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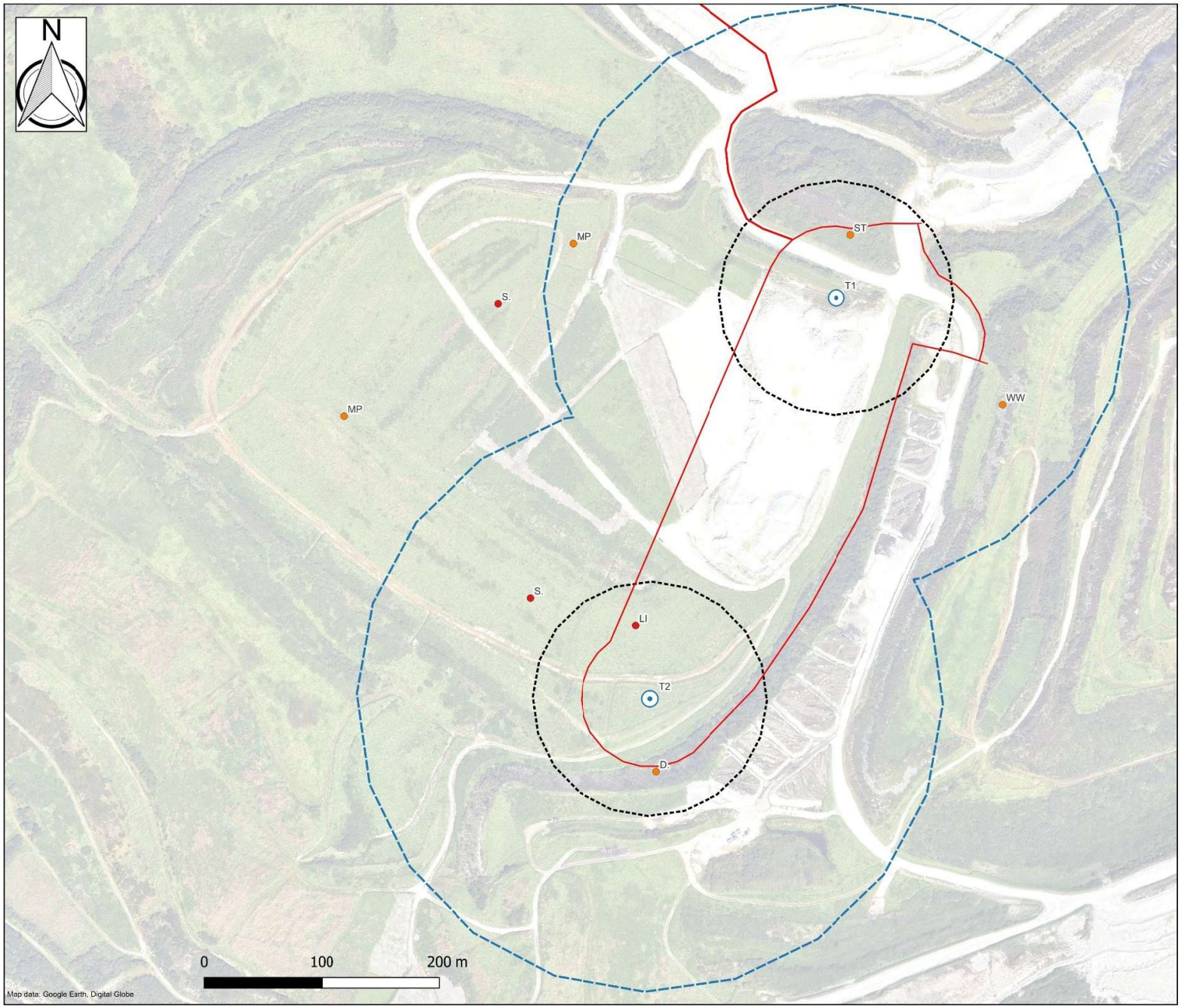


western ECOLOGY
1 Geffery Close
Landrake
Saltash
Cornwall
PL12 5HA

Tel: 0800 622 6828
email: office@westernecology.co.uk

Legend

Approximate locations and conservation status of breeding territories

- Amber listed
- Red listed

Buffers

- 100m
- 250m
- Proposed turbine location

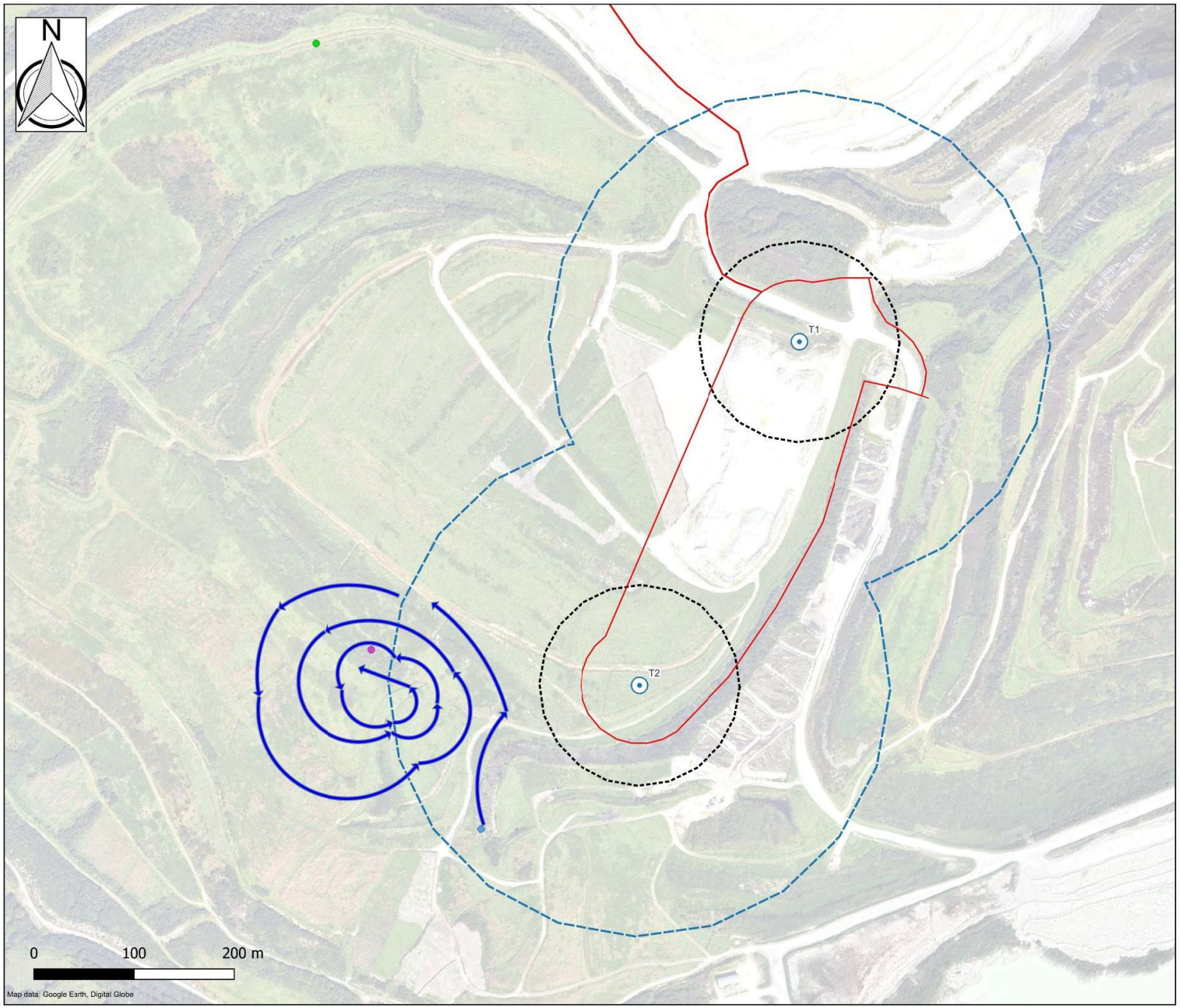
D. = Dunnock
LI = Linnet
MP = Meadow pipit
S. = Skylark
ST = Song thrush
WW = Willow warbler

Title: BBS results - breeding territories of notable species

Project: Dubbers turbines

Checked by: CDH

Version: 01
Date: 07/11/2025



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Legend

Nightjar activity

- Churring
- Foraging
- Nest site (suspected)
- Flightlines

Buffer

- 100m
- 250m

Title: Nightjar survey results map

Project: Dubbers turbines

Checked by: CDH

Version: 01
Date: 28/10/2025

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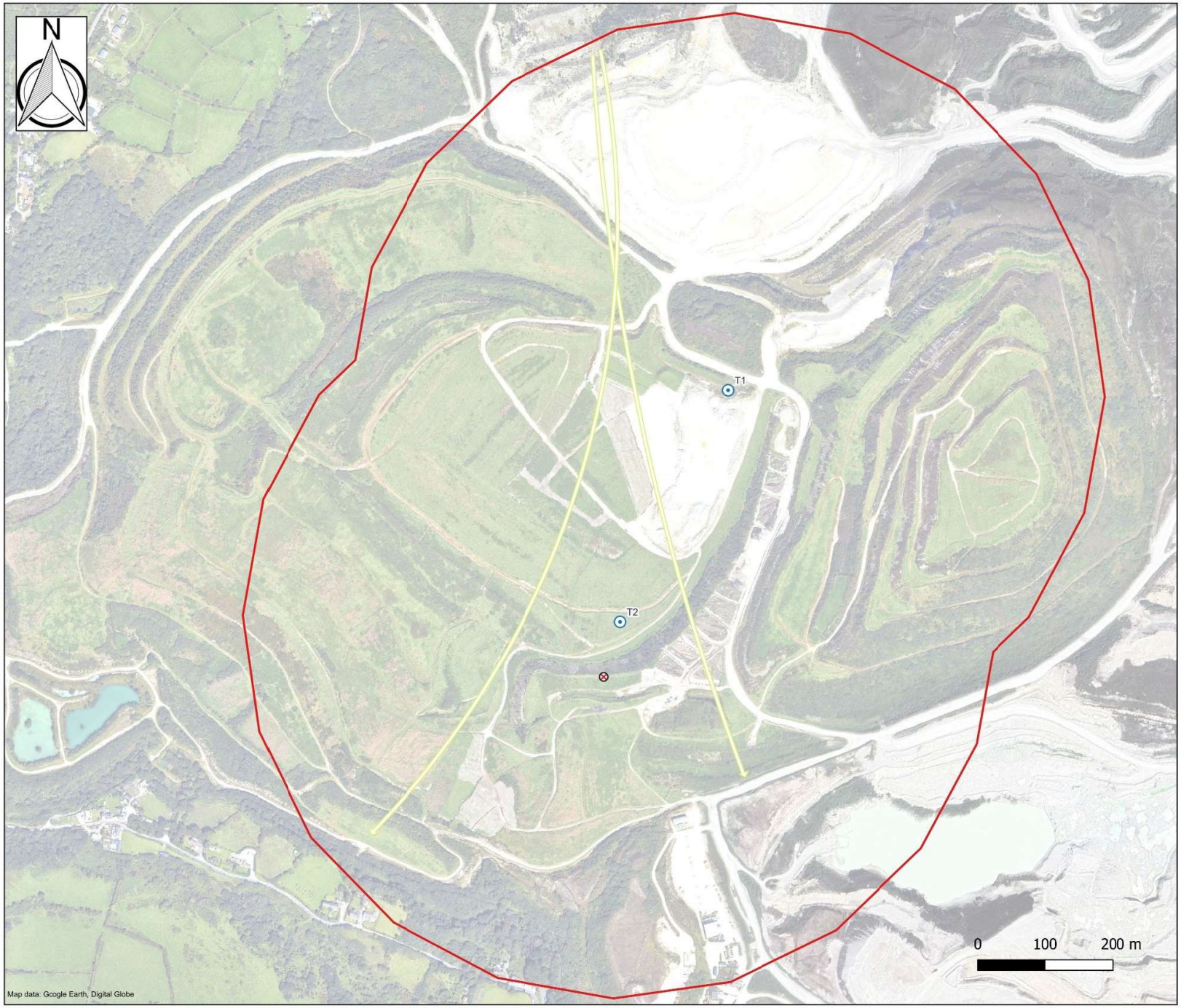
Legend
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Buzzard flight lines

Title: Breeding season VP - Buzzard flightlines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 06/11/2025



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Saltash
Cornwall
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email: office@westernecology.co.uk

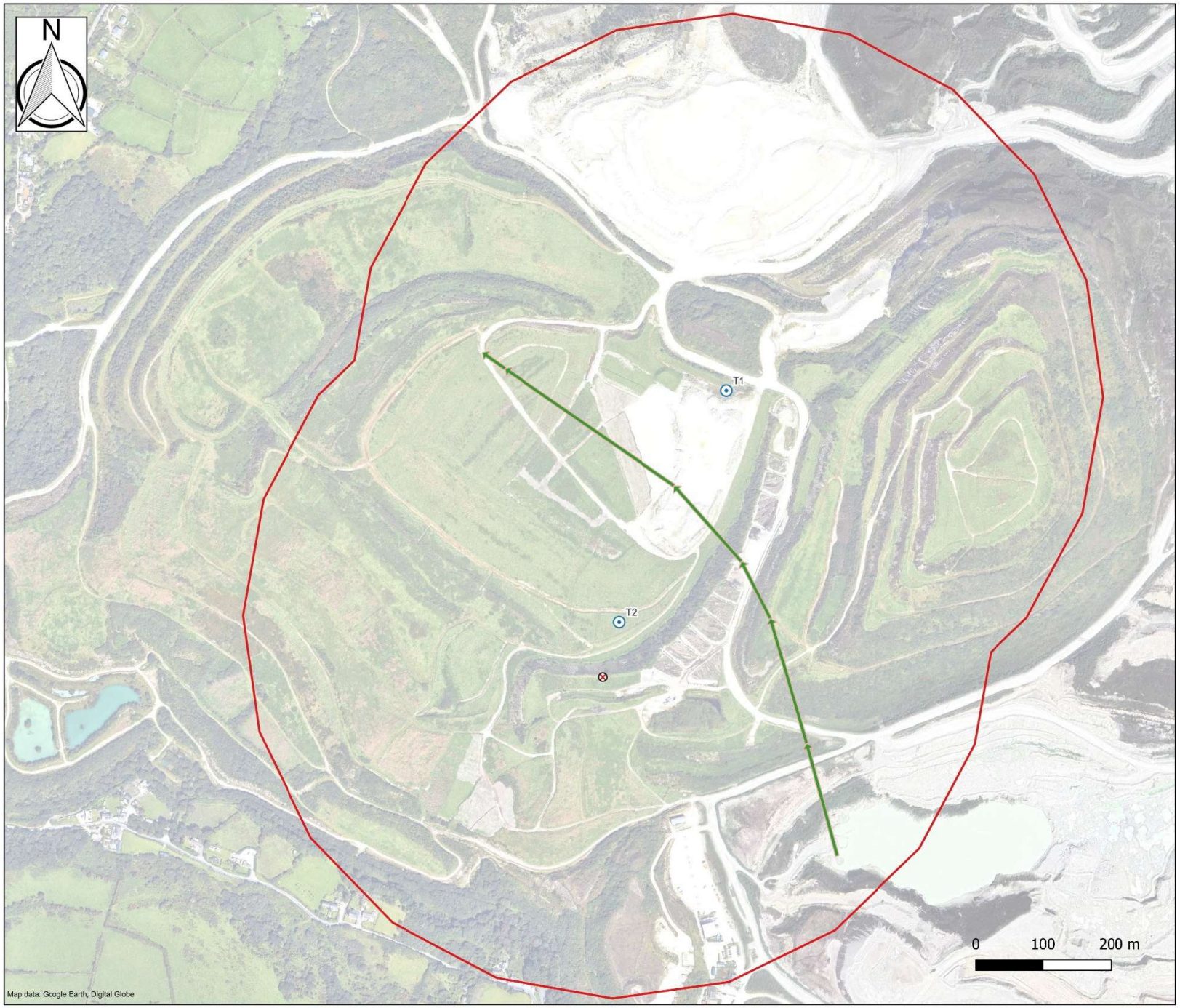
Legend
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Common gull flight lines

Title: Breeding season VP - Common gull flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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Landrake
Saltash
Cornwall
PL12 5HA

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email: office@westernecology.co.uk

Legend

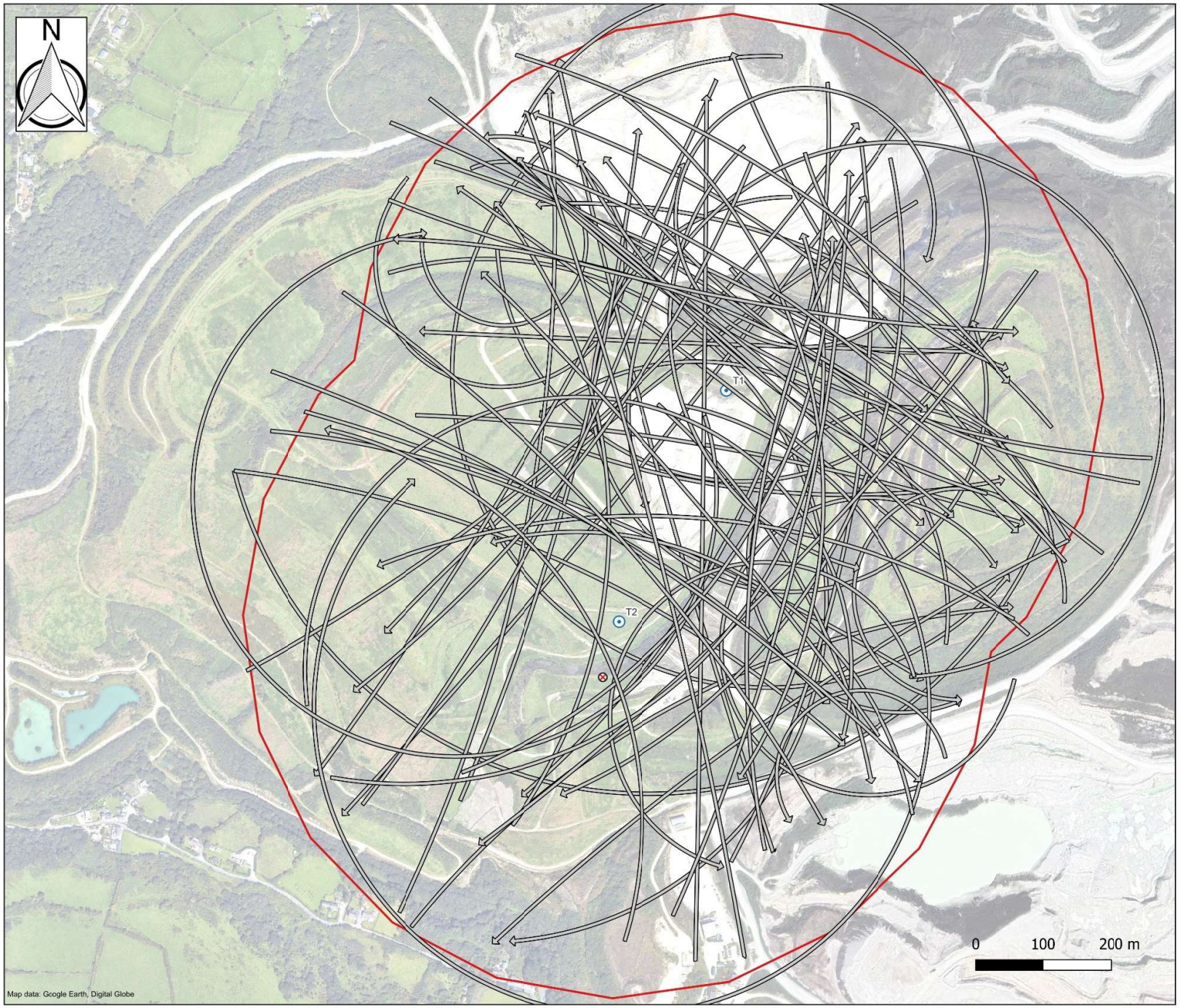
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Green sandpiper flight lines

Title: Breeding season VP - Green sandpiper flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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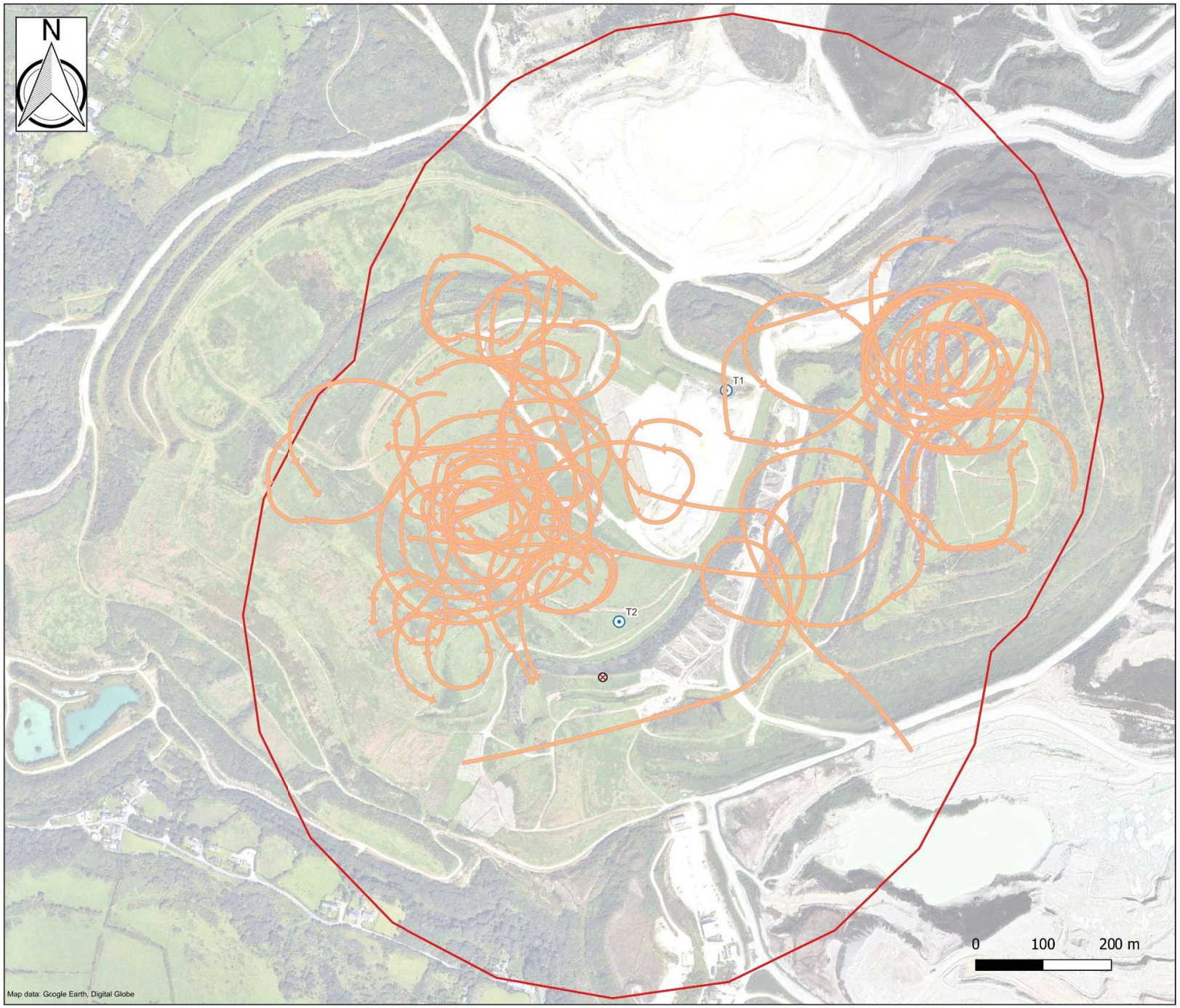
Legend
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Herring gull flight lines

Title: Breeding season VP - Herring gull flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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Saltash
Cornwall
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email: office@westernecology.co.uk

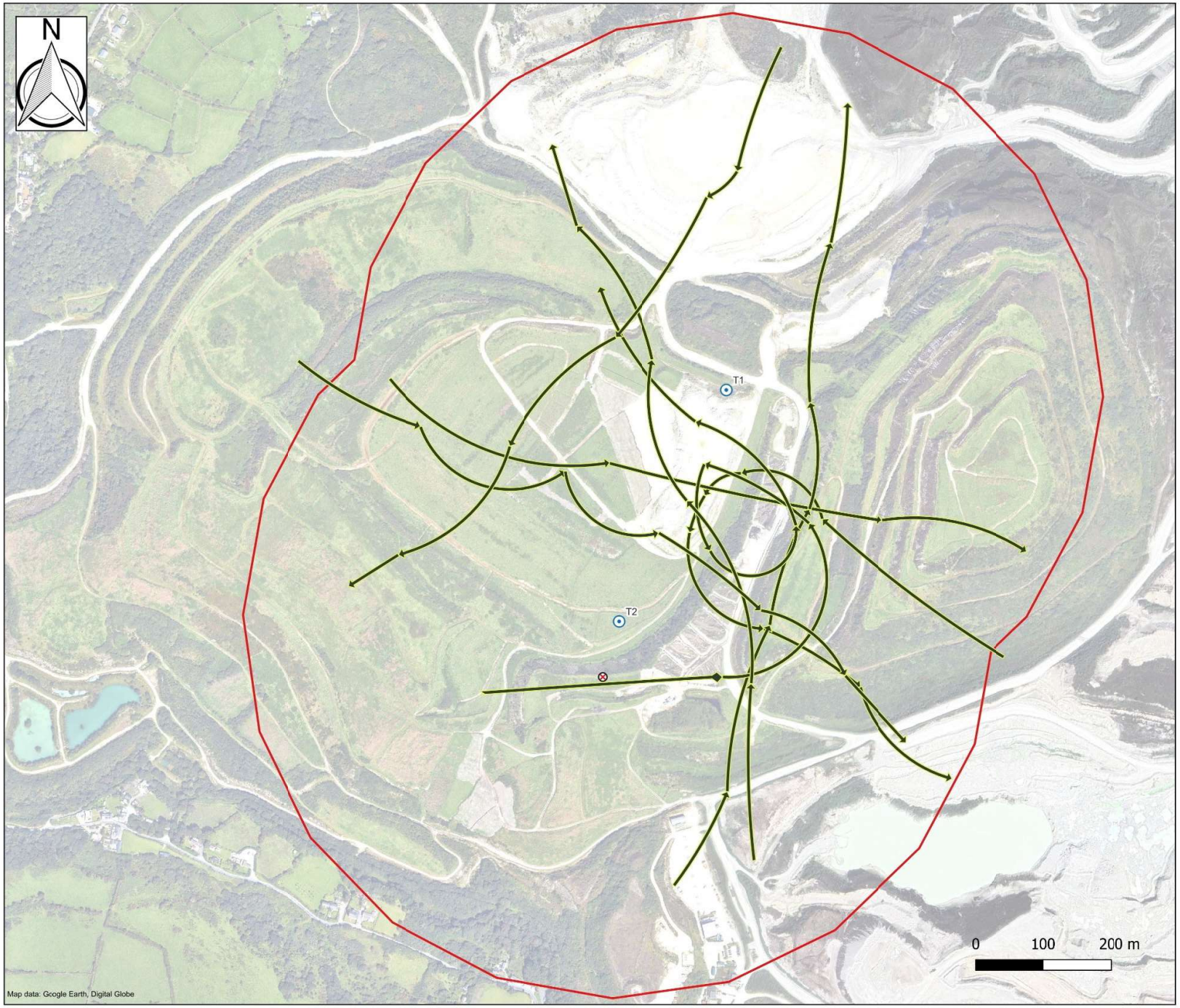
Legend
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Kestrel flight lines

Title: Breeding season VP - Kestrel flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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Saltash
Cornwall
PL12 5HA

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email: office@westernecology.co.uk

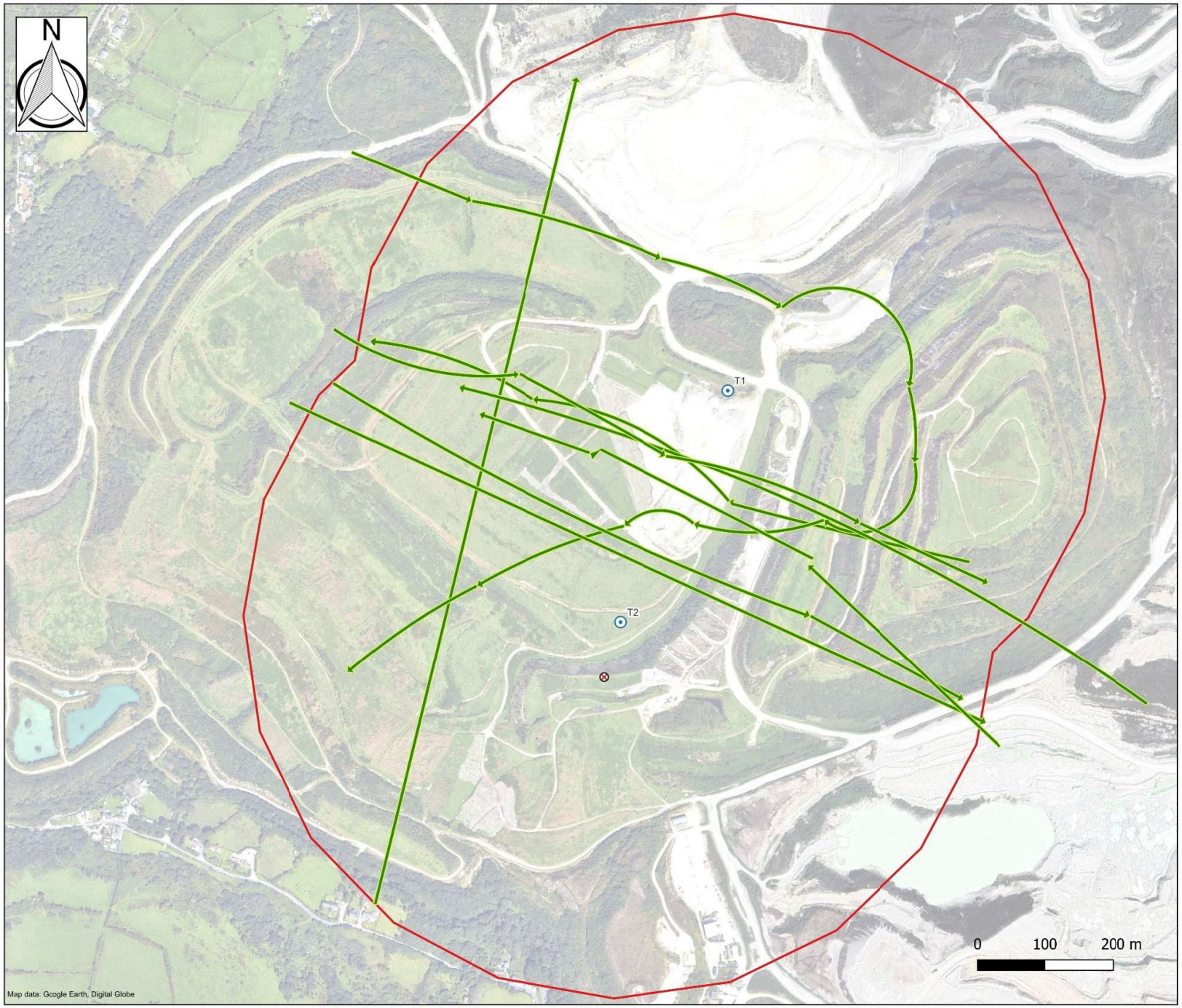
Legend
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Lesser black-backed gull flight lines

Title: Breeding season VP - Lesser black-backed gull flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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Saltash
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Legend

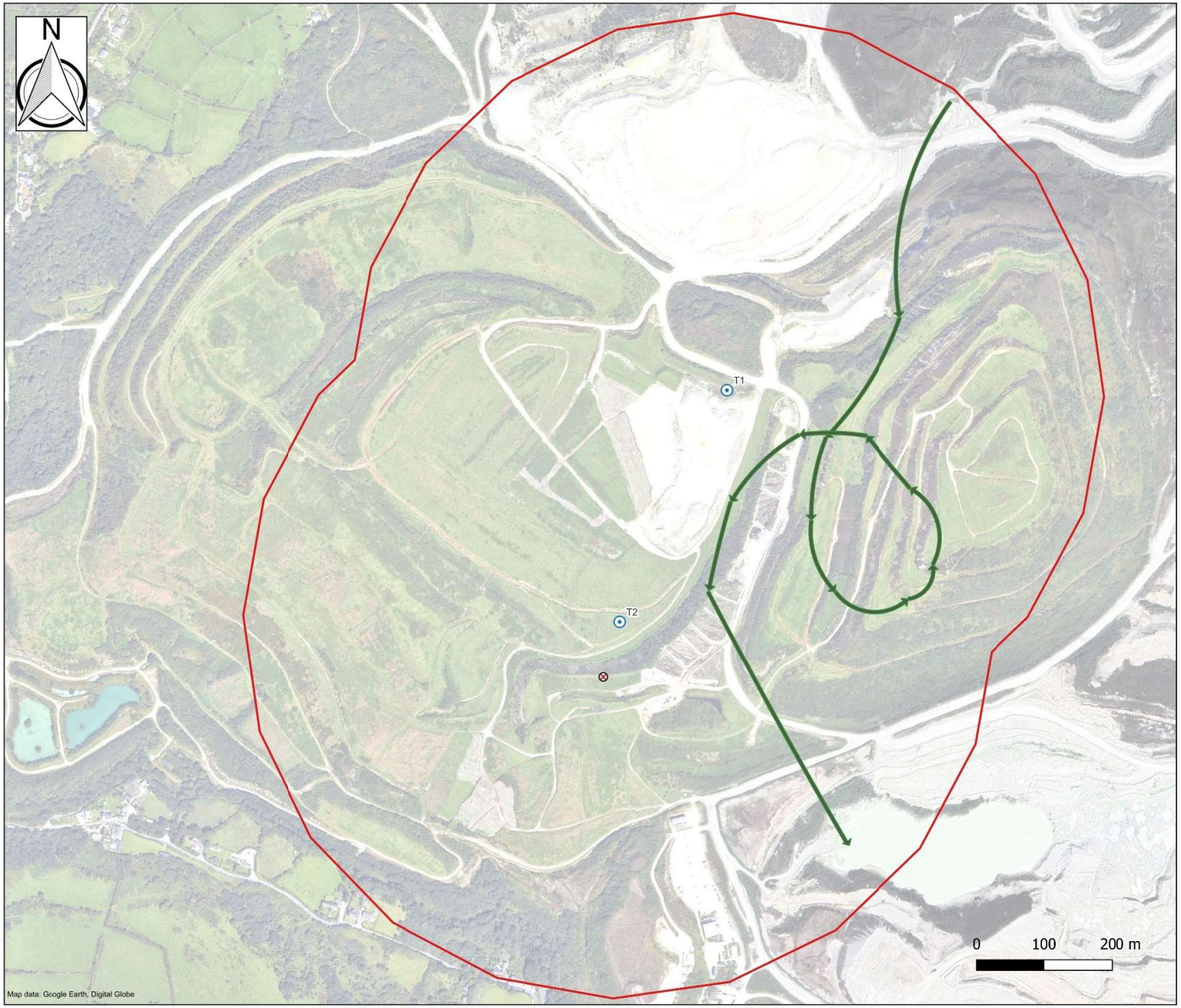
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Mallard flight lines

Title: Breeding season VP - Mallard flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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Legend

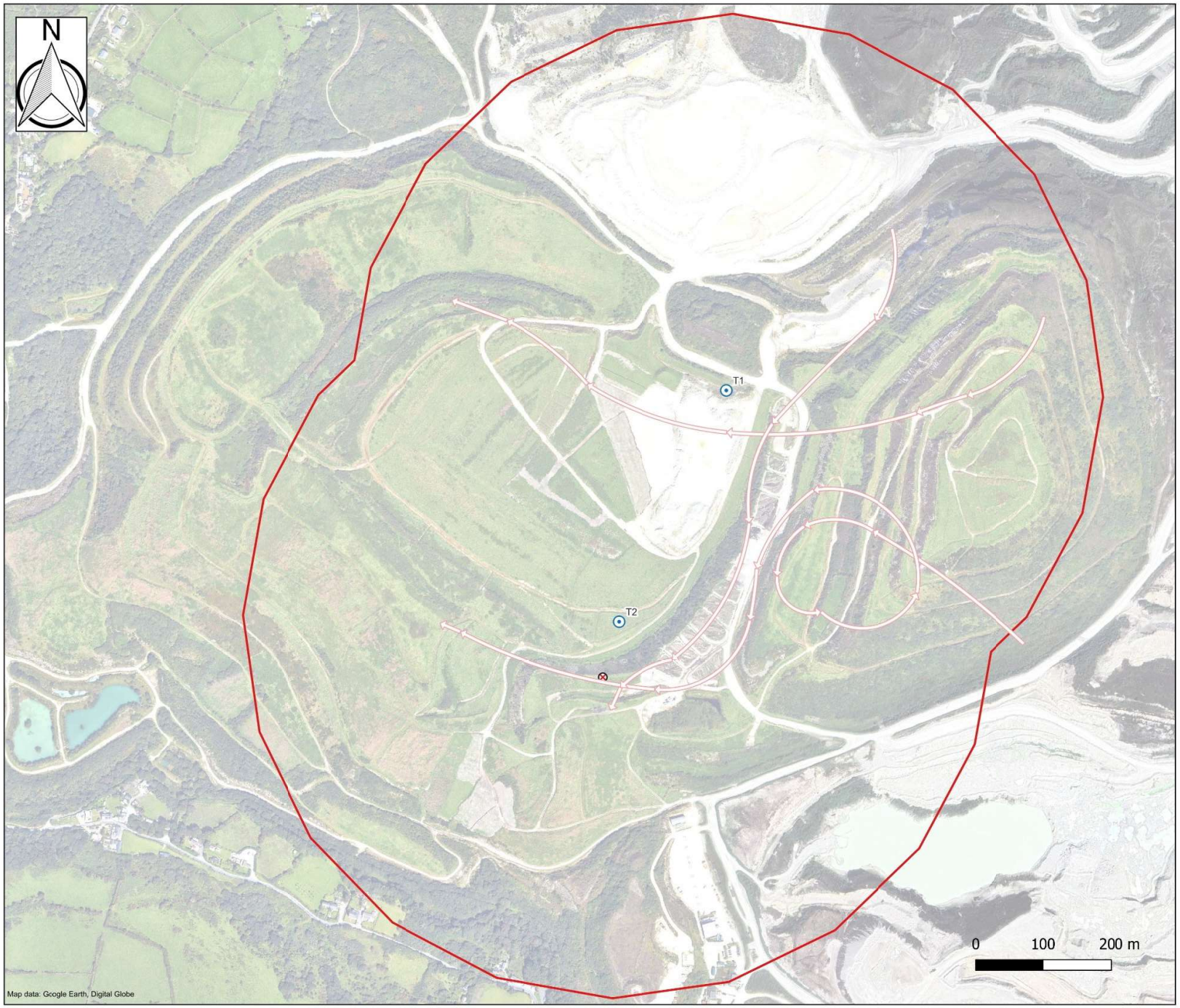
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Peregrine flight lines

Title: Breeding season VP - Peregrine flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025



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Legend
- VP survey (blade length +500m)
- Proposed turbine location
- VP surveyor location
- Sparrowhawk flight lines

Title: Breeding season VP - Sparrowhawk flight lines

Project: Dubbers turbines, Cornwall

Checked by: CDH

Version: 01
Date: 07/11/2025

Appendix 4 – collision risk models

Breeding season - Buzzard

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

		Value	Units
Bird data			
Species name		**Buzzard**	
Bird length	L	0.54	m
Wingspan	W	1.2	m
Bird flight speed	v	11.6	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

		Value	Units
Windfarm data			
Site name		**Dubbers**	
Latitude		50.37	degrees
No of turbines	T	2	
Width of windfarm	w		km

		Value	Units
Turbine data			
Model		**Vestas 4.2**	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_R		birds/km^2	0	0	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0	0	0	0.0158
Proportion at rotor risk height	Q_{2R}	55.32%														
At latitude 50.4		**Daglight hours per month**		265.2	280.5	367.1	412.6	478.4	490.4	494.7	449.9	380.5	334.3	272.1	251.4	4477.1
		Nighttime hours per month		478.8	391.5	376.9	307.4	265.6	229.6	249.3	294.1	339.5	409.7	447.9	492.6	4282.9

Stage B

No of turbines	T	2	
Rotor radius	R	59	m
		Total rotor frontal	21872
Nocturnal activity factor	f_{night}	0%	
Bird flight speed	v	11.6	m s^{-1}

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Projected number of rotor transi	0.0	0.0	42.4	47.7	55.3	56.7	57.2	52.0	44.0	0.0	0.0	0.0	**355**

Stage C

No of blades	b	3		Bird length	l	0.54	m
Rotation speed	Ω	15	rpm	Wingspan	w	1.2	m
Rotor radius	R	59	m	Bird flight speed	v	11.6	m s^{-1}
Max blade width	C	4	m	Flight type		flapping	
Pitch	λ	25	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	**upwind**	13.38%
	downwind	6.87%
	weighted mean	**10.12%**

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	3.65	4.11	4.76	4.88	4.92	4.48	3.79	0.00	0.00	0.00	**31**

Stage E

Allow for large array correction?		No	
Width of windfarm	w	0	km

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		large correction	**Collision rates allowing for avoidance**												
Avoidance rates modelled	95.00%	100.00%	0.00	0.00	0.18	0.21	0.24	0.24	0.25	0.22	0.19	0.00	0.00	0.00	**1.5**
	98.00%	100.00%	0.00	0.00	0.07	0.08	0.10	0.10	0.10	0.09	0.08	0.00	0.00	0.00	**0.6**
	99.00%	100.00%	0.00	0.00	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.00	0.00	0.00	**0.3**
	99.50%	100.00%	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	**0.2**

Breeding season – Common gull

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.2	m
Bird flight speed	v	13.5	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	$f_{nocturl}$	25%	

Windfarm data		Value	Units
Site name		Dubbers	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

Turbine data		Value	Units
Model		Vestas 4.2	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_A		birds/km^2	0	0	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0	0	0	0.0005
Proportion at rotor risk height	Q_{ER}	100.00%														
At latitude 50.6		Daylight hours per month		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

No of turbines	T	2														
Rotor radius	R	59	m													
		Total rotor frontal a	21872													
Nocturnal activity factor	$f_{nocturl}$	25%														
Bird flight speed	v	13.5	m s^{-1}	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transi		0.0	0.0	3.3	3.5	3.9	4.0	4.0	3.8	3.4	0.0	0.0	0.0	**26**

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	15	rpm	Wingspan	w	1.2	m
Rotor radius	R	59	m	Bird flight speed	v	13.5	m s^{-1}
Max blade width	C	4	m	Flight type		flapping	
Pitch	λ	25	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					
		Single transit risk	upwind	11.48%			
			downwind	5.20%			
			weighted mean	**8.34%**			

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.24	0.25	0.28	0.28	0.29	0.27	0.24	0.00	0.00	0.00	**2**

Stage E

Allow for large array correction?		No														
Width of windfarm	w	0	km													
			large correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled		95.00%	100.00%	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	**0.1**
		98.00%	100.00%	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	**0.0**
		99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**

Breeding season – Green sandpiper

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data		Value	Units
Species name		Green sandpiper	
Bird length	L	0.23	m
Wingspan	W	0.4	m
Bird flight speed	v	12.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Dubbers	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

Turbine data		Value	Units
Model		Vestas 4.2	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_R		birds/km^2	0	0	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0	0	0	0.0000
Proportion at rotor risk height	Q_{ER}	100.00%														
At latitude 50.6		Daylight hours per month		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

No of turbines	T	2		
Rotor radius	R	59	m	
		Total rotor frontal :		21872
Nocturnal activity factor	f_{night}	25%		
Bird flight speed	v	12.3	m s^{-1}	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Projected number of rotor transi	0.0	0.0	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.0	0.0	0.0	**2**

Stage C

No of blades	b	3		Bird length	l	0.23	m
Rotation speed	Ω	15	rpm	Wingspan	w	0.4	m
Rotor radius	R	59	m	Bird flight speed	v	12.3	m s^{-1}
Max blade width	C	4	m	Flight type		flapping	
Pitch	λ	25	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	
upwind	10.79%
downwind	4.37%
weighted mean	**7.58%**

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	$Q_{..}$	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	**0**

Stage E

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No															
Width of windfarm	w	0	km														
			large correction		Collision rates allowing for avoidance												
Avoidance rates modelled		95.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		98.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.50%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**

Breeding season – Herring gull

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.6	m
Wingspan	W	1.4	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		3	
Nocturnal activity factor	f_{night}	50%	

Windfarm data		Value	Units
Site name		Dubbers	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

Turbine data		Value	Units
Model		Vestas 4.2	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_a		birds/km^3	0	0	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0	0	0	0.0169
Proportion at rotor risk height	Q_{ra}	75.74%														
At latitude 50.6		Daylight hours per month		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	2															
Rotor radius	R	59	m														
		Total rotor frontal :		21872													
Nocturnal activity factor	f_{night}	50%															
Bird flight speed	v	12.8	m s^{-1}														
		Projected number of rotor transi			0.0	0.0	104.2	106.3	114.7	113.6	116.3	112.0	103.2	0.0	0.0	0.0	**770**

Stage C

No of blades	b	3		Bird length	l	0.6	m
Rotation speed	Ω	15	rpm	Wingspan	w	1.4	m
Rotor radius	R	59	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4	m	Flight type		flapping	
Pitch	λ	25	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	12.94%
	downwind	6.57%
	weighted mean	**9.75%**

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	8.64	8.81	9.51	9.42	9.64	9.29	8.56	0.00	0.00	0.00	**64**

Stage E

Allow for large array correction? No
Width of windfarm w 0 km

		large correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled	95.00%	100.00%	0.00	0.00	0.43	0.44	0.48	0.47	0.48	0.46	0.43	0.00	0.00	0.00	**3.2**
	98.00%	100.00%	0.00	0.00	0.17	0.18	0.19	0.19	0.19	0.19	0.17	0.00	0.00	0.00	**1.3**
	99.00%	100.00%	0.00	0.00	0.09	0.09	0.10	0.09	0.10	0.09	0.09	0.00	0.00	0.00	**0.6**
	99.50%	100.00%	0.00	0.00	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.00	0.00	0.00	**0.3**

Breeding season - Kestrel

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

		Value	Units
Bird data			
Species name		**Kestrel**	
Bird length	L	0.34	m
Wingspan	W	0.76	m
Bird flight speed	v	10.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	$f_{nocturnal}$	0%	

		Value	Units
Windfarm data			
Site name		**Dubbers**	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

		Value	Units
Turbine data			
Model		**Vestas 4.2**	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_A	birds/km^2	0	0	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0	0	0	0.0333
Proportion at rotor risk height	Q_{2R}	94.74%													
At latitude 50.6		Daylight hours per month	264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month	479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

No of turbines	T	2													
Rotor radius	R	59 m													
		Total rotor frontal : 21872													
Nocturnal activity factor	$f_{nocturnal}$	0%													
Bird flight speed	v	10.1 m s^{-1}	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transi	0.0	0.0	133.6	150.3	174.4	178.9	180.4	164.0	138.5	0.0	0.0	0.0	**1120**

Stage C

No of blades	b	3	Bird length	l	0.34	m
Rotation speed	Ω	15 rpm	Wingspan	w	0.76	m
Rotor radius	R	59 m	Bird flight speed	v	10.1	m s^{-1}
Max blade width	C	4 m	Flight type		flapping	
Pitch	λ	25 degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet				
		Single transit risk upwind	13.18%			
		downwind	6.49%			
		weighted mean	**9.84%**			

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	11.17	12.57	14.58	14.96	15.09	13.71	11.58	0.00	0.00	0.00	**94**

Stage E

Allow for large array correction?		No													
Width of windfarm	w	0 km													
			large correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled		95.00%	100.00%	0.00	0.00	0.56	0.63	0.73	0.75	0.75	0.69	0.58	0.00	0.00	0.00	**4.7**
		98.00%	100.00%	0.00	0.00	0.22	0.25	0.29	0.30	0.30	0.27	0.23	0.00	0.00	0.00	**1.9**
		99.00%	100.00%	0.00	0.00	0.11	0.13	0.15	0.15	0.15	0.14	0.12	0.00	0.00	0.00	**0.9**
		99.50%	100.00%	0.00	0.00	0.06	0.06	0.07	0.07	0.08	0.07	0.06	0.00	0.00	0.00	**0.5**

Breeding season – Lesser black-backed gull

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

		Value	Units
Bird data			
Species name		**lack-backed gull**	
Bird length	L	0.58	m
Wingspan	W	1.43	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

		Value	Units
Windfarm data			
Site name		**Dubbers**	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

		Value	Units
Turbine data			
Model		**Vestas 117**	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_a		birds/km^2	0	0	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	42.86%														
At latitude 50.6		Daylight hours per month		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	2															
Rotor radius	R	59	m														
		Total rotor frontal :		21872													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	13.1	m s^{-1}														
		Projected number of rotor transi			0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	**1**

Stage C

No of blades	b	3		Bird length	l	0.58	m	
Rotation speed	Ω	15	rpm	Wingspan	w	1.43	m	
Rotor radius	R	59	m	Bird flight speed	v	13.1	m s^{-1}	
Max blade width	C	4	m	Flight type		flapping		
Pitch	λ	25	degrees	% of flights upwind/downwind		50%	50%	
Blade profile		see Blade profile sheet						

Single transit risk	upwind	12.66%
	downwind	6.32%
	weighted mean	**9.49%**

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	**0**

Stage E

Allow for large array correction? No
Width of windfarm w 0 km

	large correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
95.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**

Breeding season - Mallard

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.88	m
Bird flight speed	v	18.5	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Dubbers	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

Turbine data		Value	Units
Model		Vestas 117	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_R		birds/km^2	0	0	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0	0	0	0.0000
Proportion at rotor risk height	Q_{ER}	84.62%														
At latitude 50.6		Daylight hours per month		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	2															
Rotor radius	R	59	m														
		Total rotor frontal :		21872													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	18.5	m s^{-1}														
		Projected number of rotor transi			0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	1

Stage C

No of blades	b	3		Bird length	l	0.58	m	
Rotation speed	Ω	15	rpm	Wingspan	w	0.88	m	
Rotor radius	R	59	m	Bird flight speed	v	18.5	m s^{-1}	
Max blade width	C	4	m	Flight type		flapping		
Pitch	λ	25	degrees	% of flights upwind/downwind		50%	50%	
Blade profile		see Blade profile sheet						
		Single transit risk	upwind	10.00%				
			downwind	4.36%				
			weighted mean	7.18%				

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 0 km

Avoidance rates modelled		large correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
	95.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Breeding season – Peregrine

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

		Value	Units
Bird data			
Species name		**Peregrine**	
Bird length	L	0.46	m
Wingspan	W	0.97	m
Bird flight speed	v	12.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

		Value	Units
Windfarm data			
Site name		**Dubbers**	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

		Value	Units
Turbine data			
Model		**Vestas 117**	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_a		birds/km^2	0	0	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	0	0	0	0.0000
Proportion at rotor risk height	Q_{ar}	100.00%														
At latitude 50.6		Daylight hours per month		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	2															
Rotor radius	R	59	m														
		Total rotor frontal :		21872													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.1	m s^{-1}														
		Projected number of rotor transi			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**

Stage C

No of blades	b	3			Bird length	l	0.46	m
Rotation speed	Ω	15	rpm		Wingspan	w	0.97	m
Rotor radius	R	59	m		Bird flight speed	v	12.1	m s^{-1}
Max blade width	C	4	m		Flight type		flapping	
Pitch	λ	25	degrees	% of flights upwind/downwind			50%	50%
Blade profile		see Blade profile sheet						
		Single transit risk	upwind	12.45%				
			downwind	6.00%				
			weighted mean	**9.23%**				

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**

Stage E

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No															
Width of windfarm	w	0	km														
			large correction		Collision rates allowing for avoidance												
Avoidance rates modelled		95.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		98.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.50%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**

Breeding season – Sparrowhawk

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
green boxes are for information only, to show variables used at each stage

		Value	Units
Bird data			
Species name		**Sparrowhawk**	
Bird length	L	0.33	m
Wingspan	W	0.73	m
Bird flight speed	v	11.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

		Value	Units
Windfarm data			
Site name		**Dubbers**	
Latitude		50.6	degrees
No of turbines	T	2	
Width of windfarm	w		km

		Value	Units
Turbine data			
Model		**Vestas 117**	
Hub height		76.5	m
Rotor radius	R	59	m
No of blades	b	3	
Rotation speed	Ω	15	rpm
Max blade width	C	4	m
Blade pitch	λ	25	degrees
Risk height range		18-136	m

normal approach

Set to 'normal approach' to use survey data on bird density
Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A

Stage A

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Daytime bird density	D_R		birds/km^2	0	0	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	0	0	0	0.0000
Proportion at rotor risk height	Q_{ER}	75.00%														
At latitude 50.6		**Daylight hours per month**		264.3	280.0	367.1	413.1	479.3	491.5	495.8	450.5	380.6	334.0	271.3	250.3	4477.8
		Nighttime hours per month		479.7	392.0	376.9	306.9	264.7	228.5	248.2	293.5	339.4	410.0	448.7	493.7	4282.2

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	2															
Rotor radius	R	59	m														
		Total rotor frontal		21872													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	11.3	m s^{-1}														
		Projected number of rotor transi			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**

Stage C

No of blades	b	3		Bird length	l	0.33	m	
Rotation speed	Ω	15	rpm	Wingspan	w	0.73	m	
Rotor radius	R	59	m	Bird flight speed	v	11.3	m s^{-1}	
Max blade width	C	4	m	Flight type		flapping		
Pitch	λ	25	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	**upwind**	12.14%
	downwind	5.59%
	weighted mean	**8.87%**

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**

Stage E

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No															
Width of windfarm	w	0	km														
			large correction		**Collision rates allowing for avoidance**												
Avoidance rates modelled		95.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		98.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.00%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
		99.50%	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**