	29/04/2020	850	3.00	BZ, K, LB, SN, WE	Wind: F4, W-NW Oktas:7 Temp: 7°C Ground cond: damp Rainfall: nil Visibility: Good Factors affect vis: none
3	RV	30/04/2020	645	3.00	SN	Wind: F1-2, N Oktas:1 Temp: 5°C Ground cond: damp Rainfall: drizzle Visibility: poor-mod. Factors affect vis: low cloud, with some fog & showers
3	JB	13/05/2020	1445	3.00	BZ, EA, K, Larus gull sp.	Wind: F3-4, NE-NNE Oktas:8-1 Temp: 11°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	21/05/2020	1100	3.00	BZ, EA, SH	Wind: F2-3, SW Oktas:3-4 Temp: 15-17°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
3	JB	17/06/2020	1015	3.00	No target sp.	Wind: F3, NW Oktas:8 Temp: 12°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	RV	30/06/2020	520	3.00	No target sp.	Wind: F3, W-SW Oktas:1 Temp: 10°C Ground cond: damp Rainfall: Drizzle Visibility: poor-mod. Factors affect vis: fog rolling in with persistent light drizzle
3	JB	11/07/2020	945	3.00	BZ, EA, SN	Wind: F3, W Oktas:8 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
3	RV	24/07/2020	540	3.00	EA, SH	Wind: F3, S Oktas:1 Temp: 12°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
3	KW	13/08/2020	815	3.00	No target sp.	Wind: F2, NE Oktas:8 Temp: 7°C Ground cond: wet Rainfall: nil Visibility: poor-mod. Factors affect vis: Low cloud
3	KW	13/08/2020	1140	3.00	EA, K	Wind: F2-1, NE Oktas:8-3 Temp: 8°C Ground cond: wet Rainfall: nil Visibility: mod-good Factors affect vis: low cloud lifting
3	JB	24/08/2020	1000	3.00	BZ, EA, HH, K	Wind: F2-3, S Oktas:6-7 Temp: 12°C Ground cond: wet Rainfall: nil Visibility: good Factors affect vis: none
4	JB	22/04/2020	1130	3.00	BZ, EA, WE	Wind: F3, E Oktas:4-6 Temp: 14-16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	JB	22/04/2020	1500	3.00	EA, Falcon sp.	Wind: F3-2, E Oktas:6-8 Temp: 15-17°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	28/04/2020	1320	3.00	EA, ML, RG, WE, CU*, GP*	Wind: F2, E Oktas:2 Temp: 9°C Ground cond: dry Rainfall: showers Visibility: Good Factors affect vis: none
4	RV	10/05/2020	740	3.00	GP, HG, LB, SN	Wind: F6, NE Oktas:8 Temp: 6°C Ground cond: damp Rainfall: Drizzle Visibility: good Factors affect vis: mist on far side of valley
4	JB	21/05/2020	1445	3.00	BZ, GB, K, ML, WE	Wind: F2-4, SW Oktas:5-7 Temp: 16°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	RV	26/05/2020	640	3.00	RG	Wind: F3, W Oktas:4 Temp: 10°C Ground cond: dry Rainfall: nil Visibility: good Factors affect vis: none
4	JB	17/06/2020	1345	1.00	SN	Wind: F3, NW Oktas:8 Temp: 12-11°C Ground cond: damp Rainfall: nil Visibility: good-mod. Factors affect vis: cloud base drops - stopped VP watch
4	JB	25/06/2020	1530	2.00	No target sp.	Wind: F2, NNW Oktas:6-8 Temp: 18°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	RV	30/06/2020	855	3.00	RG*	Wind: F2-3, W-SW Oktas:1 Temp: 11°C Ground cond: Wet Rainfall: Drizzle Visibility: poor-mod. Factors affect vis: fog rolling in with drizzle, began to clear from 10:45 - dry & clear for last hour
4	JB	20/07/2020	1530	3.00	EA, SH	Wind: F3-2, W Oktas:5-3 Temp: 16°C Ground cond: not rec. Rainfall: nil Visibility: good Factors affect vis: none

VP	Surveyor	Date	Start time	Duration (hr)	Target Sp. (* heard)	Weather summary
4	RV	29/07/2020	650	3.00	No target sp.	Wind: F2, W-SW Oktas:1 Temp: 11°C Ground cond: damp Rainfall: nil Visibility: good Factors affect vis: none
4	KW	12/08/2020	900	3.00	K	Wind: F1-2, N Oktas:8-3 Temp: 17-20°C Ground cond: dry Rainfall: nil Visibility: poor-mod. Factors affect vis: low cloud - banks rolling through vis ranging poor to good
4	KW	12/08/2020	1225	3.00	No target sp.	Wind: F2, N Oktas:2 Temp: 20-19°C Ground cond: dry Rainfall: nil Visibility: mod-good Factors affect vis: cloud lifts, only cover top of hill

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APPENDIX 8: AQUATIC ECOLOGY

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Appendix 1: Field data

Figure 1: Overview of rivers and catchment areas

Figure 4: Agencies distribution of juvenile salmon

Figure 5: Agencies distribution of juvenile trout

Figure 6: Key watercourses in site and downstream

Figure 7: Aged 0 trout abundance

Figure 8: Aged 0 salmon abundance


Figure 11: Watercourses intersecting grid route & road upgrades


Figure 12: Trout abundance at grid route & road upgrades intersections



Figure 13: Salmon abundance at grid route & road upgrades intersections



Appendix 1. Field data for watercourses intersecting the proposed cable route (CR), areas of proposed road widening (RW), and draining the new proposed access road through Coilte land (NR).



Watercourse intersections with cable route (C)



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C1	Un-named stream	Stracashel	184861	395786
Description: This stream flows under the existing access track to the entrance of the Tievebrack substation via a ca. 600mm plastic pipe culvert that is embedded and potentially passable to fish. The land use is previously clear-felled plantation conifer in a largely peat based area with no livestock grazing apparent. The channel is unfenced and upstream of the culvert, the becomes overgrown with rush and bramble but is mainly grade 3 nursery habitat with some areas unclassified. Downstream of the culvert, habitat is largely grade salmonid 3 Nursery with riffle and run flow habitat characterised by cobble and boulder in an incised channel of moderate gradient. The stream habitat has the potential to support resident brown trout but salmon are unlikely due to the lack of suitably deep pools and potential spawning areas.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.25-0.6	0.05-0.15	0.25
				

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C2	Un-named stream	Stracashel	184782	395589
Description: This stream flows under the existing forest access track via a ca. 400mm plastic pipe culvert. Upstream, the channel is incised through a steep forest break mainly of bog and rushes with a width of ca. 0.3m and a bed of pebble. Downstream of the pipe culvert, the channel is 0.2-0.4m wide, shallow, and cuts through dense Sitka spruce with 100% shading. The bed of the channel is a mixture of pebble and peat/ pine needles with very low fisheries potential. The stream size, habitat and location would be expected to support a low diversity invertebrate community with slight impacts due to forestry				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
5-10	Fine silt and peat	0.2-0.4	0.05-0.10	0.2
				
view upstream through forestry break			view downstream within plantation conifer	


Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C3	Un-named stream	Stracashel	184800	395559
<p align="center">Description:</p> <p>This very small drain intersects the forestry track via a ca. 400mm plastic pipe culvert; there is no useable fisheries habitat upstream owing to a very steep gradient, narrow incised channel (ca. 0.2m wide), that cuts through sphagnum and heather below plantation conifers. Downstream of the track, the gradient is steep and the channel heavily shaded by plantation conifer. The streambed is largely pebble and peat; overall local fisheries value is very low and no fish would be expected. Ecological quality also would be expected to be low due to the limited upstream available habitat for benthic invertebrate colonists and the heavy shading and poor substrate quality downstream.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
5-10	Fine silt and peat	0.2	0.05-0.10	0.2
				
view upstream to very narrow, incised drain		view downstream within plantation conifer		


Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C4	Un-named stream	Stracashel	184881	395545
<p align="center">Description:</p> <p>This very small drain is sourced by two separate small and steep drains upstream of the forest track that flow meet to flow through a ca. 400mm impassable perched plastic culvert pipe. Downstream of the pipe, the channel is narrow, shallow, and heavily shaded by Sitka spruce with a peat, clay and boulder/ cobble stream bed. The channel is relatively steep and would be classified at best as a mixture of unclassified and grade 3 Nursery habitat in places though this is undermined by 100% shading so that fisheries potential is very low. Ecological quality also would be expected to be low given the very steep upstream sources and limited downstream habitat suitability due to extensive shading.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
10-20	Fine silt and peat	0.3-0.5m	0.05-0.15	0.2
				
view upstream to two source drains above pipe culvert		view downstream within plantation conifer		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C5	Un-named stream	Stracashel	185080	395525
Description: This small stream sources from steep bog and rush within a forestry break and passes over a series of small vertical falls above the track before entering a ca. 550mm plastic culvert pipe. The pipe outlet is perched and impassable while the channel downstream is initially open and moderately deep as riffles and pool pockets over boulder before quickly running through thick grass and bog where it seeps within a forest break. The habitat is unsuitable for salmonid fish due to a lack of nursery or spawning and a bed largely of peat/ rank grass and some small pebbles. The length of open upstream channel would provide for benthic macroinvertebrate colonists but the poor quality of physical habitat downstream would limit ecological quality which at best would be expected to be Low.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
10-20	peat	0.3	0.05-0.25	0.2
				
view upstream to multiple small falls through forestry break			view downstream within forestry break	



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C5b	Un-named stream	Stracashel	185318	395481
Description: This watercourse sources as a tumbling steep stream upstream of the forestry track that is met by a small seeping drain before flowing through a ca. 650mm plastic pipe. The steep gradient upstream is unsuitable for salmonid fish. Downstream of the pipe outlet, a good flow over a moderate gradient is defined by a bed of cobble and pebble and riffles and runs. Overall salmonid quality is at best grade 3 Nursery habitat with the possibility of a small number of resident trout owing to the shallow gradient downstream of the track. Ecological quality is likely to be at least Moderate due to the available hard substrate and diverse physical habitat downstream, which is potentially suitable for a variety of sensitive benthic invertebrate species..				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.2-0.6	0.08-0.25	0.3
				
view upstream of track to stream and seepage on right.			view downstream to good flowing channel within bog and adjacent to forestry	



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C6	Un-named stream	Stracashel	185512	395468
Description: This small stream sources from an area of very steep bog/ heather and rush within a forestry break; water depth is 0.05-0.14 with good flow over boulder and cobble but owing to the gradient salmonid habitat quality is barely grade 3 Nursery. The stream flows through a ca. 500mm plastic culvert pipe and although the gradient is less severe, the outlet feeds a small pool before flowing through an incised area of heavily overgrown channel within blanket bog. The bed is a mixture of peat and pebble but there is a lack of suitable nursery and spawning habitat so that fisheries potential is very low. Ecological quality is likely to be low to moderate owing to a reasonable flow, moderate gradient, and extensive channel length upstream of the track, which could provide for invertebrate colonisation				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.2-0.65	0.05-0.3	0.2-0.3
				
view upstream through forestry break		view downstream of track over reduced gradient channel within bog area		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C7	Un-named stream	Stracashel	185749	395487
<p>Description:</p> <p>Upstream of the track, several seepages merge with a more definite channel within very steep plantation forestry and bog; just upstream of the track, there is a vertical drop of ca. 1.6m. Downstream of the track, the channel disappears into a bog and previously clear-felled area. The channel downstream is not suitable for salmonid fish while the lack of an open free-flowing hard bed would limit ecological diversity.</p> <p>Nearby (ca. 40m), another channel associated with drainage that runs parallel and upstream of the forest track crosses at 185698 395500; this flows through a ca. 500mm plastic pipe and initially opens downstream to a deep pool that then seeps through bog where clear-felling has occurred. Habitat is largely unclassified and not suitable for salmonid fish</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
25	peat	0.2-0.35	0.02-0.1	0.1
				
view upstream to poorly defined channel that is met by seepage		view downstream of track over reduced gradient channel within bog area		
				
Stream adjacent to C7 at , which captures drainage largely along the track				

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C8	Un-named stream	Stracashel	185512	395468
<p>Description:</p> <p>This small drain sources upstream of the forest track as small trickles and seepages that drain very steep ground of mature plantation conifer. There is no defined channel and the flow runs under the track via a ca. 400mm plastic pipe. Downstream of the track, the flow is through a wide vegetation area of grass that resembles a swale before narrowing and flowing through a previously clear-felled area of bog. The bed is a mixture of fine sediment and small pebbles though there is no discernible habitat that would be suitable for juvenile salmonid fish. Ecological quality would be expected to be low owing to the limited upstream habitat availability and poor physical quality of the channel downstream.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
15	Silt/ peat	0.2-1.3	0.05-0.3	0.2
				
view downstream of track to vegetated channel that flows through bog		view upstream to pipe outlet below forest track		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C9	Un-named stream	Stracashel	186729	396070
<p>Description:</p> <p>This small field drain sources upstream of the road as an incised channel through a very steep and rocky area of rough sheep grazing; the channel is narrow and of very poor salmonid habitat quality. Downstream of the road, the channel is ca. 0.2-0.5m wide and shallow with no meander. Extensive sheep grazing occurs on either bank with no fencing out of stock; the channel bed comprises a mixture of rank grass, some weed, pebbles and silt. Overall salmonid habitat quality is very poor and trout are unlikely to be present. Similarly, ecological quality would be expected to be low given the lack of channel and flow diversity, and substrate complexity.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
10	silt	0.2-0.5	0.04-0.1	0.1-0.2
				
view upstream of road to an area of rock and steep rough sheep grazing		view downstream of road to narrow drain-like channel in extensive sheep pasture		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C10	Un-named stream	Stracashel	187000	396127
<p>Description:</p> <p>This watercourse was identified for potential walkover survey from the 1:50,000 OSI map series immediately downstream of the road. However, on site visit, the area was wet and marsh-like with no channel apparent.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
N/A	N/A	N/A	N/A	N/A

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C11	Un-named stream	Stracashel	187088	396150
<p>Description:</p> <p>Small side channel, barely flowing, that runs along the road into C12 – see below</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
N/A	N/A	N/A	N/A	N/A

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C12	Un-named stream	Stracashel	187133	396162
<p>Description:</p> <p>This watercourse drains an area of steep gradient upstream of the road where sheep grazing is heavy; the channel is unprotected, very shallow, with a bed of weed and pebble and is too shallow to support trout (note this observation is despite considerable rainfall the night prior to the walkover survey). Downstream of the road, the channel emerges from stone open bed culvert and runs parallel to the road for ca. 35m before a 90-degree bend into a field heavily grazed by sheep. The channel here is of low gradient, straightened, narrow and slow flowing with a few small pools and a bed largely of sand, fines and some cobble. The depth of some of the pool areas have the potential to support a few resident trout although use of the channel upstream is highly unlikely given the poor habitat. Ecology quality is likely to be low.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
25	Silt & sand	0.42	0.11	0.15
				
view upstream of road to shallow vegetated channel in area of heavy sheep grazing		view downstream of road to straight drain-like channel		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C13	Un-named stream	Stracashel	187399	396225

Description:
Upstream of the road, the watercourses flows as a road-side drain with a bed of fines, sand and pebble; fisheries value is very low. Downstream of the road, the channel is narrow and shallow with a bed of fines, pebbles and sand and rank grass. The stream flows through a low gradient area of rough sheep grazing pasture. The presence of a few resident trout is possible given the moderate depths in some locations. Ecological quality would however be low.

Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
12	Sand	0.4	0.05-0.16	0.15



view upstream of road to drain running parallel

view downstream of road to straight drain-like channel in extensive sheep grazing pasture

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C14	Un-named stream	Stracashel	187640	396264

Description:

Upstream of the road, the watercourse sources from a wet woodland and bog area where a well-defined channel is lacking. Downstream of the road, the channel runs parallel to the road for ca. 15m before turning 90 degrees. The channel flow improves although habitat is largely run with a bed of fines, sand, peat and some boulder. The depth permits some small glides in which a few trout may occur. Overall ecological quality is expected to be low due to a lack of available colonists from upstream, and the sluggish nature and low substrate complexity of the channel downstream would however be low.

Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
20	Sand & silt	0.45	0.08 (0.05-0.1)	0.15



view upstream of road to wet woodland and bog where stream originates





view downstream of road where stream emerges pond-like and slow flowing, running parallel to road for ca. 15m






view downstream of road where flow improves

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C15	Un-named stream	Stracashel	187831	396323
<p>Description:</p> <p>Upstream of the road, the watercourse flows between a farm lane and a sheep pasture field and is fenced on both banks. Although somewhat straightened and shallow, the substrate is moderately complex and comprises cobble and gravel in riffles consistent with grade 3 nursery and spawning habitat; the landowner mentioned his observations of small fish in the past that are most likely to be resident juvenile trout though upstream passage is not possible given the 3 perched pipe culverts that occur beneath the road downstream. Downstream of the pipes, the channel is mainly grade 3 nursery with spawning pockets, particularly just above the confluence with the main Stracashel River, which is 40-50m downstream of the road. This proximity, and the presence of juvenile salmon at Excellent abundance in a nearby IFI monitoring site on the main channel Stracashel (see Figure 4), suggests the possibility that salmon may spawn in the lower stream.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
8	sand	1.45	0.05-0.3	0.25
				
view upstream of road along farm lane		view to 3 perched and impassable pipe culverts below road		
		view downstream to reasonable quality nursery and spawning habitat		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C16	Un-named stream	Stracashel	188274	396572
Description: Upstream of the road, the has some good nursery habitat that's is a mixture of Grade 2 and 3 with some grade 3 spawning gravel pockets suitable for trout. Downstream of the road, the channel emerges from a concrete pipe that is perched then falling into a 0.4-0.5m deep pool. with good flow over boulder and cobbles; a further ca. 70m upstream, the channel cuts through a steep ravine and over a significant impassable vertical falls. The stream flows under the road through a concrete perched pipe that is potentially passable; habitat downstream is a mixture of cobble and gravel in riffle/ runs consistent with Grade 3 Nursery and spawning pockets. Trout potential very high with the possibility of salmon spawning given proximity of Stracashel downstream.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.9	0.01-0.35	0.15
				
				
view upstream of road to distant vertical falls & ravine ca. 70m upstream		view immediately u/s of road to Grade 3 Nursery; Grade N2 further upstream		
pipe outlet downstream of road		view downstream of road – Grade 3 nursery and gravel pockets		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C17	Un-named stream	Stracashel	188369	396533
<p>Description:</p> <p>Upstream of the road, the watercourse flows through moderately steep rough grazing pasture although the channel has good flow over cobbles and pebbles with no fine sediment cover. The stream passes under the road via a very low pipe and emerges in moderate quality nursery habitat over cobbles and pebbles with some pockets of spawning gravels; trout highly likely although salmon unlikely given lack of suitable holding pools.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.55	0.1	0.25
				
view upstream of road		view downstream to largely grade 3 nursery in riffle/ runs		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C18	An_Beangan Bui	Stracashel	188779	396431
<p>Description:</p> <p>This designated waterbody has excellent salmonid habitat quality and is a mixture of grade 2 and 3 nursery and grade 2 and 3 spawning gravels in fast flowing riffles and runs interspersed with pool pockets. The bed is a mixture of boulder, cobble and well sorted gravels with no fine sediment cover. While the overall habitat has a high potential to support trout spawning and recruitment, there is a possibility that salmon also would utilise the stream given adequate pool depths in places, and proximity to the main Stracashel River. Ecological quality is expected to be high given the high flow, and complex substrate and moderate gradient. The bridge has a natural bed and so potential fish passage would be un-obstructed.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	2.6	0.13	0.3
				
view upstream of road grade 2/3 nursery & spawning		view downstream to grade 2/3 nursery and high gradient riffles		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
C19	Un-named	Stracashel	190030	396513
Description: This watercourse was present as a straight drain-like channel through rough sheep grazing with little flow and high emergent rank grass within the channel. The bed is a mixture of grass, pebble and sand and has very low fisheries value given the very shallow depth, lack of suitable substrate, and limited flow. Upstream, the channel becomes very steep and runs through wet woodland and rough grazing.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
10	sand	0.5	0.04	0.05-0.1
 <p><i>view downstream of heavily grass choked drain</i></p>				



Watercourse intersections at areas of proposed road widening (RW)



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW1	Un-named stream	Stranagoppoge	191842	397995
Description: Upstream of the road, 2 small drains meet after running parallel to the road east and west – both were very shallow and narrow (ca. 0.25m wide) though with a clean pebble bed. The drains pass under the road and drain as single narrow channel through a plantation forest break in boggy ground. The channel downstream is drain-like, shallow (0.1m), narrow (ca. 0.2-0.3m), incised with a shingle/ pebble bed. Overall, fisheries potential is very low with trout unlikely to be present.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.25-0.6	0.05-0.15	0.25
 <p><i>view of small drain running above and parallel to the road</i></p>  <p><i>view downstream through forest break</i></p>				



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW2	Min An Arbhair	Stranagoppoge	192900	399171
Description: Small stream running across main road and then parallel to road that crosses main Stranagoppoge and runs for 60m downstream before meeting the main river. Immediately upstream of the main road, the stream is joined by two good flowing streams both with grade 3 nursery and with potential to support trout (ca. 0.4-0.5m wide) and up to 0.1m deep. Downstream, the channel is from 0.5-1.4m wide adjacent to the proposed road widening area with a series of runs and small pools through cascade/ falls ca. 25m downstream of the main road that would be impassable to trout. Further downstream of this, the channel narrows to 0.3-0.6m wide with good flow and depth and a bed of cobble/ pebble and riffle/ runs consistent with grade 3 nursey and spawning pockets. This small stream would not support salmon but the immediate Stranagoppoge downstream does.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.95	0.08	0.3
				
view upstream to eastern tributary running parallel to road		view from just upstream of confluence with Stranagoppoge to fast flowing riffle/ run adjacent to area of proposed road widening		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW3	Un-named stream	Stranagoppoge	193417	399280
Description: Stream intercepts flow upstream of forest road/ minor road from forest cut and a channel running parallel to the road; both are very steep and overgrown with very low fisheries value. Downstream, the channel passes under the road via a large impassable plastic pipe over bedrock and boulder/ cobble before entering an area of impenetrable, dense, 100% shaded plantation woodland. Salmonid potential is very poor due to gradient, heavy shade and stream size.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.3	0.02-0.12	0.25
				
view upstream to drains cutting through rough clear-felled plantation		view downstream where the channel flows over bedrock and impenetrable plantation forest		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW4	Un-named stream	Stranagoppoge	193534	399407
Description: Very small drain that flows from upstream of the track through a very steep forest break with rank grass, scrub and rushes where the channel depth is very shallow. Downstream, the channel is steep initially running over a small fall before becoming very narrow (ca. 0.25-0.3m) and shallow (0.02-0.04m). The bed is a mixture of peat and pebble and overall fisheries value is very low; would not be expected to support trout.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.3	0.02-0.12	0.25
				
view upstream to drain cutting through rough clear-felled plantation		view downstream where the channel is narrow, shallow and incised		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW5	Un-named stream	Stranagoppoge	193591	399532
Description: Very steep upstream of track running through a cut in bog and plantation forestry. Downstream, it flows through a large plastic pipe that is impassable due to perching though habitat upstream is unusable. Downstream, the channel runs through bog and forestry though the bed is hard with a mixture of boulder, cobble and shingle; due to its shallow depth (ca. 0.03-0.1m) there is low potential to support trout in barely grade 3 nursery.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A	0.2-0.35	0.03-0.1	0.25
				
view upstream to drain cutting through steep clear-felled and replanted area		view downstream where the channel is narrow, moderately flowing but has a reasonably complex bed		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW6	Un-named stream	Stranagoppoge	193724	399700
Description: Upstream of the track, the ground is very steep and drains forestry and heath/ bog where the bed is partly peat and rock with a very shallow depth that is indicative of very low fisheries value. The stream flows through a pipe and emerges as a very shallow drain over rock before cutting through a forest break that is very steep with a bed largely of fine pebbles, vegetation, peat and some cobbles. Overall, salmonid fisheries potential is very low.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
5	Peat	0.2-0.35	0.04-0.1	0.2
				
view downstream of track to heavily overgrown area of bog and rush.		view upstream to pipe outflow at track showing initial boulder rock before cutting through peat with a fine pebble base.		



Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
RW7	Un-named stream	Stranagoppoge	194155	399958
Description: Small drain-like stream that is very shallow (ca. 0.03m deep), narrow (0.4-0.55m) and upstream drains a patch of alder wet woodland at the edge of plantation forestry in very steep ground. The stream emerges from a culvert pipe into an area of rank vegetation, rushes and plantation forestry where it is very shallow (ca. and incised with a bed of fines, peat and small pebbles. Fisheries potential is very low owing to the lack of open channel, the incised nature and shallow depth				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
10	Sand/ peat	0.2-0.3	0.04-0.08	0.1
				
view upstream of steep ground where channel drains alder and plantation forestry in bog/ rush.		view downstream to very overgrown channel that flows through rushes, bog and plantation forestry.		



Watercourse intersections at areas of the proposed new access road through Coilte land (NR):-



All of the below watercourses were surveyed at ca. 150-200m downstream of the route of the proposed new access road as there was good access along the existing forestry track/ minor road. The option to survey at this distance downstream offers a better opportunity to determine downstream sensitivity of each watercourse because the proposed road is at course for all of these watercourses; surveying further downstream allows an assessment of sections where the channel would be better developed in terms of flow, width and potential suitability for fisheries as the gradient was very steep and all were drain-like channels/ cuts.

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
NR1	Un-named stream	Stranagoppoge	195147	400317
Description: Upstream of the road the drain is very steep over rough sheep grazing; downstream the channel had a bed largely of grass, peat/ silt and fines. Downstream of the track the depth was very shallow despite previous overnight rain although the width increased. The immediate area is heavy sheep grazing with the channel open and somewhat poached. Further downstream this drain runs through heavy bog before meeting large tributaries that drain to the Stranagoppoge main channel/ Local sensitivity for fisheries is very low and fish are not expected.				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
15	peat/ silt	0.25-0.3	0.03-0.05	0.25
				
View upstream over very steep terrain with the distant forestry where the new road is proposed in the background		View downstream to narrow shallow channel open to grazing and poached with grass in the channel. The bog can be seen in the distance.		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
NR2	Un-named stream	Stranagoppoge	195057	400322
Description: This drain is part of the same series of drains as NR1 that flow through steep sheep grazing ground and eventually through moderate gradient bog to the Stranagoppoge River. It also is sourced upstream of the track as a cut in wet rank grass grazed by sheep; the channel upstream has no hard substrate and is mainly fines, peat and grass with no fisheries value. Downstream, the channel also is dominated by grass within the bed with moderate levels of peat, silt and algae indicative of enrichment. While the depth increase slightly, it remains very shallow				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
20	Silt/ peat	0.25-0.45	0.04-0.1	0.2
				
View upstream over very steep terrain where the channel is a wet vegetated cut		View downstream to poor quality steep vegetated channel with evidence of sheep poaching of the banks, enrichment and siltation		

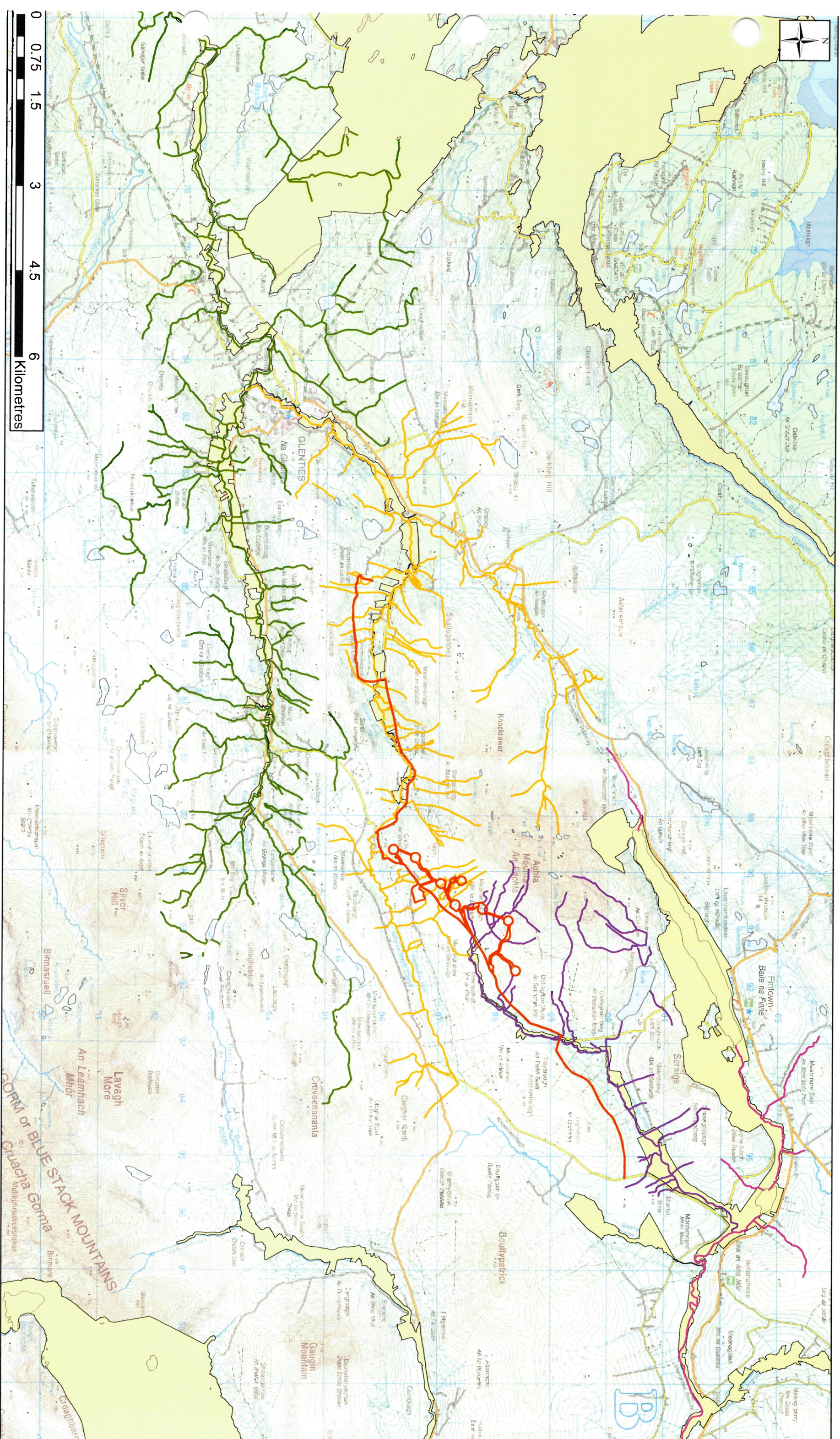
Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
NR3	Un-named stream	Stranagoppoge	195003	400314
<p>Description:</p> <p>This drain is sourced also from steep terrain below the forestry; below the track its flow is augmented by a field drainage pipe. It is highly silted with little instream substrate complexity due to a dominance of rank grass within the channel and sheep poaching of the low banks. Fisheries value is very low due to the shallow depth, lack of complex substrate, siltation, and high gradient.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
30	Silt/ peat	0.25-0.55	0.04-0.18	0.2
				
View upstream over very steep terrain where the channel cuts through rough sheep grazing		View downstream to poor quality steep vegetated channel with extensive sheep grazing and bank erosion leading to in-channel siltation		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
NR4	Un-named stream	Stranagoppoge	194929	400308
<p>Description:</p> <p>This drain is sourced from a steep cut upstream where there is significant erosion and slippage though rough grazing and rushes; the channel is poorly defined and flow occurs as seepage. Downstream, the channel is very narrow, steep and has little water depth. Sheep graze extensively and have caused significant poaching of the low banks leading to in-channel siltation. Stream bed complexity is poor and dominated by silt and vegetation. Overall fisheries significance is very low.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
35	Peat/ silt	0.2	0.05	0.2
				
View upstream over very steep terrain where the ill-defined channel seeps from rough sheep pasture and rushes		View downstream to very poor quality, arrow, shallow and steep channel with extensive sheep grazing and in-channel siltation		

Site ID	River	Catchment	Grid Ref. X	Grid Ref. Y
NR5	Un-named stream	Stranagoppoge	194839	400286
<p>Description:</p> <p>This small stream drains a steep area of plantation forestry and rough sheep grazing pasture. The channel downstream is steep and incised through rushes and bog adjacent to plantation forestry. It is fenced from the adjacent sheep grazing with a hard bottomed bed of cobbles, pebbles and fines though the channel is largely shaded by the overhanging rushes and rank grass. Flow is moderate while depth is shallow (0.05-0.12m). Of the streams that would receive drainage from the road access works (NR1-5), this stream is of slightly better quality although remains of fair fisheries potential; a few resident trout may occur further downstream.</p>				
Fine sediment cover (%)	Dominant fine sediment type	Mean width (m)	Mean water depth (m)	Mean flow velocity (ms ⁻¹)
0	N/A			
				
View upstream of steep cut adjacent to forestry and rough sheep pasture		View downstream to incised channel adjacent rush/ bog and forestry.		

APPENDIX 1.

Field data for watercourses intersecting the proposed cable route (CR), areas of proposed road widening (RW), and draining the new proposed access road through Coilte land (NR).



Planning boundary

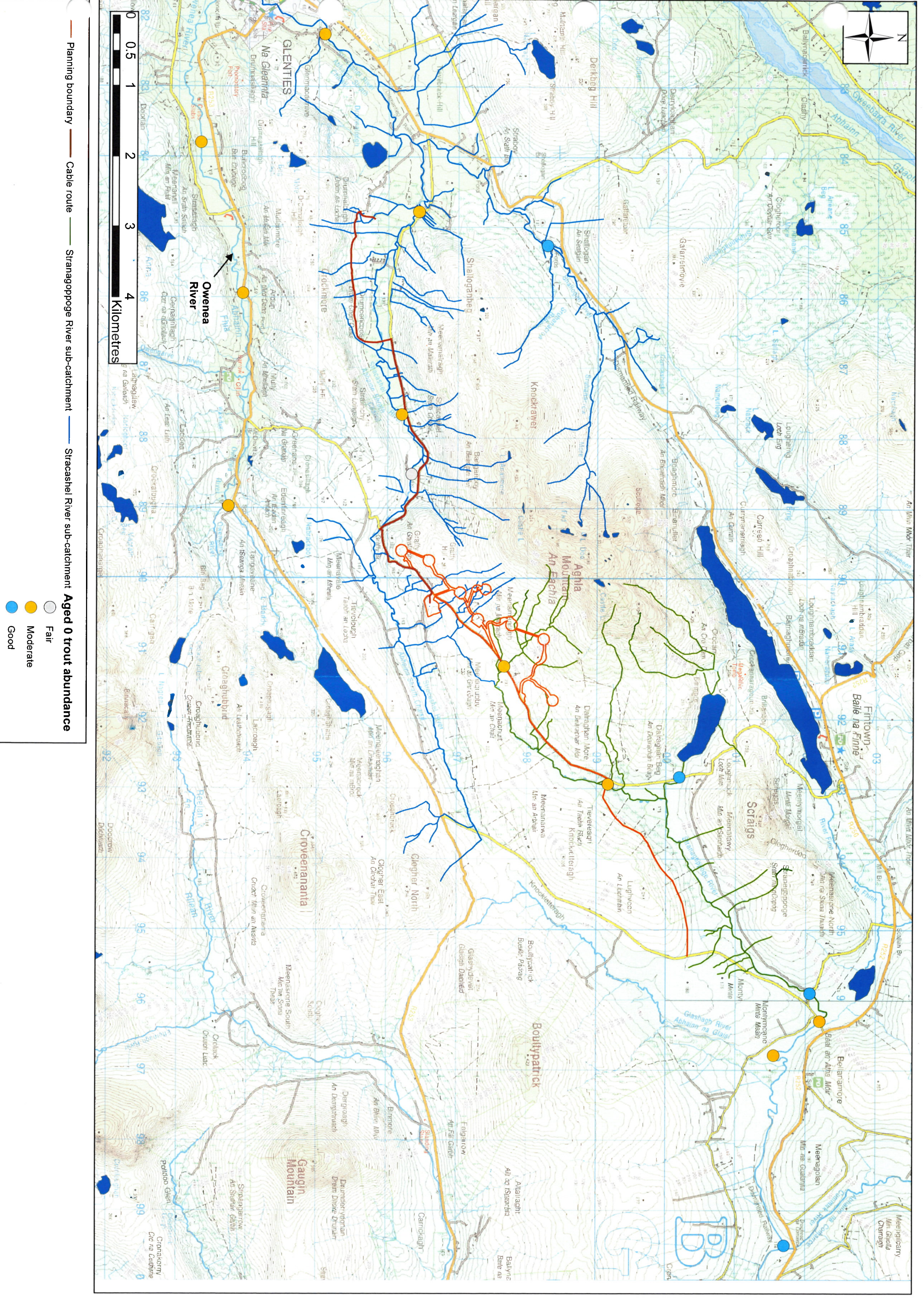
River Finn SAC

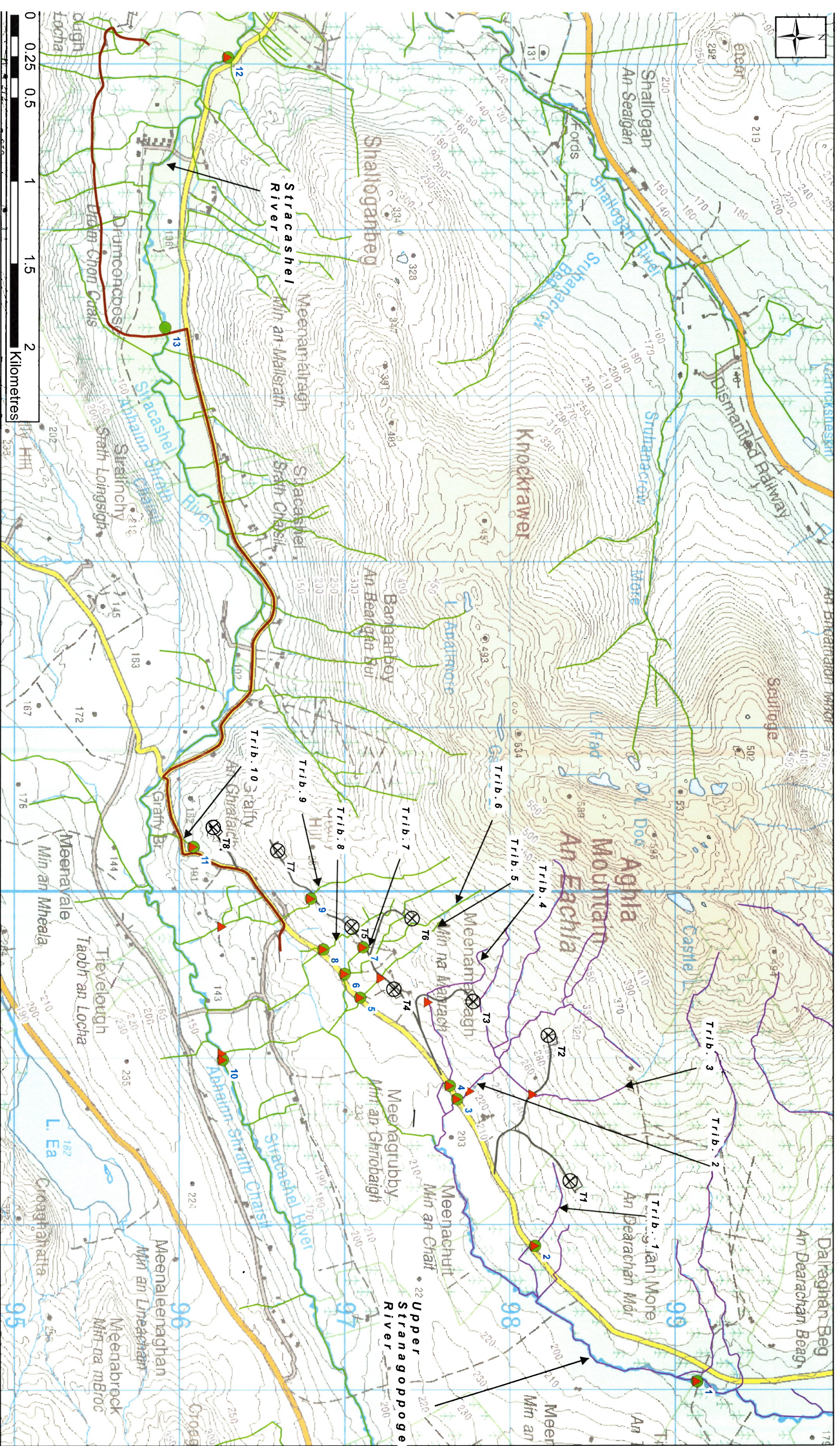
Stracashel River sub-catchment

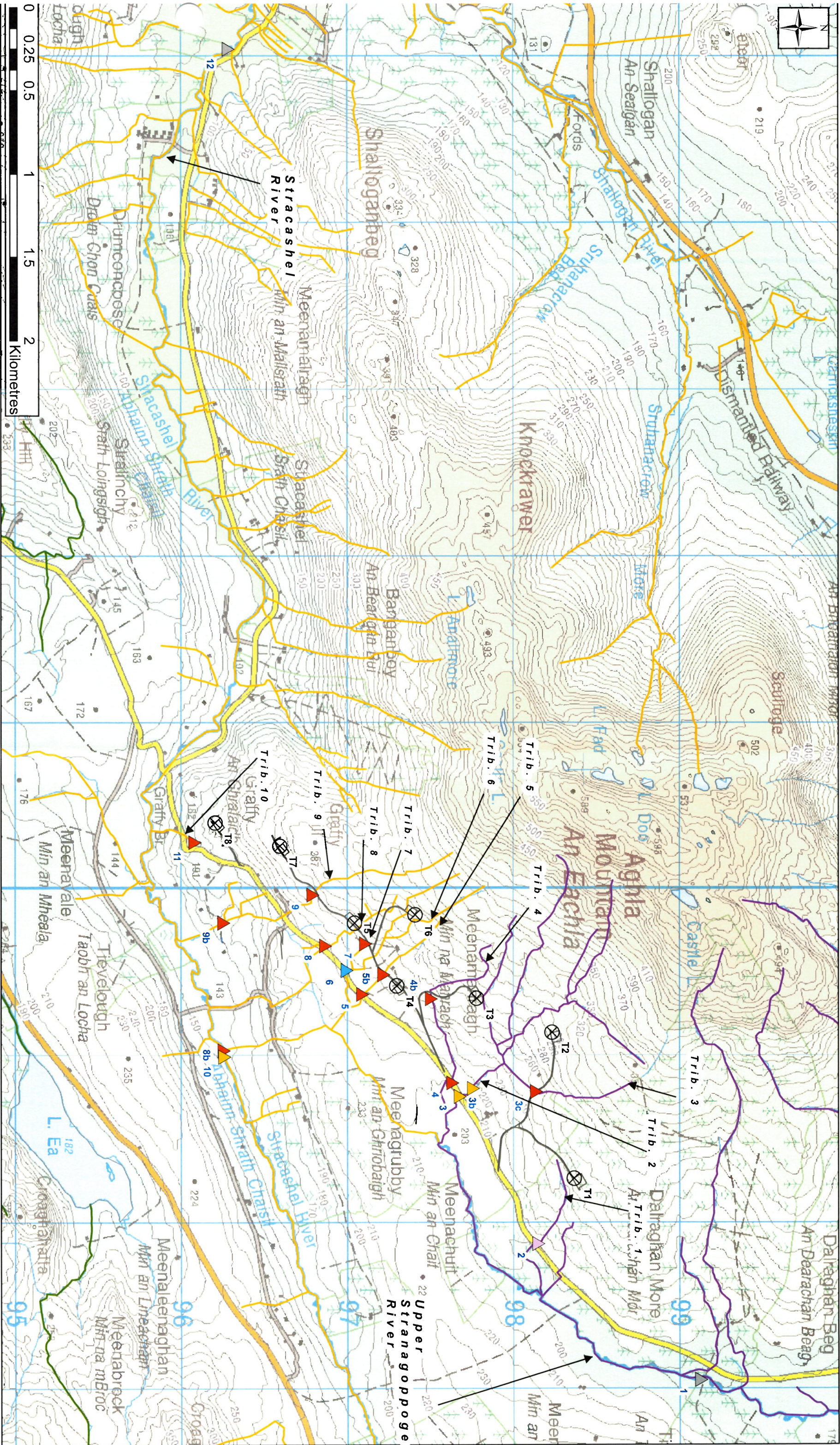
West Of Ardara/Maas Road SAC

River Finn

Stranagoppoge River sub-catchment







Aged 0 trout abundance

▲ Absent

△ Poor

▲ Fair

▲ Moderate

▲ Good

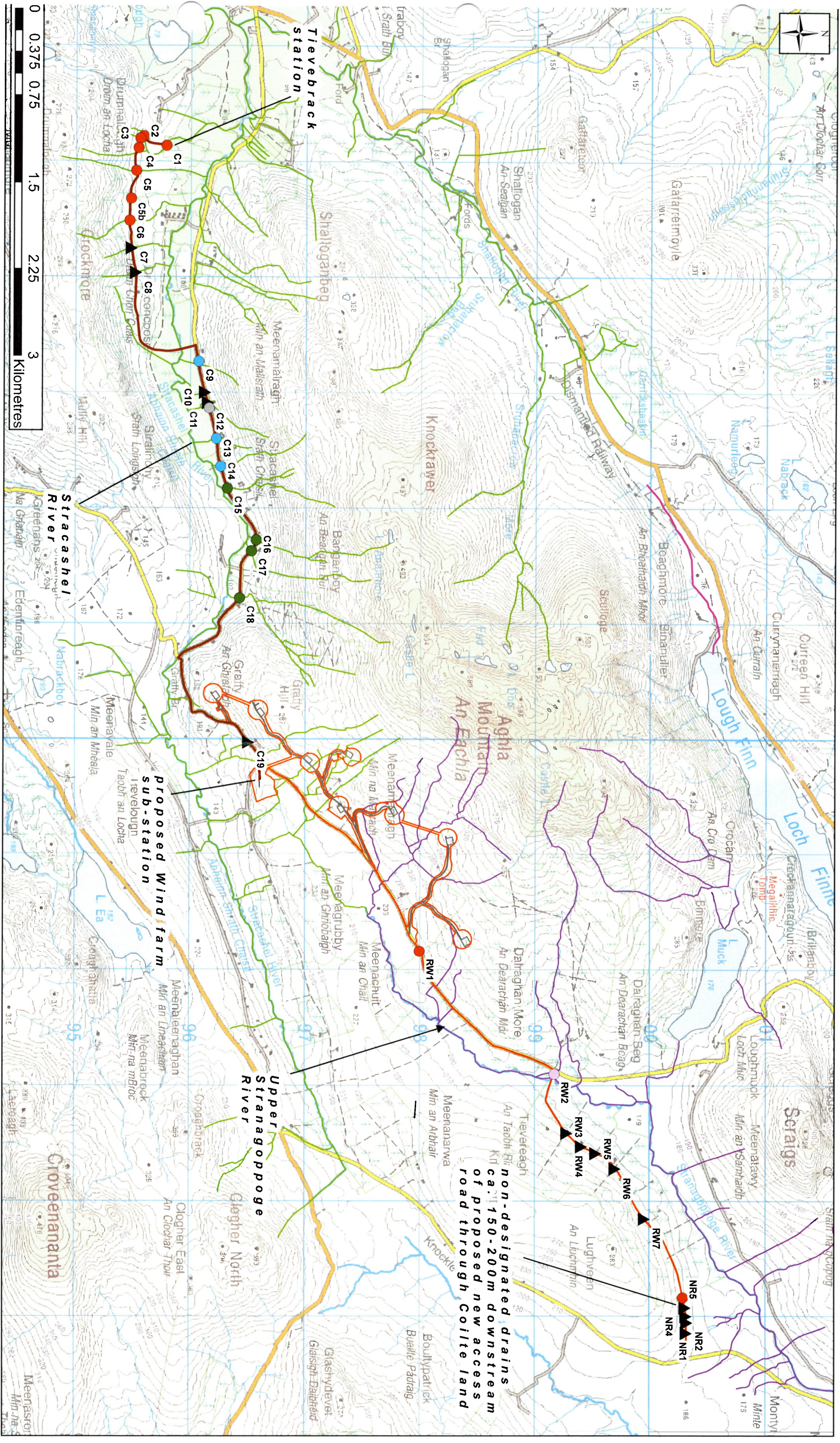
⊗ Turbine locations

--- Access tracks & hard stands

— Stracashel River sub-catchment

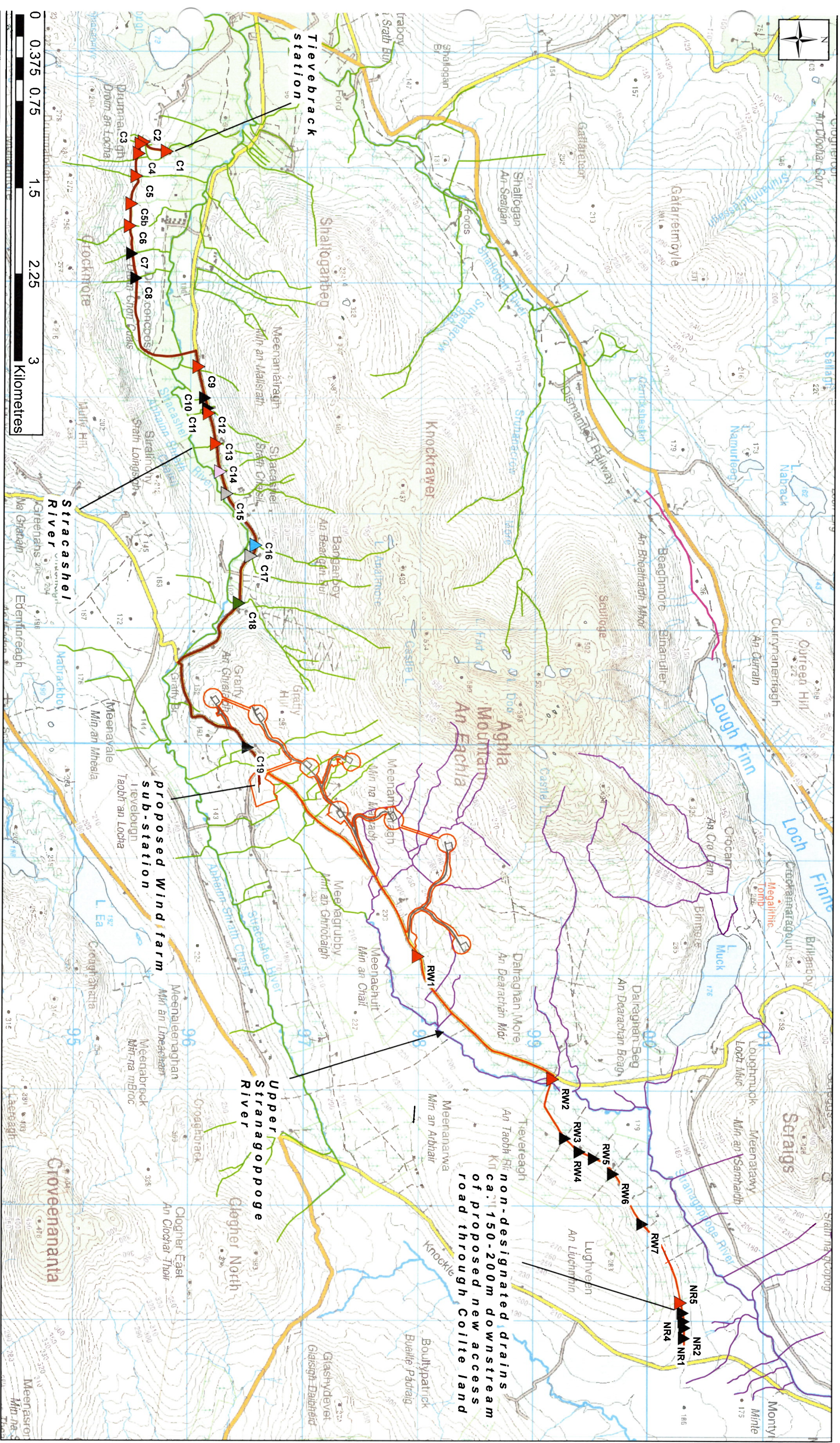
— Stranagoppoge River sub-catchment





Age 0 trout abundance

- Planning boundary
 - Cable route
 - Access tracks & handstands
 - Stranagoppoge River sub-catchment
 - Stracashel River sub-catchment
- Excellent
 - Good
 - Fair
 - Poor
 - Absent
 - Not possible to survey



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APPENDIX 9: BATS

CONTENTS

Appendix I:

Results of pre-construction bat surveys at Graffy Wind Farm

Appendix I:

Results of pre-construction bat surveys at Graffy Wind Farm

- Survey reports, maps, charts and tables displaying results

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1 OVERVIEW

This technical appendix provides detailed survey results, including tabulated results, maps and charts, as well as reports from roost suitability surveys, roost inspections, bat activity surveys and seasonal static bat detector surveys. Outputs in charts and maps use abbreviations and colour codes listed in **Table 1** to display the data.

Figure 17 to **Figure 22** illustrate proposed mitigation measures involving the creation of bat buffer zone around proposed turbines.

Table 1. List of abbreviations and colour codes used to display species data on charts and maps

Abbreviation	Common name	Latin
NYLE	Leisler's bat	<i>Nyctalus leisleri</i>
PIPY	Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>
PIPI	Common pipistrelle	<i>Pipistrellus pipistrellus</i>
PINA	Nathusius' pipistrelle	<i>Pipistrellus nathusii</i>
MYSP	<i>Myotis</i> species, including: <ul style="list-style-type: none">- Daubenton's bat- Whiskered bat- Natterer's bat	<i>Myotis</i> species including: <ul style="list-style-type: none">- <i>M. daubentonii</i>- <i>M. mystacinus</i>- <i>M. nattereri</i>
PLAUR	Brown long-eared bat	<i>Plecotus auritus</i>

2 DESK BASED STUDY

To assess survey requirements for bats at the Application Site and to provide an initial indication of habitat suitability, aerial imagery and old 6-inch maps covering the proposed wind farm site were examined for habitat features potentially utilised by foraging and roosting bats. Bat suitability indices displayed online at NBDC Biodiversity Maps within 5x5 km squares were also examined. The area of interest – Graffy WF, Co. Donegal straddles two 5x5 km squares. Based on Lundy *et al.*, (2011)¹, the overall suitability for the squares encompassing the proposed wind farm have been scored as holding habitats of low suitability for all species bats. For individual species, habitat suitability was ranked low for all species, with the exception of soprano pipistrelles and for this species habitat suitability scored moderate-low.

A data request was submitted to Bat Conservation Ireland (BCI) for known roost records and other bat data for the two 10-km squares covering the site [G89 and G99]. The data received is displayed in **Table 2**, which indicates that six species occur within the vicinity of the Application Site, including:

- | | |
|------------------------|----------------------------------|
| • Common pipistrelle | <i>Pipistrellus pipistrellus</i> |
| • Soprano pipistrelle | <i>Pipistrellus pygmaeus</i> |
| • Leisler's bat | <i>Nyctalus leisleri</i> |
| • Brown long-eared bat | <i>Plecotus auritus</i> |
| • Daubenton's bat | <i>Myotis daubentonii</i> |
| • Natterer's bat | <i>Myotis nattereri</i> |

The only Natura 2000 sites designated for bats in Ireland are for lesser horseshoe bats (*Rhinolophus hipposideros*). The area of interest in Co. Donegal is outside the range for this species and with the closest Special Areas of Conservation (SACs) being in Co. Mayo there are designate sites no within the 15 km Zone of Influence of the proposed wind farm at Graffy.

As precaution, none of the roost locations provided by BCI are published to protect these sites for any unnecessary attention. A review of the roost records received found that none were located within the Application Site and all were well beyond the Zone of Influence (266 m) of the proposed turbine locations.

¹ Lundy, M.G., Aughney, T., Montgomery, W.I., & Roche, N., (2011) Landscape conservation for Irish bats & species specific roosting characteristics. Bat Conservation Ireland

Table 2. Results of BCI roost data and other records within 10km of the Application Site

BCI roost data within 10km of the proposed Graffy Application Site			
Roost Data - Transect Surveys			
Data set	Distance from site	Species	
G89 (1) 2006-	c. 8.0km	<i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus pygmaeus</i> , <i>Pipistrellus</i> spp. (45kHz/55kHz), Unidentified bat	
G89 (2) 2006-	c. 4.5km	<i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus pygmaeus</i> , <i>Pipistrellus</i> spp. (45kHz/55kHz), <i>Plecotus auritus</i>	
G89 (3) 2006-	c. 1.8km	<i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus pygmaeus</i> , <i>Pipistrellus</i> spp. (45kHz/55kHz), <i>Plecotus auritus</i> Unidentified bat	
G89 (4) 2006-	c. 4.7km	<i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus pygmaeus</i>	
G89 (5) 2004-2004	c. 6.2km	<i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus</i> spp. (45kHz/55kHz)	
G89 (5) 2006-	c. 8.9km	<i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus pygmaeus</i> , <i>Pipistrellus</i> spp. (45kHz/55kHz)	
G89 (6) 2004-2004	c. 10.3km	<i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus</i> spp. (45kHz/55kHz)	
National Biological Data Centre of Ireland			
Data set	Grid Square	Species	
National Bat Database of Ireland	G89	<i>Myotis daubentonii</i> , <i>Myotis nattereri</i> , <i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> , <i>Pipistrellus pygmaeus</i> , <i>Plecotus auritus</i>	
National Bat Database of Ireland	G99	<i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> , <i>Pipistrellus pygmaeus</i>	
Ad-hoc Observations			
Data set	Grid reference	Species	Date
BATLAS 2010	c. 0.7km	<i>Pipistrellus pygmaeus</i>	15/09/09
BATLAS 2010	c. 5.6km	<i>Nyctalus leisleri</i> , <i>Pipistrellus pygmaeus</i>	17/09/09
BATLAS 2010	c. 4.0km	<i>Pipistrellus pygmaeus</i>	24/09/09
BATLAS 2010	c. 9.0km	<i>Myotis daubentonii</i> , <i>Pipistrellus pipistrellus</i> (45kHz)	24/09/09
BATLAS 2010	c. 7.5km	<i>Myotis daubentonii</i> , <i>Myotis</i> spp., <i>Nyctalus leisleri</i> , <i>Pipistrellus pipistrellus</i> (45kHz), <i>Pipistrellus pygmaeus</i> , <i>Pipistrellus</i> spp. (45kHz/55kHz)	15/09/09
BATLAS 2010	c. 6.0km	<i>Myotis daubentonii</i> ; <i>Pipistrellus pygmaeus</i>	17/09/09
BATLAS 2010	c. 4.3km	<i>Myotis</i> spp.; <i>Pipistrellus pipistrellus</i> (45kHz); <i>Plecotus auritus</i>	24/09/09
BATLAS 2010	c. 6.3km	<i>Myotis</i> spp.; <i>Pipistrellus pygmaeus</i>	25/09/09
EIS Surveys	c. 1.4km	<i>Myotis nattereri</i> , <i>Pipistrellus pipistrellus</i> (45kHz)	06/09/10

3 BAT ACTIVITY SURVEYS

3.1 Roost survey reports

3.1.1 Roost suitability and inspection surveys

Figure 2 shows the location of potential roost features (PRF) identified in the vicinity of the Application Site and **Table 5** provides the results of preliminary roost assessment surveys. In summary there were 18 buildings and two trees were assessed for roost potential, including four along the proposed grid connection route. Five of the buildings were assessed as having moderate or moderate to high roost potential. Of these only three buildings and a tree were considered to be within the 266 m Zone of Influence (ZoI) of the proposed turbines – Structure 1, 6 and 14.

Structure 1 was assessed as having moderate-high potential as a maternity/summer roost, however altitude, a south facing aspect and a thinly uninsulated tin roof lowered potential suitability as a hibernation roost. This structure is within c. 95 m of T4 and is directly adjacent to the Application Site. A building inspection was conducted in Feb-2021 to investigate usage as a hibernation roost survey; and while no roosts were identified several features within the structure could not be monitored effectively – see notes. Ongoing monitoring (building inspections and emergence/ re-entry surveys) will be required to monitor this potential roost pre-construction given the proximity to T4 and proposed construction works.

<i>Bat roost inspection notes</i>	<i>Date: 11-Feb-2021 11:00-13:30</i>	<i>Feature: Structure 1</i>
<i>Surveyor(s):</i> Róisín NigFhloinn (NPWS licence holder), Oisín O Sullivan		
• Feature type	-	Abandoned traditional cottage
• Age	-	Building last occupied approx. 1987
• Wall construction	-	Solid
	-	Stone/brick - lime mortar
	-	Cladding - wood/MDF inside
• Roof covering	-	Corrugated iron
	-	Lined with boards & vegetation - probably original thatching material
• Position of bat access point(s)	-	Multiple, including open/broken windows, through door, between roof & wall, cervices in outer masonry
	-	Height: 1 to 5m
	-	Aspect: south facing
• Bat roosting site(s)	-	No hibernation roost confirmed
	-	Potential for summer roost behind roof cladding
	-	Potential for hibernation roost in lime mortar walls
• Species	-	Emergence survey (Sep-2020): 3 individuals thought to be <i>Myotis</i> sp.
• Droppings	-	Dropping found: 4 pellets, under hole in wall/door frame – probably from autumn

- Roost category - Confirmed transitional roost, possible hibernacula - unconfirmed (could not inspect all parts building)

Notes: Structure 1 – building inspection 11-Feb-2021

- There were several crevice features in the outer brick and mortar wall from 1 - 5m above ground. These were examined with the use of an endoscope and a thermal imaging camera. Crevices facing NW on the house were noted to be filled with frost and considered unlikely to have hibernating bats. An examination with the endoscope and thermal imaging camera confirmed this. **No bats were found in the outer walls.**
- Crevices in the wooden cladding inside the building were also examined. **No bats were found in the interior wooden cladding.** Four bat droppings were found below a hole in a wall/doorframe; however, these droppings were not recent and were likely residual from the autumn season.
- Though no bats were found the features accessed, this building could still potentially sustain a low number of hibernating bats in some of the crevices that could not be examined. It also is likely to hold a larger seasonal population as a transitional roost

Structure 6 was the most intact building surveyed and was considered to have the most potential to act as a hibernation roost, with access into an attic space noted. Bat droppings were observed above the main door of the cottage with small gaps in the eaves/soffit above noted as showing signs of activity in and out of the attic. Further droppings were noted above the entrance to the outhouse, with possible entrance holes noted under the corrugated iron roof. An old sycamore tree adjacent to cottage was assessed as having low to moderate potential, with several large openings in the trunk and evidence of rot. The location of this cottage and tree right at the edge of the 266 m ZoI (c. 255 m from T7) and c. 45 m from the grid connection route means these potential roosts do not require further building inspections or emergence/ re-entry surveys other than ones already conducted.

Structure 14 was assessed as having moderate potential as a maternity/summer roost; however, was considered to offer lower potential as a hibernation roost. This cottage was considered to be sufficiently removed from proposed turbine locations (c. 235 m from T8) and c. 20 m from the grid connection route. Even though Structure 14 falls within 30 m potential ZoI of the grid connection route, considering the limited scale, constrained nature and distance from the proposed cabling works, a 15 m ZoI would be more appropriate. Therefore, no further building inspections were considered necessary.

3.1.2 Emergence surveys: 23-Jul-2019

On 23-Jul-2019 surveyors undertook simultaneous emergence surveys at Structure 1 (c. 95 m from T4) and Structure 14 (c. 235 m from T8) for approximately one hour after sunset. No bats were observed emerging from either structure.

A single (possibly two) common pipistrelle was detected adjacent to Structure 1 and moved through the area at 22:35, foraging briefly before moving on and possibly the same animal returned again at 22:39.

At Structure 14, a relatively early pass of a Leisler's bat was recorded at 22:03 and was noted as a relatively high/ distant pass (faint), probably of a commuting bat. After 22:26 a small number of

common pipistrelles (1 to 2, possibly 3 bats) were recorded adjacent to the cottage. These bats were appeared to have moved into the area and were observed foraging around the trees between Structure 14 and Structure 12. Towards the end of the emergence survey soprano pipistrelle (6 passes) and *Myotis* species (1 pass) were recorded.

3.1.3 Emergence surveys: 07-Aug-2019

On 07-Aug-2019, two surveyors covered possible exit points identified during external building inspections at Structure 6 (c. 220m from T7) for up to one hour after sunset. Although there was evidence of bat droppings recorded during building inspections, no bats were observed emerging from the structure. Both common and soprano pipistrelles (11 passes), brown long eared bat (1 pass) and *Myotis* sp. (1 pass) were detected and observed foraging around the area.

3.1.4 Emergence surveys: 15-Sep-2020

On 15-Sep-2020 surveyors undertook simultaneous emergence surveys at Structure 1 (c. 95 m from T4) and Structure 6 (c. 220 m from T7) for a duration of 1h 14mins after sunset. No bats were observed emerging from Structure 6. There were three relatively large bats with pale undersides observed leaving via the front door of Structure 1 at 20:09, 20:12 and 20:15. No calls were emitted as the bats departed the roost and given the failing light combined with observation distance positive identification was not possible. The silent behaviour, size, pale colouration and flight pattern were suggestive of brown long-eared bats.; however, given the pre-dusk emergence time (dusk approx. 20:30), they could equally have been a species of *Myotis* bat. Later during the emergence survey *Myotis* species bat were recorded from around the roost (7 passes recorded between 20:28 and 20:42). Based on the current evidence, Structure 1 was judged most likely to be a transitional roost occupied by *Myotis* species, possibly males, as these are known to roost in small numbers together.

While no bats were recorded emerging from Structure 6, single common pipistrelle (2 passes), soprano pipistrelle (2 passes) and *Myotis* species (4 passes) were recorded passing through the survey area.

3.1.5 Emergence survey: 17-May-2021

On 17-May-2021 an emergence survey was conducted at Structure 1. As observed for the previous autumn surveys, emerging bats were silent and no echolocation calls were detected. Flight behaviour was suggestive of *Myotis* species. A maximum of two bats were recorded leaving the roost, however the first bat re-entered the roost and may have been counted twice leaving. Given the date and small numbers this was judged to be a spring transitional roost supporting c. 2 bats, probably *Myotis* species.

3.2 Transect and point count reports

3.2.1 Visit 1 – Summer: 23-Jul-2019

Following on from emergence surveys conducted at Structure 1 and Structure 14, surveyors undertook walked transects. In the northern eastern part of the site a total of 30 bat passes were recorded during 131 minutes of survey time, equating to 13.7 bat passes/ hour (bp/h). Three species of bat were recorded, with Leisler's bat (17 passes) and common pipistrelle (12 passes) being the most active across the area covered and only a single soprano pipistrelle was recorded. For records were bats were observed only 1 to 2 bats were noted. As shown in **Figure 3**, activity was typically associated with the edge of coniferous forestry plantation and forestry rides, with the bats recorded in apparently more open areas utilising scrub/ bushes associated with streams and shelter belts adjacent to farm outbuildings.

3.2.2 Visit 2 – Summer: 07-Aug-2019

Following on from an emergence survey conducted at Structure 6 surveyors undertook a walked transect. No bats were recorded during the transect. Winds were light and temperatures mild during the transect, however periodic light drizzle may have dampened bat activity higher up the slope, in favour of more shelter valleys.

3.2.3 Visit 3 – Autumn: 15-Sep-2020

Following on from emergence surveys at Structure 1 and Structure 6, surveyors undertook a short walked transect (T4 to the burnt house), a point count (at the burnt house) and a driven transect covering the grid connection route.

As shown in **Figure 5**, during the short walked transect from T4 to the burnt house, only a single common pipistrelle (2 passes) was recorded at 21:08.

The point count at the burnt house lasted for 60 mins and the following species were recorded: common pipistrelle (64 passes), soprano pipistrelle (26 passes), Leisler's bat (7 passes), *Myotis* species (7 passes). This location was selected for conducting an extended point count as it represents an optimal foraging location for bats near potential roosts and would be likely to capture all the species utilising the area. A total of 104 bat passes were recorded over an hour and the area was heavily utilised by foraging bats with some social calls (male mating) also detected. However, overall numbers appeared to remain low and while usage was intense over the hour, it was thought the same passes were largely generated by the same individuals. Observations were almost exclusively of single bats and only very occasional were two bats observed together.

The driven transect of the grid connection route start after the point count. As shown in **Figure 6**, there were three species of bats distributed along the transect, with records dominated by common pipistrelle (15 passes) and soprano pipistrelle (13 passes) and only a single Leisler's bat (1 pass).

4 STATIC MONITORING REPORTS

The map in **Figure 7** shows the deployment locations for each season – spring, summer and autumn and **Table 6** provides a summary of the data recorded for each deployment period. **Figure 10**, **Figure 13** and **Figure 16** are maps illustrating the relative density of bat activity (bat passes/ hour - bp/h) at each deployment location across the site, for each seasonal deployment – spring, summer and autumn, respectively.

Analysis of the data recorded during static detector surveys use bat passes per hour (bp/h) to assess levels of bat activity during surveys. This is effectively bat contacts per hour and is worked out on the basis of the time that the static bat detectors operated during the deployment period (set to record from half an hour before sunset to half an hour after sunrise). Bat activity within sites is considered to be a useful proxy for assessing the potential collision risk posed by new wind farm sites.

In order to provide a context of significant levels of activity for the recorded data, the data has been presented taking account of a Polish study by Kepel *et al.* (2011)². The study sought to attribute significance levels to bat activity recorded during wind farm surveys. **Table 3** shows the levels attributed to low, medium and high activity in the Polish study. For the purpose of wind farms in Ireland, the activity levels of the Polish study have been adapted into bands representing low, medium, and high levels of bat activity. These are illustrated in **Table 4**.

SNH *et al.* (2019) recommend using a standard reference system for analysis allowing comparison (Ecobat). However, Ecobat uses a reference system based on British bat populations. It is unclear how this currently relates to Ireland, and so we have deferred to using Kepel *et al.* (2011), until a clear comparative database including Irish bat populations is available.

Table 3. Bat activity levels associated with bat passes per hour (bp/h) - Kepel *et al.* (2011)

Image sourced from *A Review of the Impacts of Wind Energy Developments on Biodiversity*³

Bat activity	<i>Nyctalus</i> species	<i>Pipistrellus</i> species	All bat species
Low	2.5	2.5	3
Medium	4.3	4.1	6
High	8.6	8.0	12

² Kepel, A., Ciechanowski, M. & Jaros, R. (2011). How to assess the potential impact of wind turbines on bats using bat activity surveys? A case study from Poland, XII European Bat Research Symposium, August 22-26, 2011, Vilnius Lithuania.

³ Tosh, D.G., Montgomery, W.I. & Reid, N. (2014). A review of the impacts of wind energy developments on biodiversity. Report prepared by the Natural Heritage Research Partnership (NHRP) between *Quercus*, Queen's University Belfast and the Northern Ireland Environment Agency (NIEA) for the Research and Development Series No. 14/02.

Table 4. Bat activity levels associated with bp/h adapted from Kepel *et al.* (2011).

Attributed activity level	<i>Nyctalus</i> species	<i>Pipistrelle</i> species	All bats
Low	0.0 to 3.5	0.0 to 3.5	0.0 to 4.0
Medium	3.6 to 6.5	3.6 to 6.5	4.1 to 10.0
High	> 6.5	> 6.5	> 10.0

The following sections detail the results from static monitor surveys for each of the seasonal deployments in 2019. Maps are provided for each season deployment in 2019 (**Figure 10**, **Figure 13** and **Figure 16**), which represent the location of each static detector as a pie chart. The relative size of the pie charts illustrates the total number of bat passes per hour in relation to neighbouring units, with segments showing the percentage makeup of different bat species. This helps to provide a visual indication of usage of the site by the local bat population. Note that the pie charts are not set to the same scale across the three separate maps for each seasonal deployment and therefore are not visually comparable between season. For comparative assessment, across all the deployments and for all the species recorded, refer to bat passes per hour in **Table 6**.

Note the distance that bats are from static bat detectors when calls were recorded cannot be gauged effectively; and the same is often true for handheld recording devices in some instances. The detection distance for bat recording equipment is highly variable, and affected by atmospheric attenuation, the frequency of the bat call, the loudness of the bat and the direction of the bat call itself. Results therefore show bat activity for a general locality (for example within 30-40m of a location) rather than at a single point.

4.1 Spring – Static detector monitoring results: 13 to 26 June 2019

The spring deployment of static bat detect was undertaken in June, which is slightly later than recommended by the SNH *et al.*, (2019) guidelines for the spring survey period which is April and May. As Graffy is an upland site it was considered appropriate to extend the ‘spring’ survey window into June. Nine static units were deployed for the spring (June) deployment and the units recorded for 14 consecutive nights, with the exception of the unit covering T8 (D.09), which stopped recording on the fifth night. Fortunately, additional representative coverage of habitats in the southwest of the site was provided by two units deployed to the north and south of T8 (D.10 and D11). In addition, by expressing the data as bat passes per hour, the bat passes recorded during the first five nights can be analysed comparatively between all the units to show relative densities of use across the site.

As shown in **Figure 8**, poor 3G coverage over Graffy resulted in the weather station failing to transmitted data consistently until the 17-Jun-2019, when the station was relocated and remote data downloads resumed. As a substitute, weather data from several Met Éireann sources was examined,

including weather stations at Finner and the Glenties hatchery. Weather conditions over the first five nights were considered to be within compliant weather parameters, although there were two evenings and one morning that experienced brief periods of light rain. As would be expected for an exposed upland site like Graffy, wind speeds were slightly elevated, with speeds often exceeding compliant parameters rising to 0.5 to 1 m/s (1 to 2 mph) above the recommended limits of 5 m/s (c. 11 mph). However, given the upland nature of the site, the majority of deployment nights were considered to fall within acceptable wind parameters of < 7 m/s (< 15.5 mph). Over the 14-night deployment only three nights fell out of compliance due to mean wind speeds significantly exceeding 5 m/s with a prolonged breezy period (wind speeds above 7 m/s or 15.5 mph) recorded between 22 to-24-Jun-2019 and notably windy conditions over the night of 26/27-Jun-2019, when mean hourly wind speeds of up to 17.4 m/s (39 mph) were recorded. Generating bat passes per hour (bp/h) using data sets that excluded periods when wind speeds were non-compliant was found to give lower values bp/h for the majority of deployments, as bats were remaining active during these periods. Therefore, the analysis reported in **Table 6** for the spring (June) deployment includes data from windy nights and uses a 14-night deployment period (except for the D.09-T9 deployment when analysis uses 5 nights).

Despite of the windy conditions, which are considered a feature of this upland site, **it is considered that the spring deployment provides sufficient baseline data to facilitate a robust assessment of potential impacts of the proposed wind farm.**

Figure 10 shows the distribution of bat passes recorded at all the deployment location over the spring (June) deployment period and **Table 6** provides a summary of the data recorded by each of the static units deployed.

Across all the deployment locations a minimum of five bat species were recorded during the spring (June) deployment, including common pipistrelles, *Myotis* species, soprano pipistrelles, Leisler's bats and brown long-eared bats. As highlighted in **Table 6**, for all the species recorded bat passes per hour were categorised as *low*. In terms of aggregated bat passes for each deployment location, bat passes per hour were also classed as *low* for all the static detectors deployed across site in June.

For the 14-night deployment period the highest levels of bat activity were recorded by units covering turbine locations that were subsequently altered (D.10 and D.11). Slightly higher levels of activity at the D.11 location would be expected given the lower elevation and the relative closeness of habitat features potentially utilised by bats. The deployment location D.10 was interesting, as it was positioned towards the upper slopes of Graffy Hill and lacked any significant features; although, the location was noted as a weak feature, being in a slight depression at the head of an upland stream and area of wetland. The periodic, but almost nightly nature of the bat passes recorded (0 to 3 passes) was suggestive of commuting bats, rather animals engaged in prolonged bouts of foraging. It is possible that the relatively sheltered position on the edge of the stream valley, leading up from the main valley

of the Stracashel River draws bats up this tributary and onto parts of the hill. **Figure 9** showing the data for the D.11-T09 deployment, illustrates this pattern of limited numbers bats passes per night (1 to 3 passes) recorded across the deployment period, especially at units where slightly more bat activity was registered, excluding D.08-T7 with no records and D.09-T8 which stopped recording prematurely. At deployment locations recording fewer bat passes (e.g. D.06-T6 and D.07-T6/T5) there were gaps of several nights with no records.

Common pipistrelle and *Myotis* species were the only species recorded at all the deployment locations, except for the unit covering T7 (D.08), which did not detect any bats during the deployment period. The lack of records at T7 (D.08) was likely to be a function of the exposed nature of the area towards the top of Graffy Hill and low levels of bat activity in the general area. Low numbers of passes (0 to 3 passes) were recorded for Liesler's bat (detected at 6 deployment locations) and soprano pipistrelle (detected 3 deployment locations).

The highest number of records for *Myotis* species (9 passes over 6 different nights) and brown long-eared bats (9 passes over 5 different nights) was at deployment location D.10, which also recorded the second highest number of common pipistrelles (7 passes). Interestingly, this was one of the more elevated deployment locations being near the top of Graffy Hill.

Bat activity for the 5 nights that the unit at D.09 (T8) recorded was comparable to the slightly busier deployment locations on the site and was still categorised as low. Like the deployment location D.10, the unit covering T8 recorded 9 passes for *Myotis* species; however, the majority (6 passes) were recorded periodically over the course of a single night and were detected during the early hours of 14-Jun-2019 (00:30 to 02:35). This location was considered relatively exposed and the data salvaged from the weather station prior to signal failure, showed that over this period light winds prevailed < 0.8 m/s (WSW, turning S), although the mean hourly temperature dropped from 7 to 5°C and some very light period rain was recorded (mean hourly rain of < 0.2 mm/h).

Overall, the units covering the north east of the site (D.01-T1/T2 and D.03-T3) and those in the middle section (D.04-T4, D.06-T6, D.07-T6/T5, D.08-T7) registered less bat activity than those located in southwest of the site (D.09-T8, D.10, D.11). This result may have been influenced by the prevailing wind directions during the latter part of the deployment period, which were dominated by easterly and northerly airflow and coincided with a strengthening of wind speeds. Under these conditions the pronounced west facing lower slopes of Graffy Hill and the influence of the Stracashel River valley in the southwestern part of the site would provide the most sheltered areas.

4.2 Summer – Static detector monitoring results: 01 to 13 August 2019

The summer deployment of static bat detect was undertaken over August. Nine static units were deployed for the summer deployment and most of the units recorded for 11 consecutive nights, with the exception of the units covering T1/T2 (D.01), which recorded for 10 nights.

As shown in **Figure 11**, over the summer deployment period only one night exceeded compliant weather parameters, when mean hourly wind speeds gradually increased from 6.7 m/s to 15.6 m/s over the night of 8/9-Aug-2019. Gusty condition over the 2/3-Aug-2019 also pushed wind conditions slight over compliant levels. Prolonged spells of light rainfall were recorded over two nights (5/6-Aug & 10/11-Aug), however levels were low and these nights were considered as falling within compliant weather parameters. As would be expected for the time of year, overnight temperatures remained above 10°C throughout the recording period, apart from the final night when temperatures dipped to 8°C over the morning of 12-Aug-2019. The analysis reported in **Table 6** for the summer deployment includes data from windy and/ or nights and uses a 11-night deployment period, except for the D.01-T1/T2 deployment, which uses 10 nights. **It is considered that the summer deployment provides sufficient baseline data to facilitate a robust assessment of potential impacts of the proposed wind farm.**

Figure 13 shows the distribution of bat passes recorded at all the deployment location over the summer (August) deployment period and **Table 6** provides a summary of the data recorded by each of the static units deployed.

Across all the deployment locations a minimum of five bat species were recorded during the summer (August) deployment, including Leisler's bats, common pipistrelles, soprano pipistrelles, *Myotis* species and brown long-eared bats. As highlighted in **Table 6**, for all the species recorded bat passes per hour were categorised as *low*. In terms of aggregated bat passes for each deployment location, bat passes per hour were also classed as *low* for all the static detectors deployed across site in August.

The highest levels of bat activity (39 passes) were again recorded at the unit deployed at the lowest elevation and covering the location which was subsequently dropped from the final layout D.11 (T9). For the locations covering D.09-T8 (21 passes) and D.10 (22 passes), activity levels across the southwestern part of site were also higher than for other units deployed at more exposed locations across the middle and north-eastern sections of the site, including: D.01-T1/T2 (9 passes), D.06-T6 (10 passes), D.07-T6/T5 (11 passes) and D.08-T7 (8 passes). Higher levels of activity were recorded by the unit deployed at D.04 covering T4, which may be influenced by the relatively close proximity to a small clump of mature trees around an abandoned cottage (c. 70 m) and a conifer plantation to the north and west (c. 150 m), which could create a slightly sheltered pocket. The unit deployed D.03-T3 recorded a slightly higher number of bat passes (19 passes) compared to other units in similarly open locations and this location could be influenced by bat commuting along nearby upland streams.

Leisler's bats (1 to 12 passes) and common pipistrelles (1 to 13 passes) were recorded at all the deployment locations over the summer. Overall activity levels for Leisler's bat across the site were noticeably higher than for spring deployment. Soprano pipistrelle activity was up on spring levels and were also recorded over the majority of deployment locations (1 to 7 passes), with the exception of D.06-T6. Compared to the preceding spring deployment, there were less records for *Myotis* species and records were less well distributed across the site (5 units in summer compared to 9 unit in spring), with the highest number of passes was recorded at D.04-T4 (9 passes). Likewise, small numbers of brown long-eared bat passes were recorded at 6 deployment locations and as for the spring deployment the highest number of passes was recorded at D.10 (7 passes), on the western slopes of Graffy Hill.

Only statics deployed at D.04-T4, D.09-T8 and D.11-T9 registered the full range of species recorded over the summer deployment. **Figure 12** shows the data for the D.04 deployment covering T4 and illustrates the low (0 to 6 passes per night) and sporadic usage of area by different species of bat. This would be considered typical for upland sites, where bats will often be detected periodically exploiting foraging/ commuting opportunities over a constraint period and this is often related to weather conditions. For instance, over the summer for deployment location D.04-T4 (see **Figure 12**), single passes for *Myotis* species were recorded over three consecutive night (AM 6-Aug, PM 6-Aug and PM 7-Aug) and this coincided with falling wind speeds. This pattern of activity was observed again over the 11/12-Aug when 6 passes for *Myotis* species were recorded. Obviously, there are also complex relationships between wind speeds and wind direction to consider and these affect the range over which microphones are effectively recording. For example, a dropping off in wind speeds may result in 'quieter' species like brown long-eared bats being more readily detected.

4.3 Autumn – Static detector monitoring results: 26 Sept. to 09 Oct. 2019

For the autumn (September-October) deployment, four units recorded for 13 nights and due to the longer recording nights batteries became depleted in the other four units after 10 nights of recording. As shown in **Figure 14**, overnight temperatures did not fall significantly below 8°C throughout the deployment period and over the first 10 nights only two nights (30/1 & 3/4-Oct-2019) exceeded compliance parameters, as wind speeds reached 9 to 11 m/s (20 to 24 mph). There was a prolonged windy spell over the last three nights of the deployment period (6 to 9-Oct-2019) when mean hourly wind speeds ranged from 7 to 11 m/s (15.5 to 24 mph). At the start of the deployment period, two nights experienced rainfall; however, these nights were considered as falling within compliant weather parameters. The first night of the deployment (26/27-Sep-2019) experience periodic showers; while the second night of the deployment (27/28-Sep-2019) was subject to heavier rainfall over a constrained period spanning the evening to several hours after dusk and then proceeded to dry up from midnight onwards, remaining dry until dawn. In the context of wind speeds for the time of year

and in view the of upland nature of the site, the majority of nights were compliant with the weather parameters (8 out 10 nights with simultaneous recordings for all eight static units deployed) and **it is considered that the autumn deployment provides sufficient baseline data to facilitate a robust assessment of potential impacts of the proposed wind farm.**

Figure 16 shows the distribution of bat passes recorded at all the deployment location over the autumn (Oct-Sept) deployment period and **Table 6** provides a summary of the data recorded by each of the static units deployed.

Across all the deployment locations a minimum of three bat species were recorded during the autumn (Sept-Oct) deployment, including soprano pipistrelles, common pipistrelles and *Myotis* species. Leisler's bats and brown long-eared bats recorded the during spring and summer deployments were not recorded during the autumn deployment. As highlighted in **Table 6**, for all the species recorded bat passes per hour were categorised as **low**. In terms of aggregated bat passes for each deployment location, bat passes per hour were also classed as **low** for all the static detectors deployed across site over the end of September and into October.

Compared to the low levels of bat activity recorded over the spring and summer deployments; activity was even lower during the autumn deployment. Given the cooling in temperatures and increasing wind speeds, which typically accompany autumn deployments, a tailing off in bat would be expected; especially for upland sites like Graffy where there are more sheltered and slightly warmer foraging opportunities nearby at lower elevations along the Stracashel River valley.

While bat activity was notably low across the site, the highest levels of activity were recorded at units deployed in relatively close proximity to conifer plantation or small woodland features, including the two 'new' deployment locations that were aimed at covering the changes to the final locations for T1 and T5, which were re-located closer to the forestry. The highest number of bat passes was recorded at D.05 covering T5 (17 passes), followed by D.04 covering T4 (7 passes) and D.02 cover T1 (6 passes). No bat passes were recorded at three units deployed at D.01 (T1/T2), D.08 (T7) and D.09 (T8) and these locations are relatively distant from any habitat features. The other deployment location more distance from habitat feature D.03 (T3) and D.07 (T6/T5) also registered very low bat activity, with 4 and 2 bat passes recorded respectively.

Figure 15 shows the data for the D.05 deployment covering a position close to the final location of T5, which bring the turbine closer to the conifer plantation a feature potentially utilised by bats. As for the summer deployment, **Figure 15** illustrates the low (0 to 6 passes per night) and sporadic usage of area by different species of bat over the autumn.

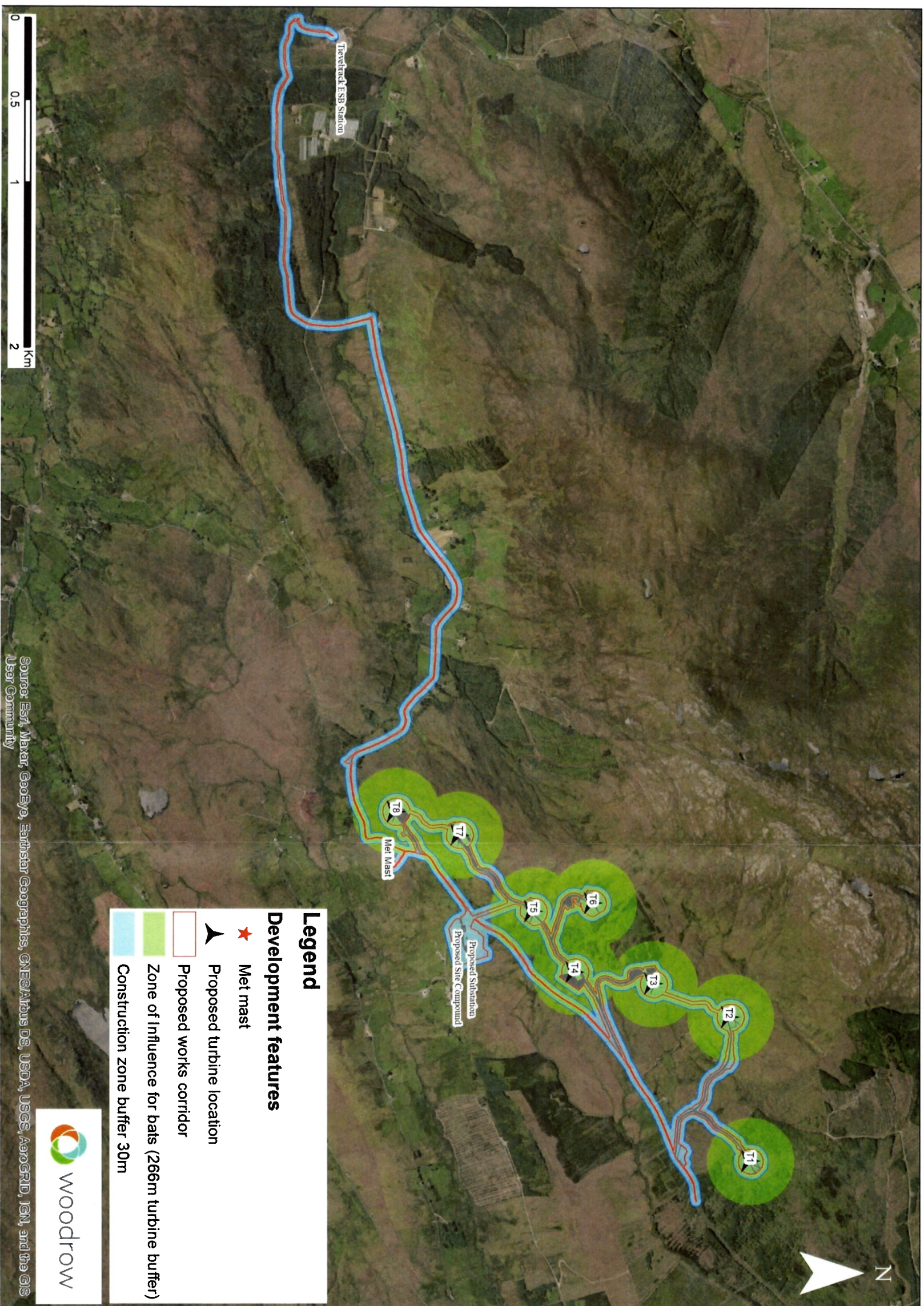


Figure 1. Grafty Wind Farm Application Site, showing potential Zone of Influence for bats

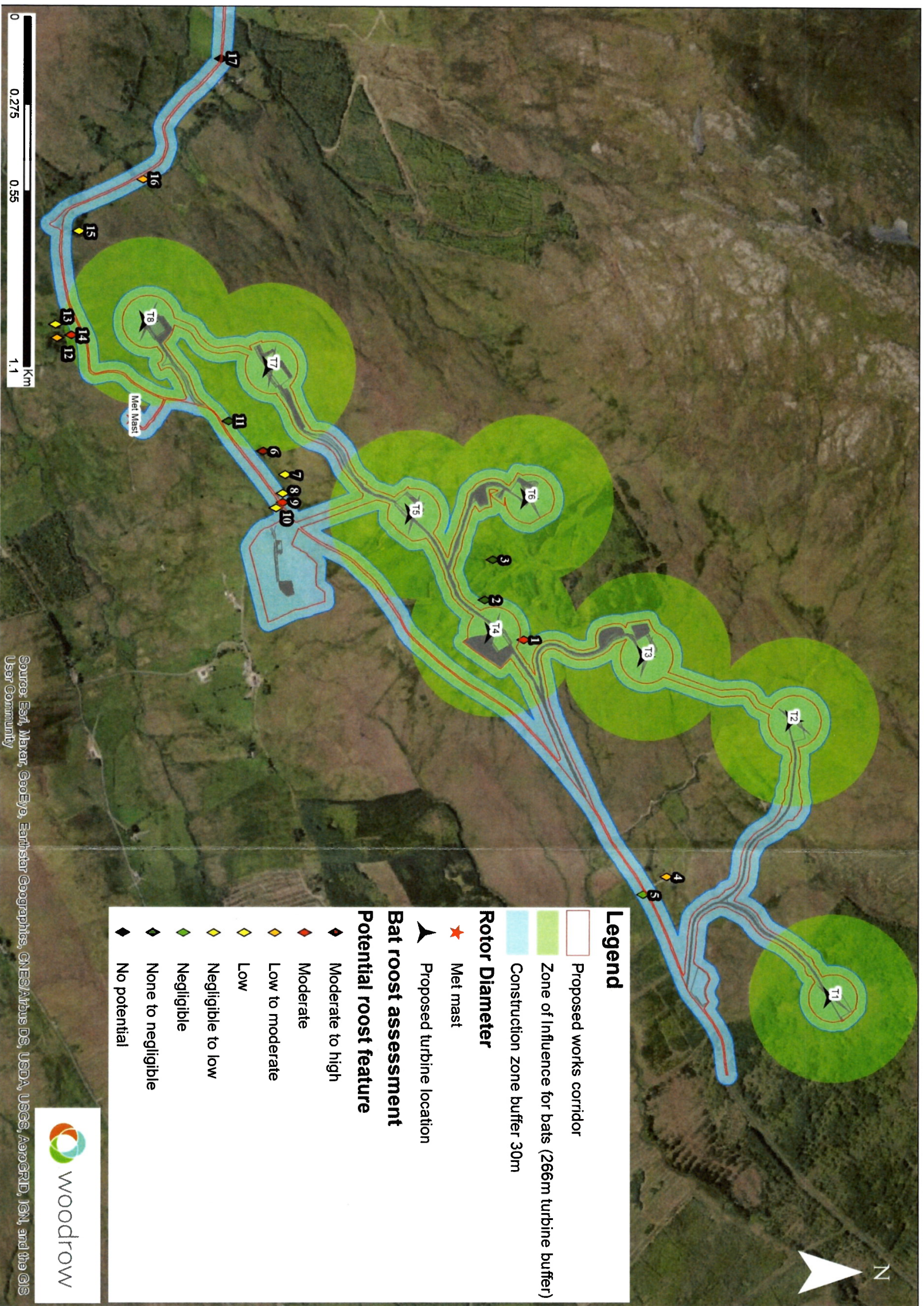











Figure 2. Distribution of potential bat roost features in relation to Gruffy Wind Farm
Numbers on map cross-reference with Id numbers in **Table 5**, which provides detailed roost assessment

Table 5. Assessment of potential bat roost features adjacent to Graffy Wind Farm
- Id numbers cross reference with numbered locations on map in **Figure 2**

Id No.	Potential roost feature - Location (see Figure 2)	Lat-Long.	Type	BRP - Bat roost potential Notes	Survey(s) undertaken	Images of features
1	Directly adjacent to Application Site boundary c. 95 m N from T4	54.824275 -8.14688	Derelict cottage	Moderate potential Tin roof without thin insulation - internal structure dilapidated, e.g. buckled MDF wall & ceiling cladding providing roosting options, with easy access through open/ missing windows & doors. Good connectivity to surrounding central plantation. Lower potential as hibernation roost. Lots of mature trees surrounding cottage, mainly spruce, with occasional sycamore - all assessed as having negligible roost potential.	<ul style="list-style-type: none">• Daytime inspection (internal/external)• Emergence surveys (x2)• Full building inspection (Feb-2021)	
2	Directly adjacent to Application Site boundary c. 100 m W from T4	54.823166 -8.148811	Derelict cottage	No to negligible potential No roof, fissures between stones offer some limited potential within exposed masonry	<ul style="list-style-type: none">• Daytime inspection (internal/external)	
3	Beyond Application Site boundary, equidistance from T4, T5 & T6, within the 266m turbine buffer	54.823392 -8.150793	Derelict cottage	No to negligible potential No roof, fissures between stones offer some limited potential within exposed masonry. Open tin shed in area also assessed as offering no to neg. potential. Good connectivity to wider landscape through forestry rides	<ul style="list-style-type: none">• Daytime inspection (internal/external)	
4	Beyond Application Site boundary & 30m construction zone buffer	54.828366 -8.135245	Occupied cottage, with outbuildings	Low to moderate potential Buildings assessed as likely to have moderate BRP, however exhibited weak connectivity with surrounding landscape	<ul style="list-style-type: none">• Not inspected - viewed from distance	No image
5	Directly adjacent to Application Site boundary, within 30m construction zone buffer	54.827702 -8.134365	Small tin shed	Negligible potential Highly unlikely to support roosting bats, as a low tin shed with weak connectivity to surrounding landscape	<ul style="list-style-type: none">• Daytime inspection (external)	No image
6	Beyond Application Site boundary, at edge of 266m turbine buffer c. 255 m ESE from T7	54.816864 -8.156086	Abandon cottage & old tree	Moderate to high potential Main cottage had slate roof - internal structure in relatively good condition, with access point into loft. Bat droppings above the main door of cottage and small gaps in the eaves/soffit lacking cobwebs were suggestive of activity in and out of the attic. Smaller adjacent building had an asbestos roof, with further droppings noted above the entrance to a small tin roofed outbuilding with possible entrance holes under the tin roof. An old sycamore tree adjacent to cottage assessed as having low to moderate potential, with several large openings in the trunk & evidence of rot	<ul style="list-style-type: none">• Daytime inspection (external) Emergence surveys (x2)	
7	Beyond Application Site boundary & 266m turbine buffer > 340 m from T7 & T5	54.817505 -8.154928	Modern byre	Low potential Plastered breeze-blocks with no fissures, uninsulated asbestos roof & no connectivity - easily accessible through door. Smaller adjoined structure exhibited slightly more suitability	<ul style="list-style-type: none">• Daytime inspection (internal/external)	

Id No.	Potential roost feature - Location (see Figure 2)	Lat-Long.	Type	BRP - Bat roost potential Notes	Survey(s) undertaken	Images of features
8	Beyond Application Site boundary & 266m turbine buffer, just within 30m construction zone buffer > 400 m from T7 & T5	54.817442 -8.154025	Medical shed & garage	Low potential Plastered breeze-blocks with no/ limited fissures & uninsulated tin roof - easily accessible through door. Situated within a good patch of foraging habitat	<ul style="list-style-type: none"> Daytime inspection (internal/external) 	
9	Beyond Application Site boundary & 266m turbine buffer > 400 m from T7 & T5	54.817448 -8.153571	Burnt down house with outbuildings	Moderate potential Abandon house recently (in 2019) subject to sever fire damage totally gutting main structure, with some outbuildings remaining intact. One of surviving buildings was covered in dense ivy. Situated within a good patch of foraging habitat created by over grown garden & surrounding trees	<ul style="list-style-type: none"> Daytime inspection (external & partial internal - limited access due to H&S concerns) 	
10	Beyond Application Site boundary & 266m turbine buffer > 420 m from T7 & T5	54.817238 -8.153295	Agricultural shed	Low potential Tin shed with limited, but some roosting potential between tin & roofing joists	<ul style="list-style-type: none"> Daytime inspection (external) 	
11	Beyond Application Site boundary, within 266m turbine buffer c. 220 m SE from T7 & within 30m construction zone buffer	54.815882 -8.157537	Derelict cottage	No to negligible potential No roof, fissures between stones offer some limited potential within exposed masonry.	<ul style="list-style-type: none"> Daytime inspection (internal/external) 	No image
12	Beyond Application Site boundary & 266m turbine buffer c. 290 m S from T8	54.811023 -8.161584	Derelict cottage	Low to moderate potential Limited fissures in masonry - most of inner walls plastered, some timber cladding remaining forming a ceiling & providing some roof space parts, potential for roosts in chimneys	<ul style="list-style-type: none"> Daytime inspection (internal/external) 	
13	Beyond Application Site boundary & 266m turbine buffer c. 290 m S from T8	54.810976 -8.162246	Ash tree	Low potential Ivy clad ash tree with limited dead wood or knots	<ul style="list-style-type: none"> Daytime inspection (external) 	No image
14	Beyond Application Site boundary & at edge of 266m turbine buffer c. 235 m S from T8	54.811428 -8.161719	Derelict cottage	Moderate potential Uninsulated asbestos & tin roofs, with some ceiling cladding remaining. Inner & outer walls mainly plastered limited fissures, potential for roosts in chimneys. Low potential as a hibernation roost	<ul style="list-style-type: none"> Daytime inspection (internal/external) Emergence surveys (x2) 	
15	Beyond Application Site boundary & 266m turbine buffer c. 350 m SW from T8	54.811625 -8.166808	Derelict cottage	Low potential Tin roof with some fissure in masonry & options up chimneys, however mortar still intact between much of the stone. Walls relatively damp in places	<ul style="list-style-type: none"> Daytime inspection (internal/external) 	

Id No.	Potential roost feature - Location (see Figure 2)	Lat-Long	Type	BRP - Bat roost potential Notes	Survey(s) undertaken	Images of features
16	Adjacent to grid route, within 30 m construction zone buffer	54.813439 -8.169362	Derelict cottage, within ivy clad ash trees	Low to moderate potential Old abandoned farm building surrounded by mature trees. Buildings are sufficiently distant from grid connection route to be consider beyond the Zone of Influence	<ul style="list-style-type: none"> Not inspected - viewed from distance 	
17	On grid connection route	54.815624 -8.175306	Bridge	No potential Modern material used in bridge construction, including concrete & breezeblocks	<ul style="list-style-type: none"> Daytime inspection (external) 	No image
18	Adjacent to grid route, within 30 m construction zone buffer	54.812761 -8.203474	Derelict cottage	Moderate to high potential Largely intact slate roof with lots of access points & much of the internal structure preserved providing cover for roosting bats	<ul style="list-style-type: none"> Daytime inspection (external) 	
19	On grid connection route	54.810895 -8.20865	Bridge	Negligible to low potential Some older stonework with fissures on banks, however bridge has been strengthened using concrete limiting the occurrence of roost holes. Potential for sheltered open roost sites between supporting beams on underside	<ul style="list-style-type: none"> Daytime inspection (external) 	

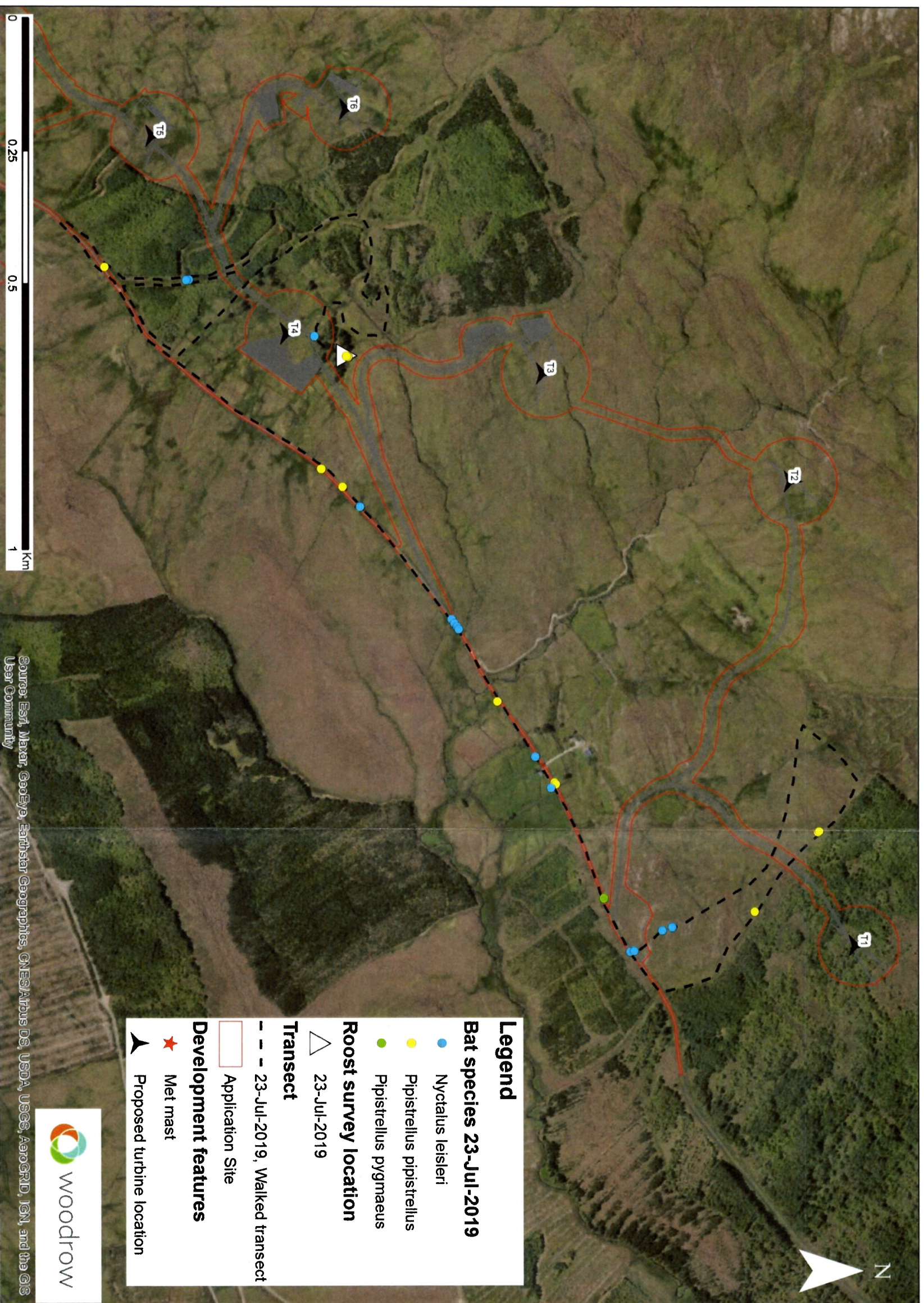


Figure 3. 23-Jul-2019: Roost surveys, transect routes and distribution of bat passes

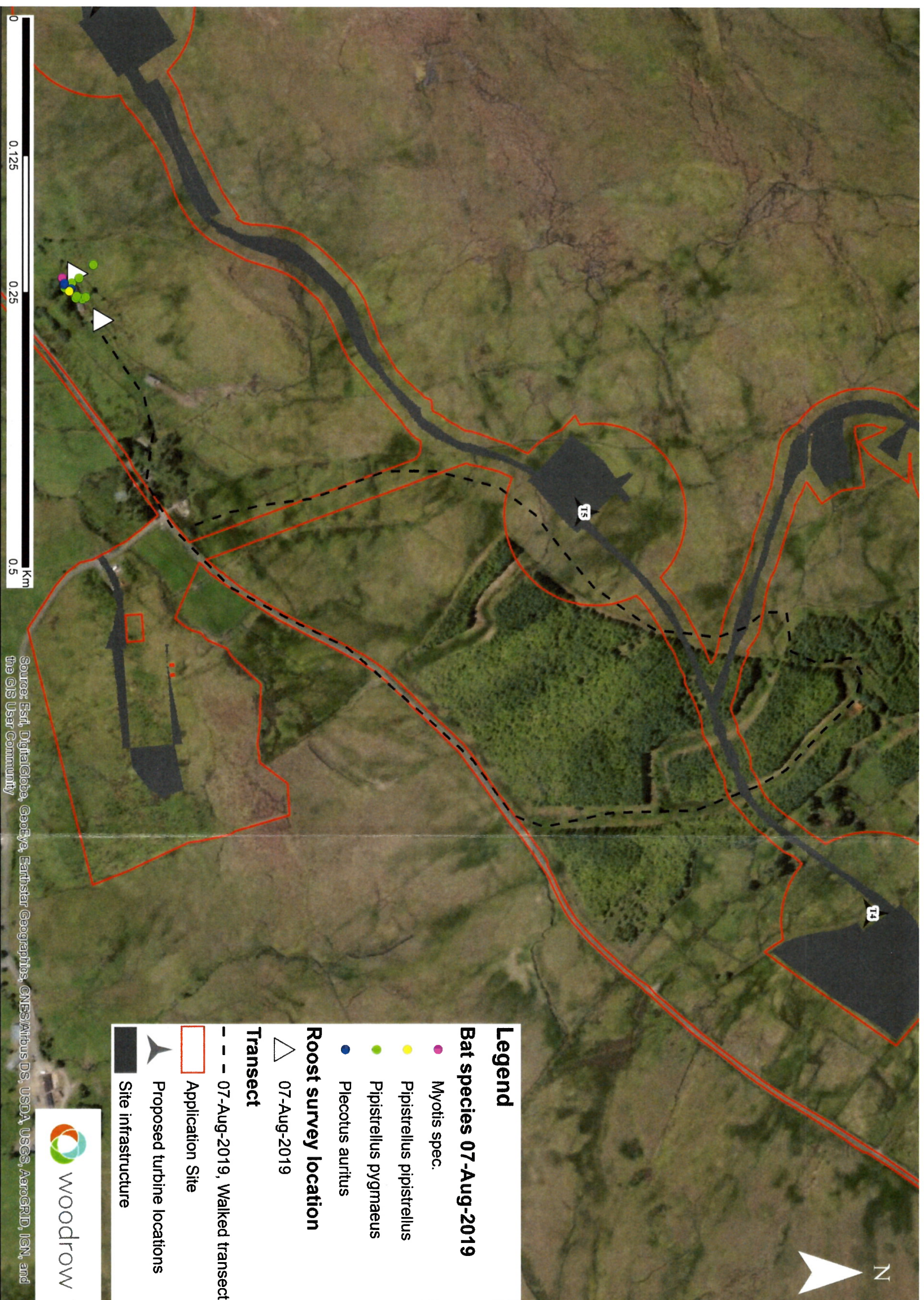


Figure 4. 07-Aug-2019: Roost surveys, transect routes and distribution of bat passes

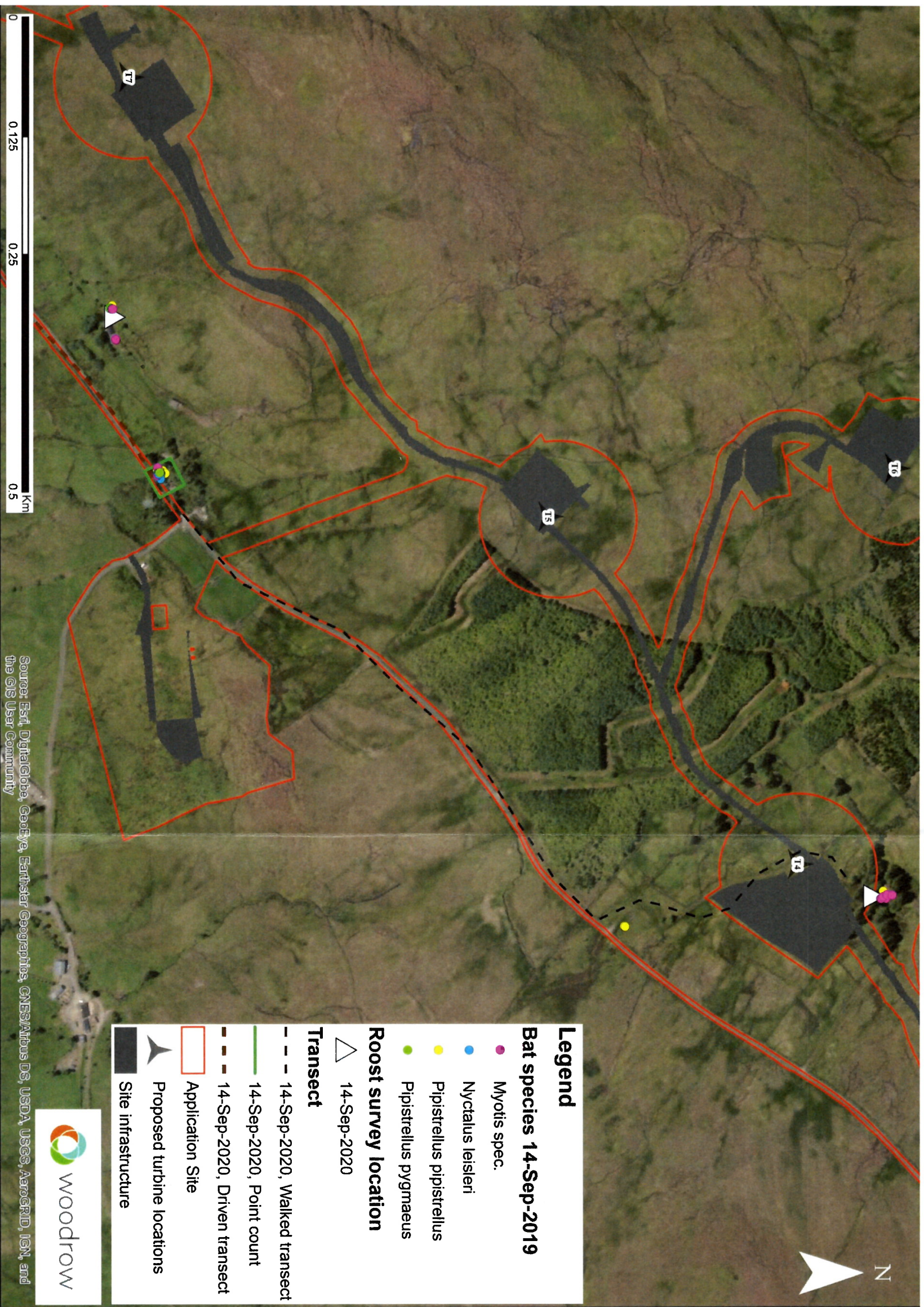


Figure 5. 15-Sep-2020: Roost surveys, transect routes, point count and distribution of bat passes

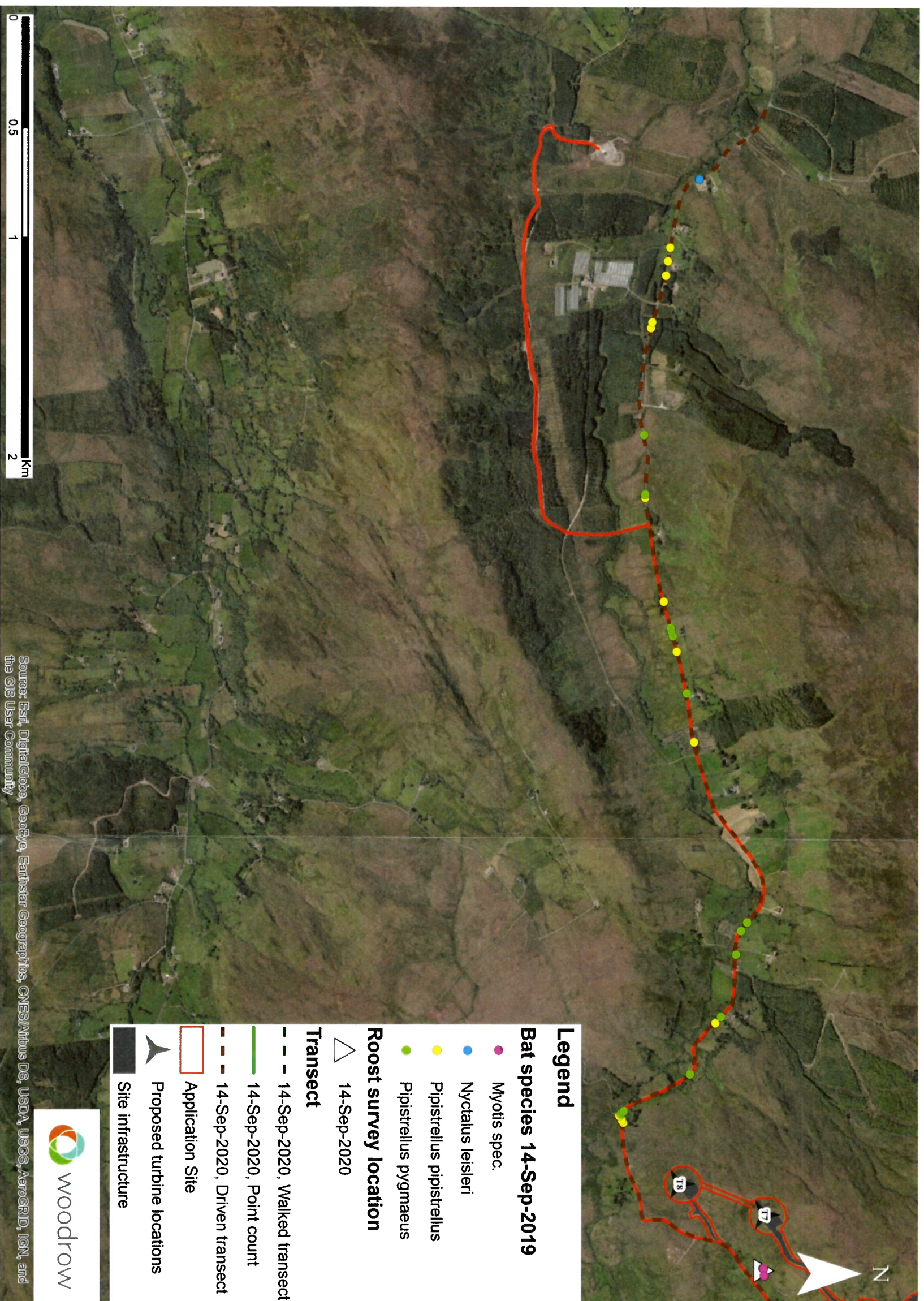


Figure 6. 15-Sep-2020: Grid connection route - driven transect and distribution of bat passes

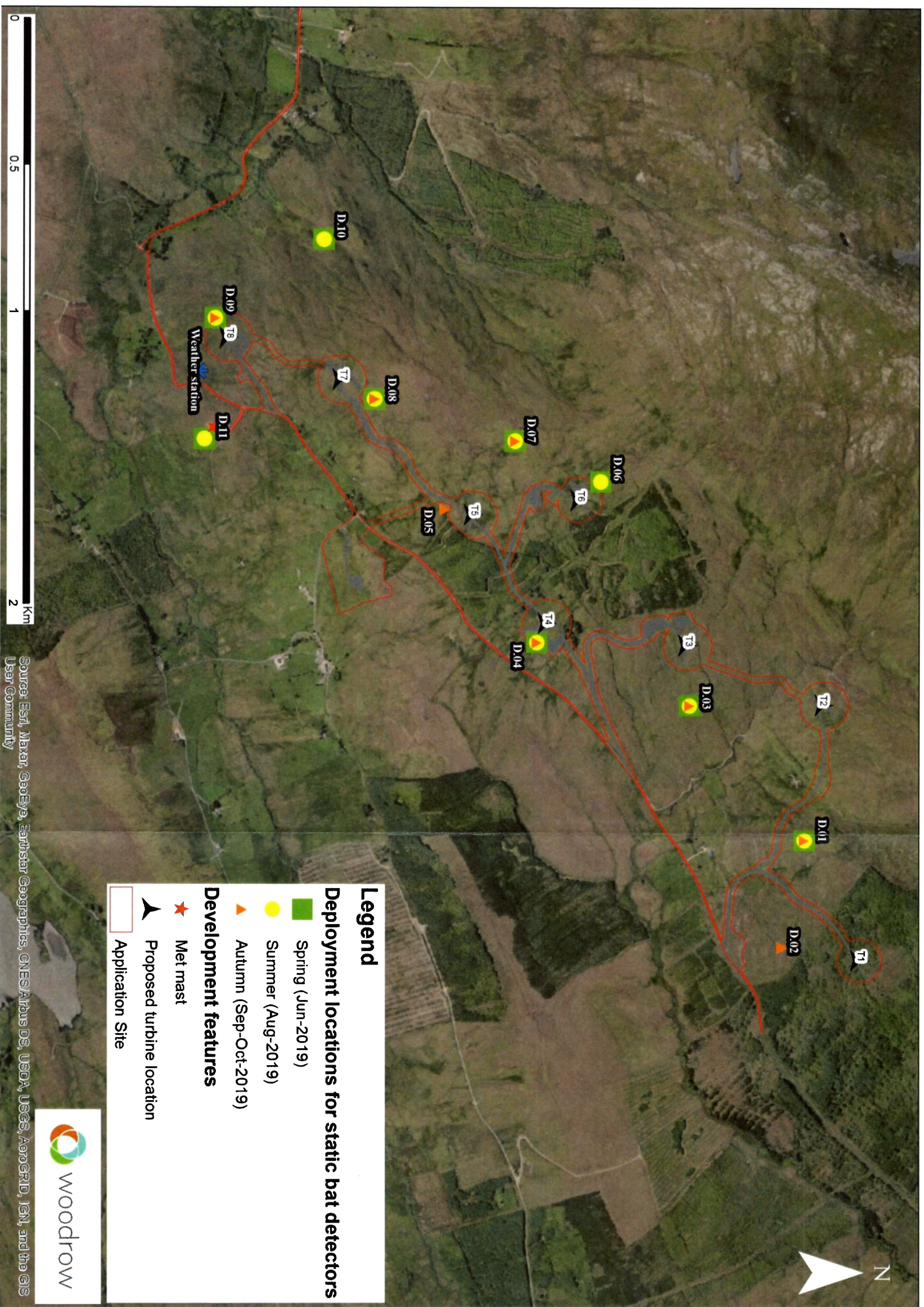


Figure 7. Deployment locations for static bat recording equipment and weather station

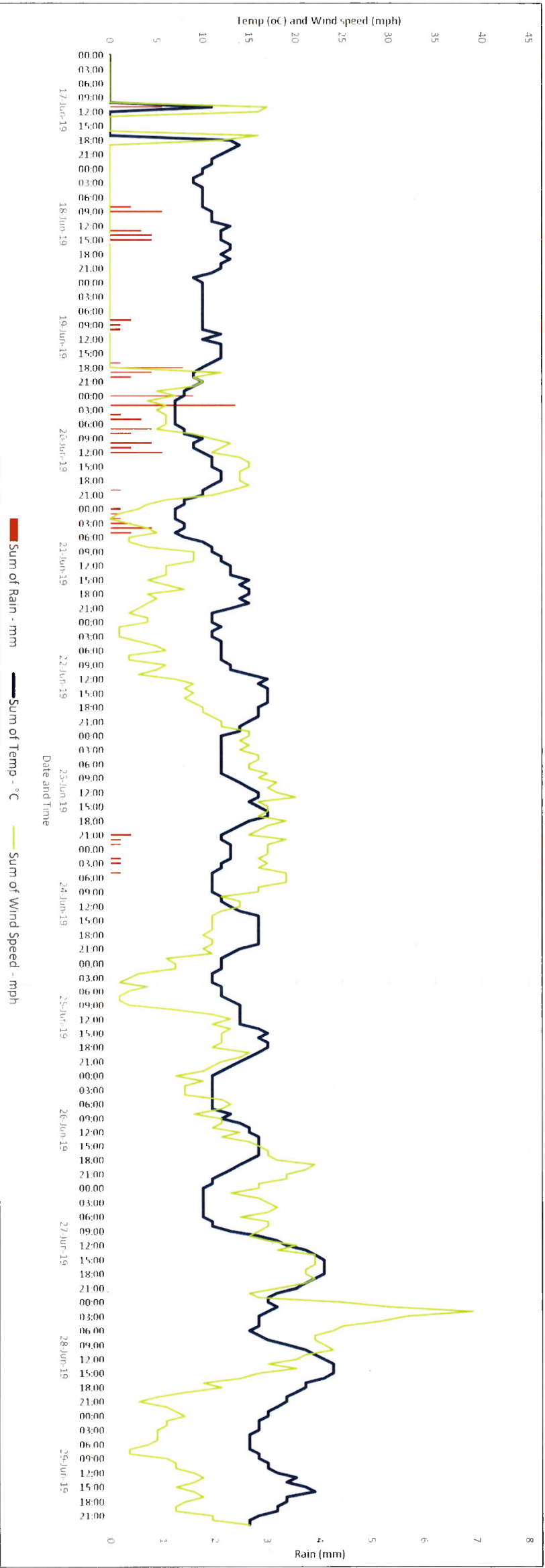


Figure 8. Spring – Weather conditions during deployment period (June)

NOTE: No weather data until night of 17-Jun-2019

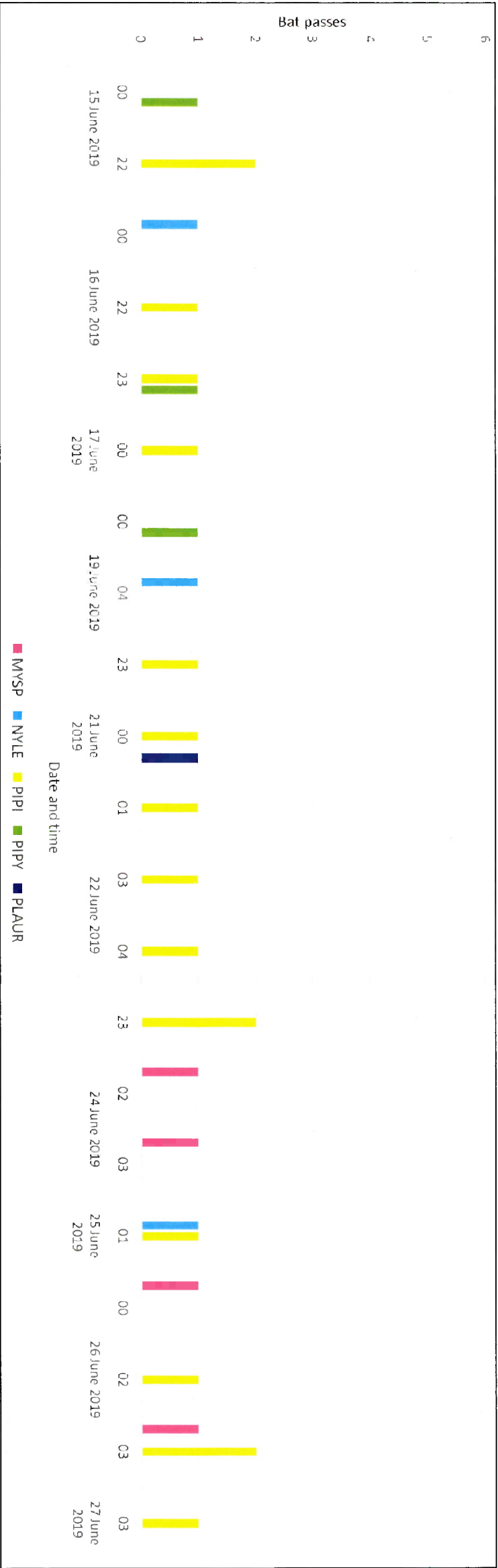


Figure 9. Spring – Bat passes over time: 13 to 29-Jun-2019 for D.11: unit in SW corner near T8

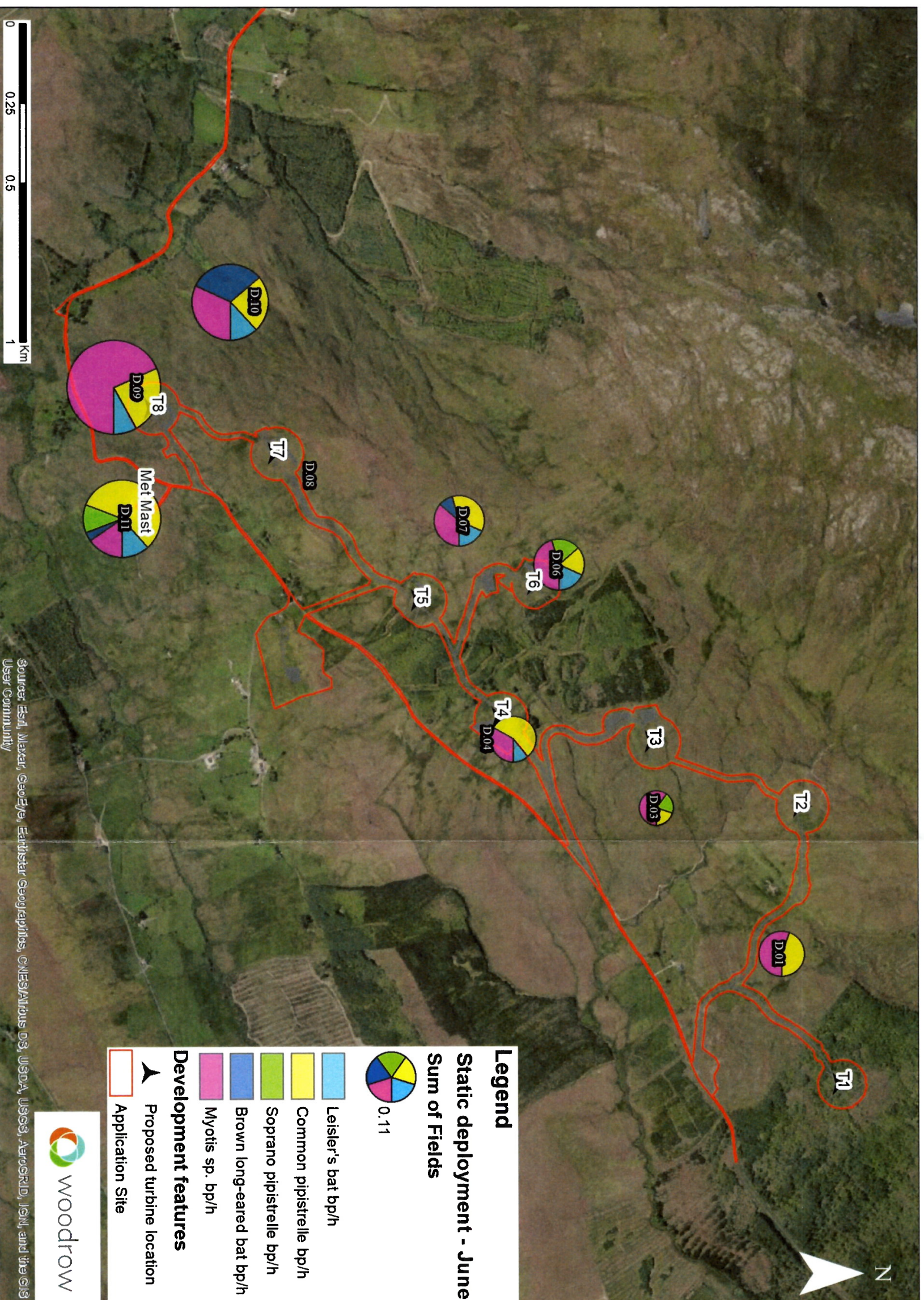


Figure 10. Spring (June) – Distribution of bat passes recorded for each species

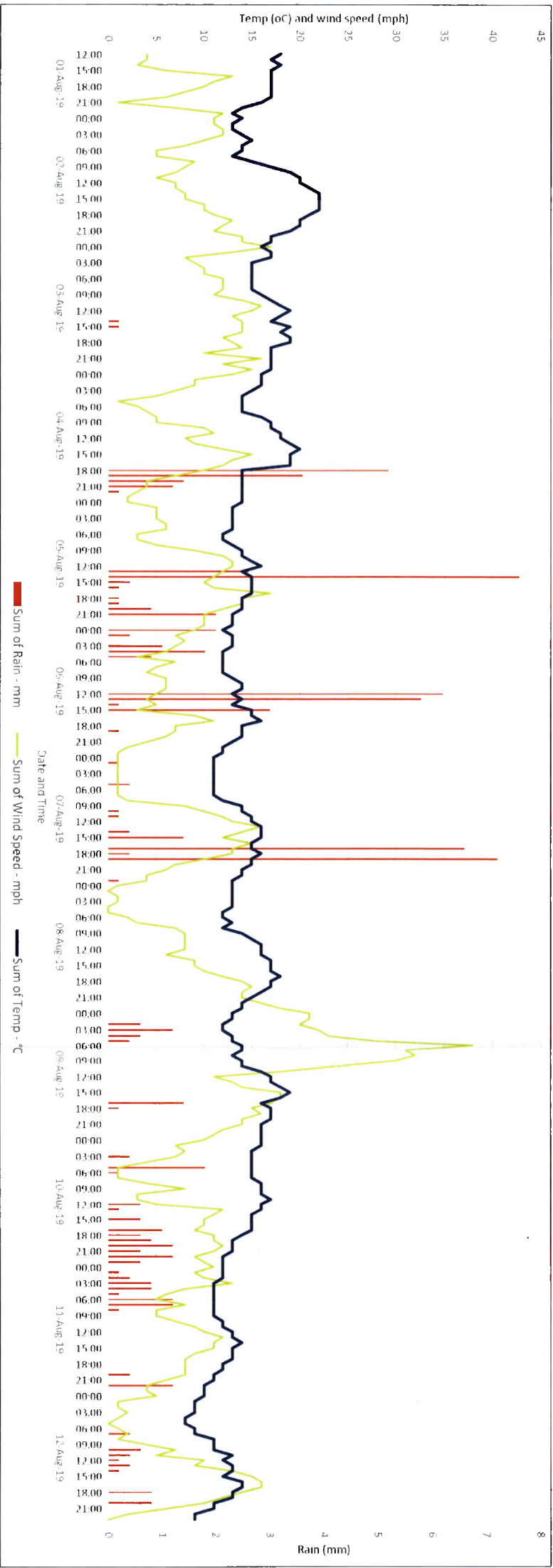


Figure 11. Summer — Weather conditions during deployment period (August)

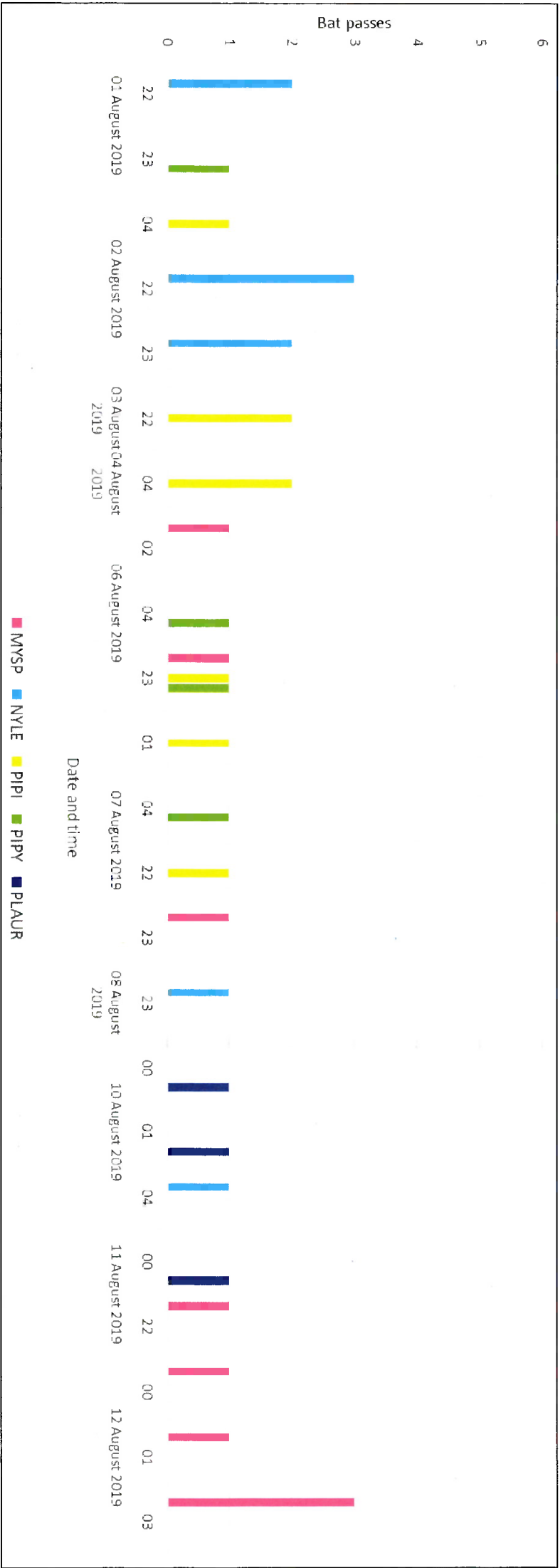


Figure 12. Summer — Bat passes over time: 01 to 12-Aug-2019 for D.04: unit near T4

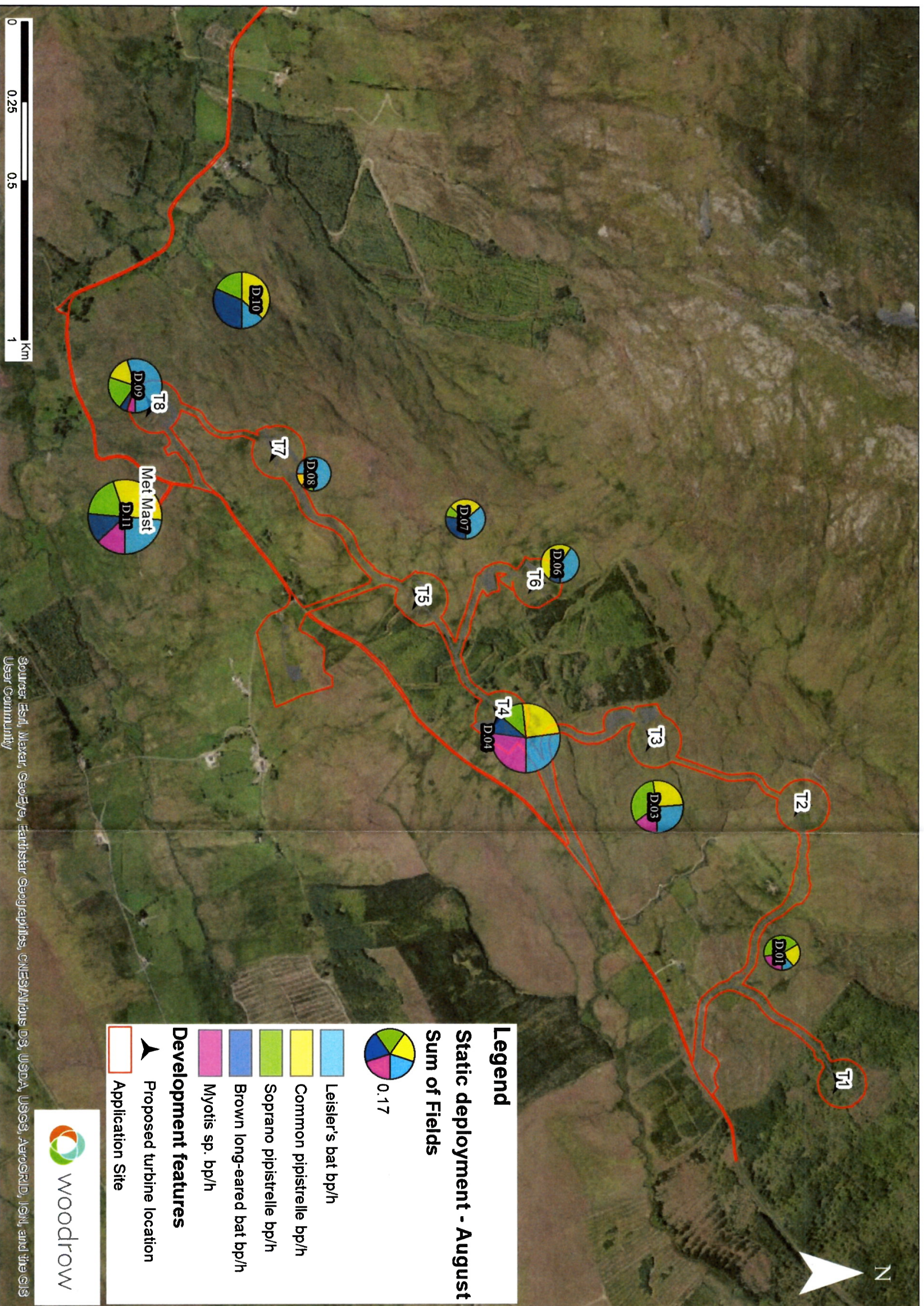


Figure 13. Summer (August) – Distribution of bat passes recorded for each species

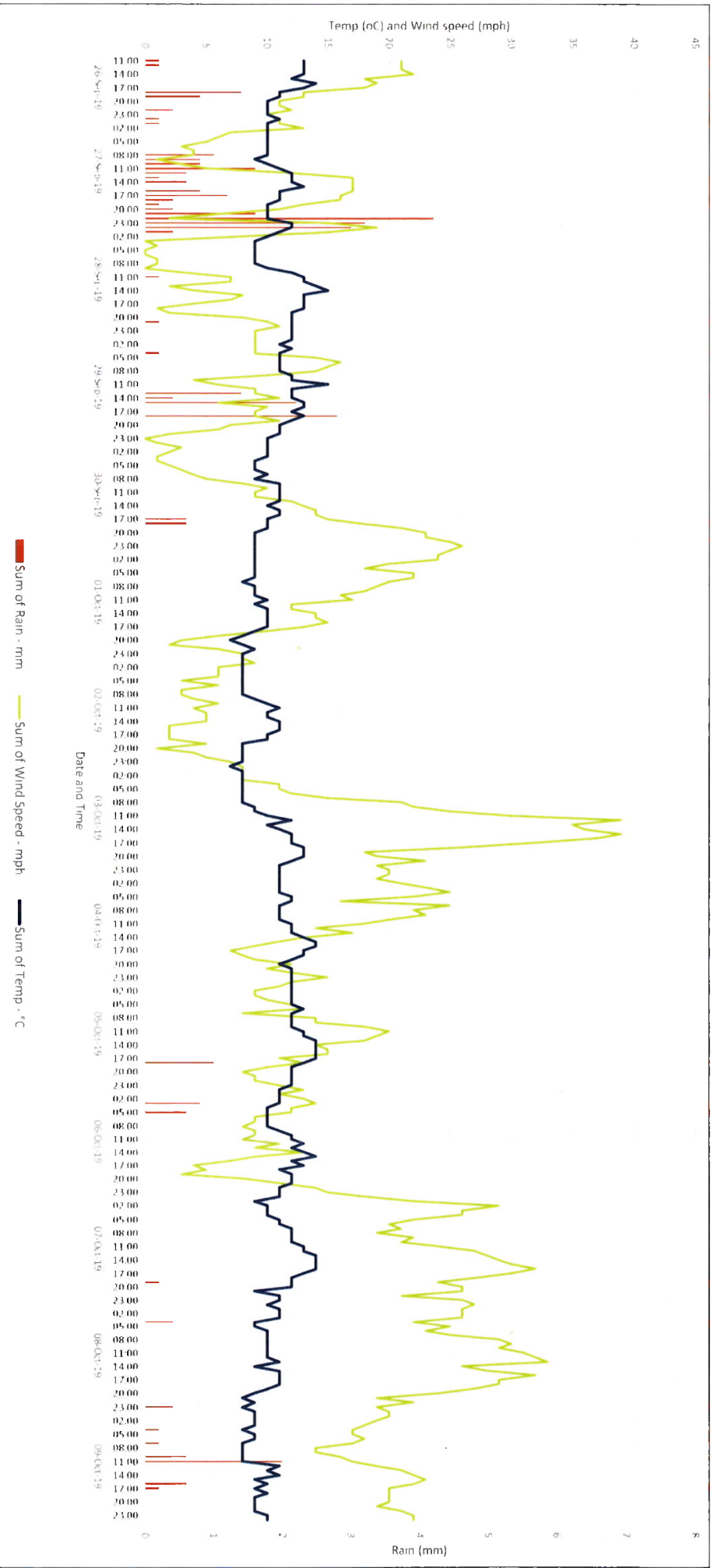


Figure 14. Autumn - Weather conditions during deployment period (September-October)

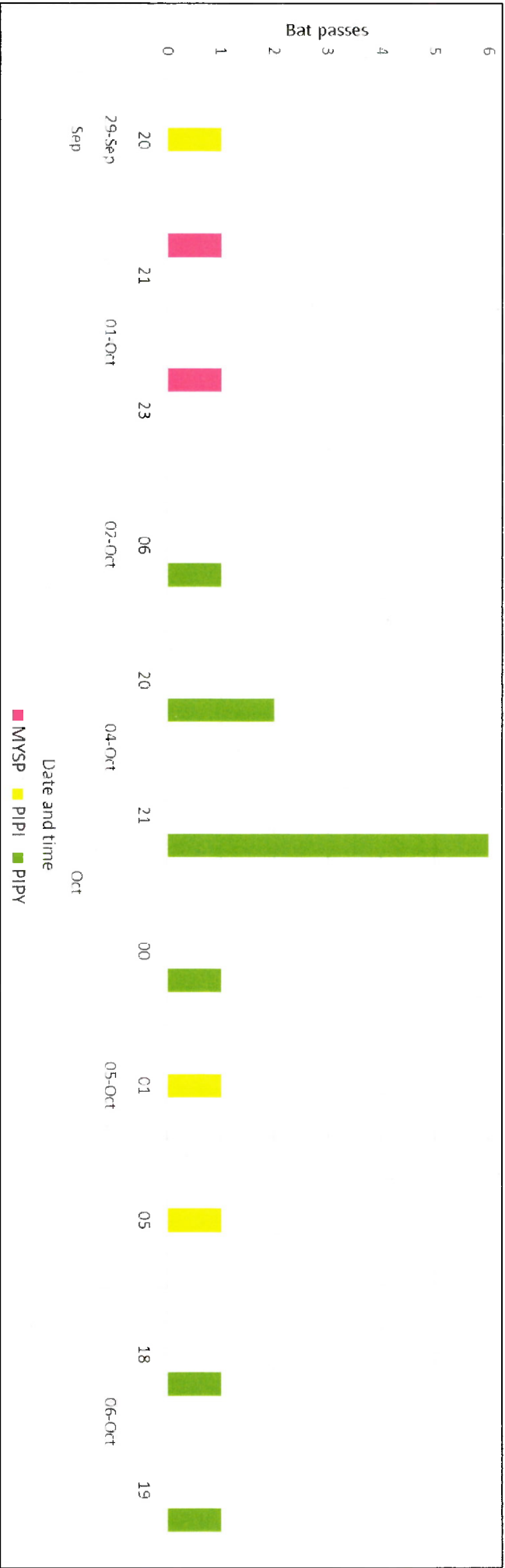


Figure 15. Autumn - Bat passes over time: 29-Sep to 06-Oct-2019 for D.05: unit near T5

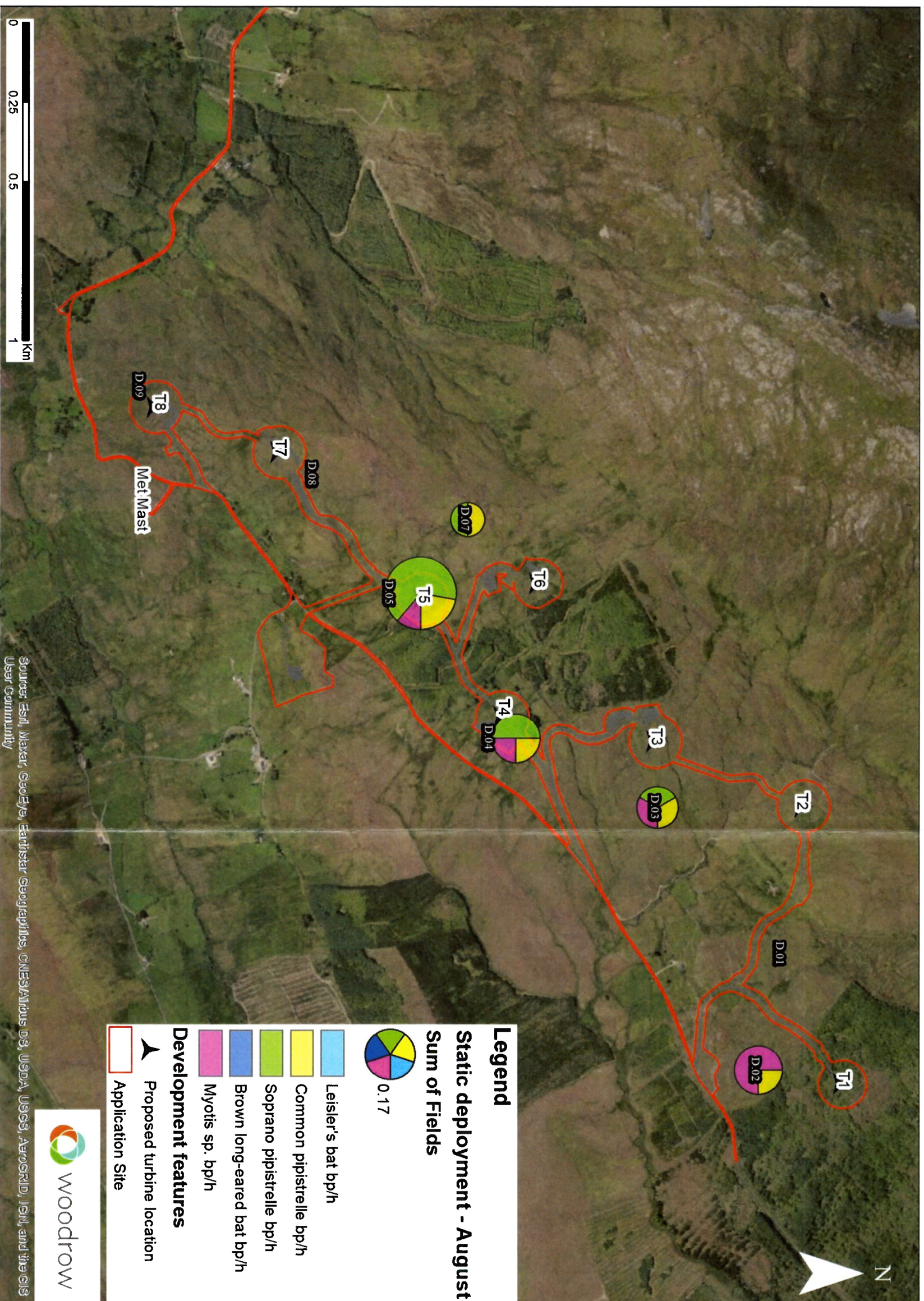


Figure 16. Autumn (Sept-Oct) – Distribution of bat passes recorded for each species

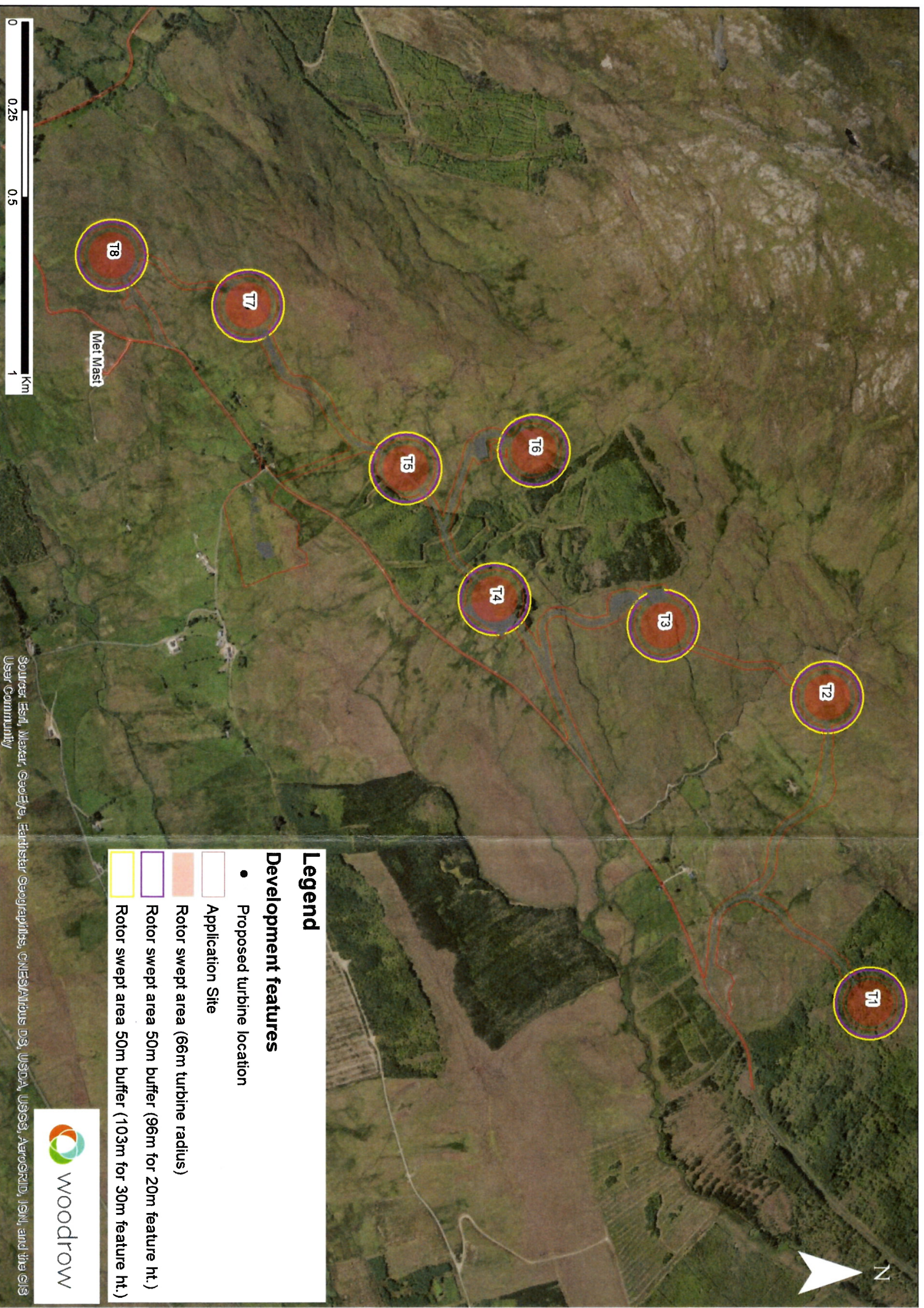


Figure 17. Turbine buffers for minimum 50 m blade tip-feature separation distances

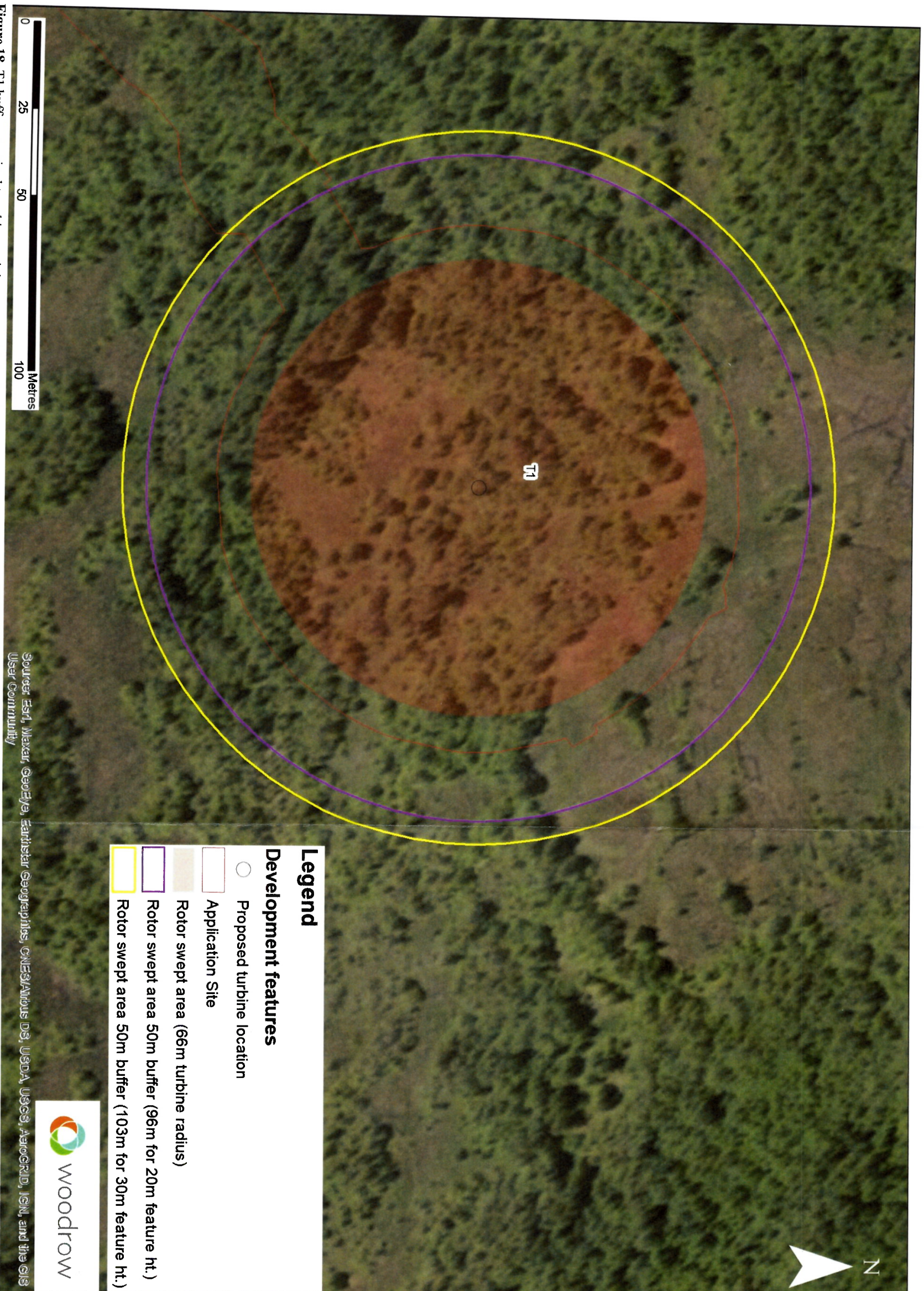


Figure 18. T1 buffers required to achieve minimum 50 m blade tip-feature separation distances

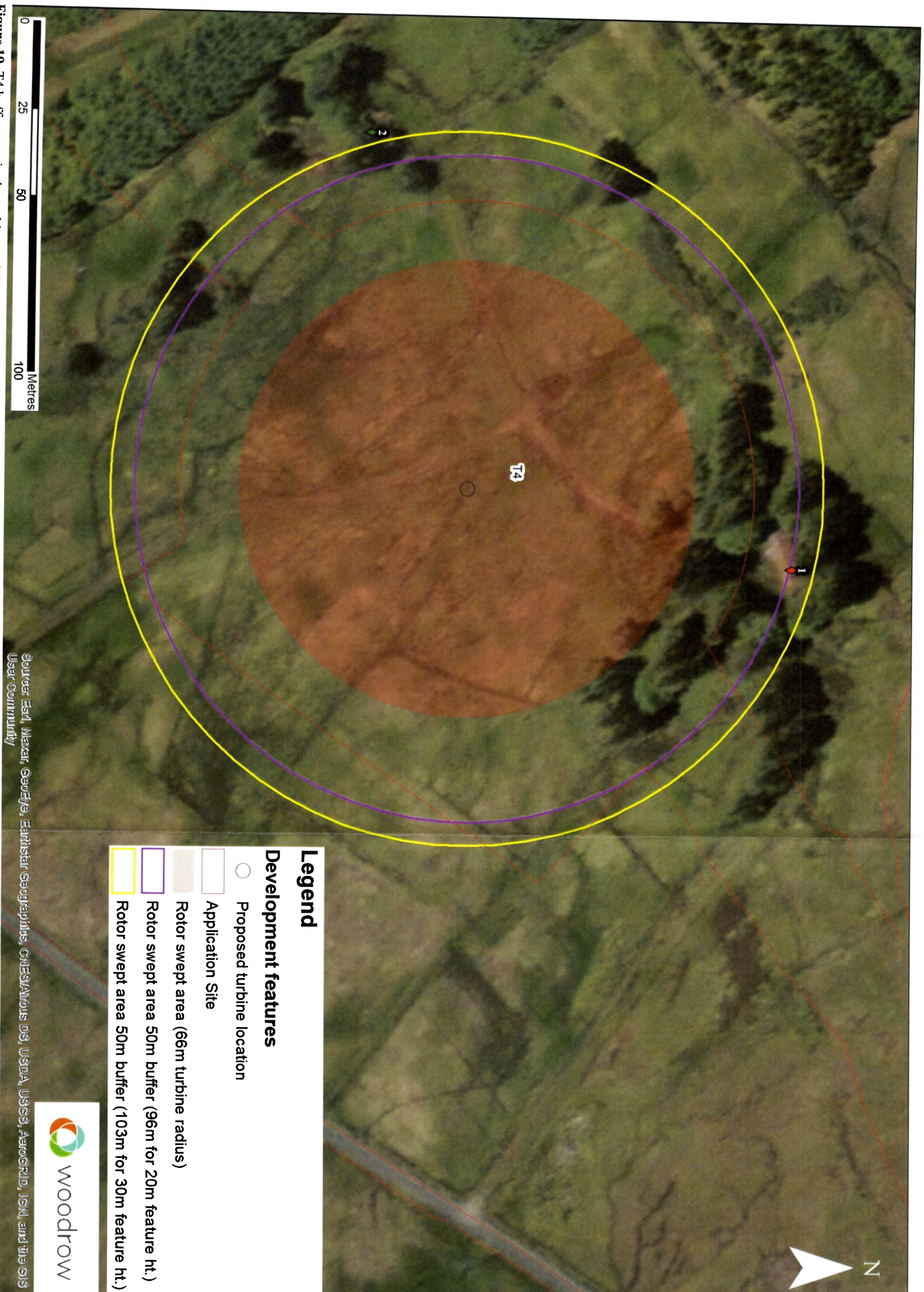


Figure 19. T4 buffers required to achieve minimum 50 m blade tip-feature separation distances

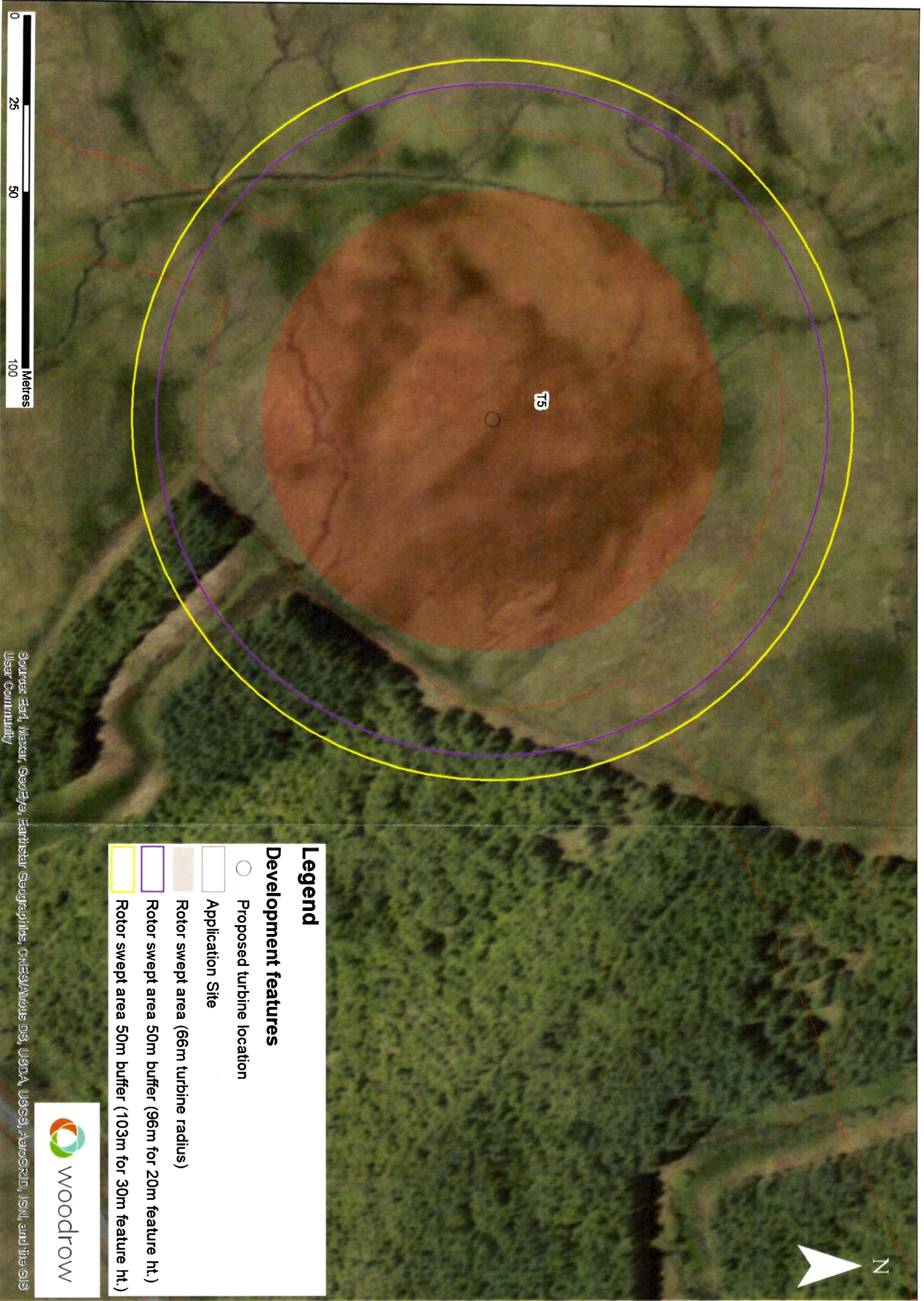


Figure 20. T5 buffers required to achieve minimum 50 m blade tip-feature separation distances

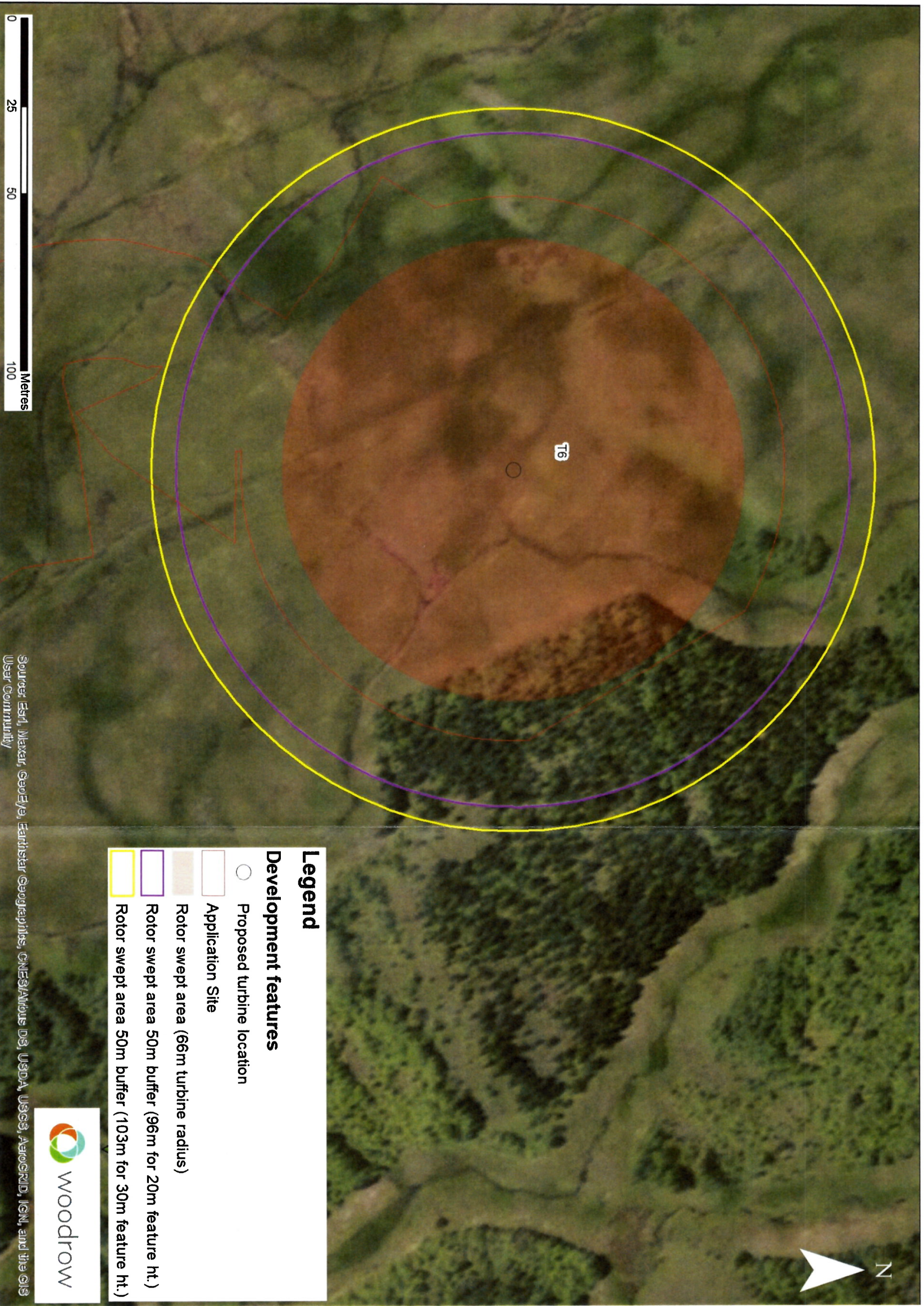


Figure 21. T6 buffers required to achieve minimum 50 m blade tip-feature separation distances

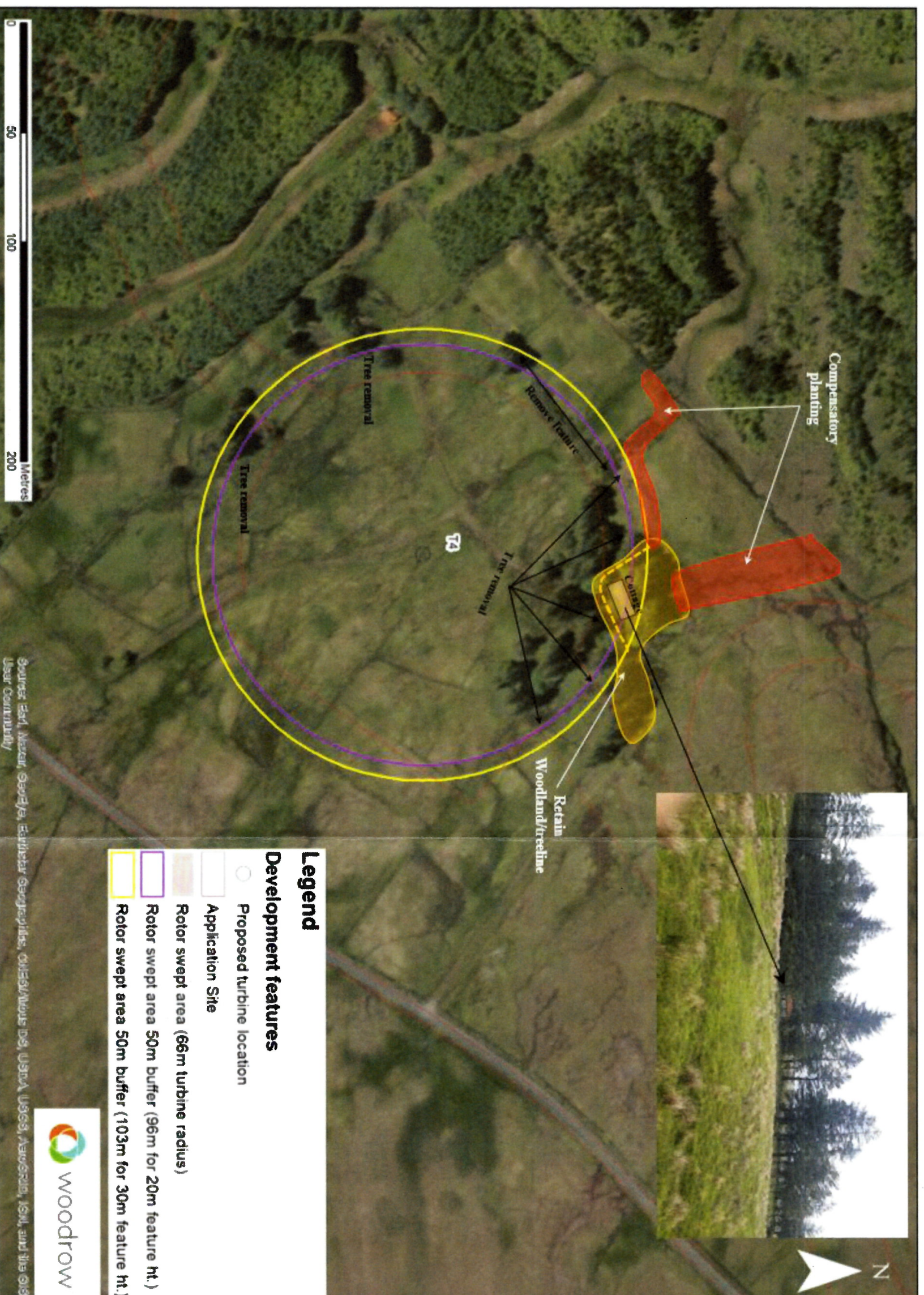


Figure 22. T4 proposed replanting scheme

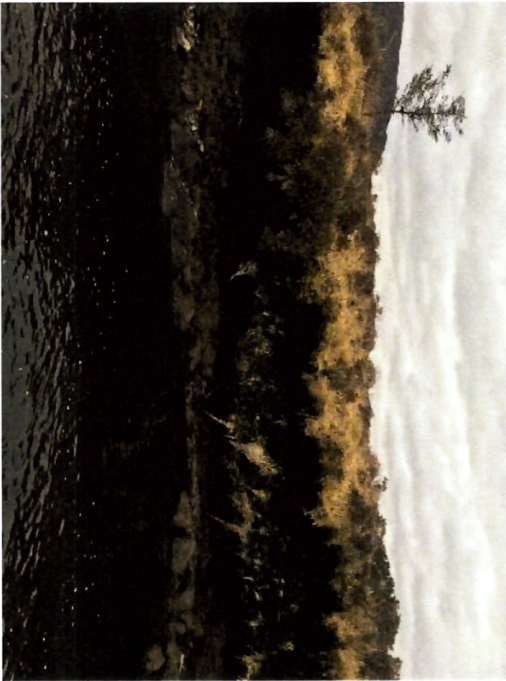

10(v) Freshwater Pearl Mussel



Appendix 10.5.1



Freshwater Pearl Mussel Survey - Stracashel and Owenea Rivers



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Table 10.5.1: Stage 2 FPM Survey

River	Reach No.	Catchment	Location	Description	Photograph
Stracashel	1	Owenea	G8425 9647 – G8430 9646 downstream of the connection to Tievnabrack sub-station	Occasional occurrence (1–40/100m) Suitable Habitat but in very poor condition with significant silt infiltration. Left hand bank subject to undercutting resulting in peat material falling into the reach. The channel had extensive deposits of peat clumps that once dominated the lower layers of the riparian soils; these have entered the channel after bank collapse	 Stracashel section 1 with significant bank undercutting at d/s end of reach
Stracashel	2	Owenea	G8430 9646 – G84390 9650	Frequent occurrence (41–300/100m) Suitable habitat but poor to fair quality due to an abundance of fine materials and considerable fine fragmented peat, and silt. The riparian zone was dominated by grasses with little tree cover and extensive bank collapse due to erosion.	 Stracashel section 2 looking u/s
Stracashel	3	Owenea	G8478 9644 – G8484 9637	No Evidence of mussels Bedrock and boulder habitat shallow not suitable for pearl mussel but capable of carrying silt.	

River	Reach No.	Catchment	Location	Description	Photograph
Owenea at Mulantiboyle	1	Owenea	G8059 9387 – G8063 9402 8.5 km downstream of the proposed development	No evidence of mussels, habitat not suitable	
Owenea at Mulantiboyle	2	Owenea	G8063 9402 – G8072 9404 8.5 km downstream of the proposed development	No evidence of Mussels, habitat not suitable	

River	Reach No.	Catchment	Location	Description	Photograph
Owenea at Kilrairie (Dr McCloskey Pool)	1	Owenea	G8021 9307 - G8034 9309 (250 metres) 10.0 km downstream of the proposed development	<p>Occasional occurrence (1-40 /100 m)</p> <p>Good mix of clast sizes and good stable FPM habitat but heavily silted and in poor condition</p> <p>Approximate % Cover Macrophytes – 15%</p> <p>Approximate % Cover filamentous algae – 10%</p> <p>Riparian land use - improved grassland, land clearance noted upstream of this survey section and some drain maintenance.</p> <p>Total of 26 live mussels counted, sparsely distributed across this reach</p> <p>2 dead shells</p>	 <p><i>Right bank at start of survey reach</i></p>  <p><i>Right bank at ends of survey reach</i></p>

River	Reach No.	Catchment	Location	Description	Photograph
Owenea at Kilrairie (Dr McCloskey Pool)	2	Owenea	G 8153 9367 10.0 km downstream of the proposed development	<p>Suitable FPM habitat on right bank, but heavily silted and in poor condition. The revetment on the left bank has resulted in scour and overdeepening of the channel and therefore has resulted in conditions which are not suitable for FPM.</p> <p>Approximate % Cover Macrophytes – 10% Approximate % Cover filamentous algae – 10%</p> <p>Riparian land use - improved grassland, land clearance noted upstream of this survey section and some drain maintenance. Revetment on left hand bank has created deep pool along this section</p> <p>4 live mussels counted No dead shells</p>	 <p><i>Revetment along the left bank of the main channel</i></p>  <p><i>Confluence of Stream A and the Owenea River</i></p>

River	Reach No.	Catchment	Location	Description	Photograph
Owenea at Clonmacwal	1	Owenea	G7647 9274 - G7655 9271 14.5 km downstream of the proposed development	<p>Common to good numbers, not at capacity (301-1,500 /100m of river length)</p> <p>Good pearl mussel habitat with good mix of clast sizes and stable substrate however the condition of the habitat is very poor with significant fine silt infiltrated through the substrate. Bank erosion is a significant issue with 100 metres of bank collapse recorded on the right bank looking downstream resulting in fine silt and peat fragments in the pearl mussel habitat with large clumps of bank fallen directly on the habitat</p>	 <p>U/S end of the reach surveyed</p>  <p>Right bank collapse in pearl mussel habitat</p>

