Garrane Green Energy Limited

Appendix 8.2 - Ornithology Collision Risk Modelling Report

Garrane Green Energy Project, Charleville, Co. Limerick

2486055

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1.0 INTRODUCTION

1.1 Purpose of this report

This report presents the methodology and findings of bird collision risk modelling for the proposed Garrane Wind Farm Project (hereafter referred to as 'the Project'). This study was undertaken by RSK Biocensus on behalf of Garrane Green Energy Limited (hereafter known as 'the Developer').

This collision risk modelling study forms a technical appendix (**Appendix 8.2**) to **Chapter 8** of the Environmental Impact Assessment Report (EIAR) of the Project. This study been undertaken in order to identify the potential impacts of the Project on bird species through collisions with new wind turbines, and to inform any requirement for mitigation measures. The results of this study should therefore be used to inform mitigation efforts in **Chapter 8: Ornithology** of the EIAR to minimise potential operational impacts on bird populations.

The collision risk modelling study presented in this report has been prepared in reference to current best practice guidance, using field data from monthly Vantage Point (VP) surveys undertaken between 2020 and 2024 during the breeding and non-breeding seasons. Further details for the baseline information provided in this report can be found in **Appendix 8.1 – Ornithology Baseline Report**.

This report should be read in conjunction with the following figures:

- **Figure 1** – Site location;
- **Figure 2** – Designated sites;
- **Figure 3** – VP locations;
- **Figure 4** – Flight observations from VP surveys for target species during the breeding season; and
- **Figure 5** – Flight observations from VP surveys for target species during the non-breeding season.

1.2 Site overview

The Project site (hereafter referred to as 'the Site') (**Figure 1**) is located in County Limerick, approximately 2.5 kilometres (km) north of Charleville town. The Site is rural in nature, with land cover predominantly comprising agricultural grassland interspersed with rivers and hedgerows. The N20 road extends along the western border of the Site. The Site is in a lowland location on relatively level ground, with elevation ranging from approximately 58-61 metres (m) Above Ordnance Datum (AOD) in the northern side of the Site, to 63-73m AOD in the southern portion of the Site.

A desk-based search was undertaken to identify any designated sites with features of ornithological interest (i.e., Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Ramsar sites and Important Bird Areas (IBAs)) within 20 km of the Site boundary (**Figure 2**). This identified two relevant internationally designated sites, as indicated in **Table 1**. Relevant species listed on the citations for these internationally designated sites have been considered within this collision risk modelling study, with those recorded within the flight risk volume for the Project subject to collision risk modelling on a precautionary basis (further details are provided in Section 3.3).

Based on the level of activity recorded by species relevant to River Shannon and River Fergus Estuaries SPA/IBA during the field surveys (notably black-headed gull), and the mobile nature of species relevant to this internationally designated site, River Shannon and River Fergus Estuaries SPA/IBA was also taken into consideration in this report.

Table 1. Relevant internationally designated sites of ornithological interest

Designated site	Distance from the Site	Description
Blackwater River (Cork/Waterford) SAC	9.2 km south	The Blackwater River extends through six counties including the majority of County Cork, during which it extends through five mountain ranges. Whilst not forming Qualifying Interests for SAC designation, within County Cork the Blackwater River provides important habitat for bird species such including grey heron (*Ardea cinerea*), cormorant (*Phalacrocorax carbo*) and mute swan (*Cygnus olor*).
Ballyhoura Mountains SAC / IBA	11.9 km south-east	Extensive mountain range straddling the border between counties Limerick and Cork. The area within County Cork is largely afforested with conifer plantations, whilst other areas contain extensive open heathland and blanket bog. Whilst not forming Qualifying Interests for SAC designation, the Ballyhoura Mountain range is identified as being important for birds, supporting seven pairs of hen harrier (*Circus cyaneus*) and one pair of peregrine (*Falco peregrinus*). Ballyhoura Mountains IBA is designated on account of supporting an important breeding hen harrier population, with 17-19 breeding pairs identified within the IBA in 2005 (BirdLife International, 2024).
River Shannon and River Fergus Estuaries SPA / IBA	29.8 km north	Estuaries forming the largest estuarine complex in Ireland. Qualifies on account of regularly supporting over 20,000 waterbirds during the non-breeding season, and due to its important wintering populations of numerous waterbird species including golden plover (*Pluvialis apricaria*), light-bellied brent goose (*Branta bernicla hrota*), shelduck (*Tadorna tadorna*) and whooper swan (*Cygnus cygnus*). Additional Special Conservation Interest (SCI) features include the wintering population of black-headed gull (*Chroicocephalus ridibundus*).

1.3 Key guidance

This collision risk modelling study has been undertaken in reference to current key industry standard guidance including that provided by Scottish Natural Heritage (SNH, now NatureScot). Relevant guidance referred to includes:

- Recommended bird survey methods to inform impact assessment of onshore wind farms (SNH, 2017);
- Wind farms and birds: Calculating a theoretical collision risk assuming no avoiding action (SNH, 2000);
- Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model (SNH, 2018);
- Developing field and analytical methods to assess avian collision risk at wind farms (Band et al., 2007); and
- Calculation of collision risk for birds passing through rotor area (Band, 2011).

Any departures from the standard approaches specified in the above best practice guidance, and any additional assumptions, are specified in this report.

2.0 DEVELOPMENT DESIGN

2.1 Wind farm area

The Site is indicated in **Figure 1**, which show the proposed turbine locations. For the purposes of collision risk modelling, the Wind Farm Area (WFA) has been defined as the maximum area covered by the turbine bases, allowing for a 174 m radius around each turbine base for the turbine layout. This radius accounts for the span of the turbine blades plus a 100 m buffer to allow for any inaccuracies when mapping bird flight lines during VP surveys. The WFA includes land between the turbine bases on a precautionary basis. The WFA for the turbine layout measures 122.74 ha.

2.2 Turbine specifications

The collision risk modelling study presented in this report is based on the technical specifications of the selected turbine model. Technical specifications for the selected turbine model are provided in **Table 2**. It is assumed turbines will have an operational lifespan of 35 years.

Table 2. Turbine technical specifications for the turbine layout

Specification	Value
Turbine model	Vesta EnVentus V-150
Number of blades per turbine	3
Tower height	95 m
Rotor radius	73.65 m
Rotor diameter (including hub)	150 m
Lower tip clearance (ground to lower blade tip)	20 m
Turbine height (ground to blade tip)	170 m
Rotor sweep zone (RSZ)	17,671 m^2
Maximum rotor chord	4.2 m
Rotor pitch	6°
Rotor depth	4.3 m
Maximum rotation period	4.76 seconds

3.0 METHODOLOGY

3.1 Overview

This section presents the methods used for collision risk modelling, including survey coverage, selection of Key Ornithological Features, and collision risk model selection.

Collision risk modelling was undertaken using the standard approach described in the best practice guidance and calculation tools specified in Section 1.3.

Collision risk modelling is essentially a three-stage process:

1. Initial modelling uses field survey data on bird flight activity at the Site to assess the number of birds passing through the zone swept by the rotating turbine blades (i.e., the 'flight risk volume');
2. Modelling then estimates the probability of a bird being hit if it were to fly through an operational turbine, based on the estimated flight parameters of the specific bird species and the turbine specifications. This stage assumes birds take no action to avoid collisions with turbines (i.e., 'avoiding actions');
    - The outputs of Stages 1 and 2 are then multiplied together to provide an estimate of the number of collisions that would occur in the absence of avoiding actions. This provides an estimate of the number of fatalities that would occur, assuming that all collisions result in fatalities.
3. Finally modelling applies an avoidance rate to account for avoiding actions. This is based on the understanding that birds will often either avoid the WFA entirely, fly above or below an operational turbine, or perform 'emergency' manoeuvres to avoid a moving turbine blade.
    - This provides an estimate of the number of fatalities that would occur, taking into account avoiding actions (again assuming all collisions result in fatalities).

Once collision risk modelling has calculated the estimated number of fatalities for the modelled species resulting from collisions with the new turbines, taking into account avoiding actions, this information can be applied to knowledge of the species in question to assess the potential significance of operational turbine collision impacts. Where significant impacts are anticipated, mitigation measures may be required to minimise the potential for impacts and thus avoid any significant adverse effects.

3.2 Survey coverage and methods

Field survey data used for collision risk modelling were collected during VP surveys undertaken at the Site from October 2020 to September 2024. These surveys were undertaken in accordance with best practice guidance (SNH, 2017) in order to record bird flight activity throughout the Site (including the WFA) during the breeding season (i.e., April to September inclusive; 'B') and the non-breeding season (i.e., October to March inclusive; 'NB'), with emphasis on recording activity by target species (see Section 3.3).

VP surveys were undertaken twice per month from an initial four VPs (VPs 1-4) from October 2020 to March 2023 inclusive, with the aim of generating a survey effort of 36 hours per VP per season. Across the four seasons initially surveyed (i.e., the breeding seasons of 2021 and 2022, and the non-breeding seasons of 2020/21 and 2021/22) these four VPs were surveyed for a total of at least 36 hours per season per VP.

To provide increased coverage of the Site, an additional four VPs (VPs 5-8) were surveyed from October 2022 to September 2024. Additional site coverage provided by the new VPs removed the necessity for VP3 and VP4, which were not surveyed during between October 2022 to September 2024.

The locations of VPs 1-8 are indicated in **Figure 3**. VP survey effort is summarised in **Table 3**.

Table 3. Summary of Vantage Point survey effort

VP	Hours of observation								
	NB 20/21	B 21	NB 21/22	B 22	NB 22/23	B 23	NB 23/34	B 24	Total
VP1	36	36	36	36	36	36	36	36	288
VP2	36	36	36	36	36	36	36	36	288
VP3	36	36	36	36	-	-	-	-	144
VP4	36	36	36	36	-	-	-	-	144
VP5	-	-	-	-	36	36	36	36	144
VP6	-	-	-	-	36	36	36	36	144
VP7	-	-	-	-	36	36	36	36	144
VP8	-	-	-	-	36	36	36	36	144

Recording of flight data

Detailed information on all flights by target species within and near the Site was recorded during the VP surveys to enable collision risk modelling. For each flight observation (referred to in this report as 'flight lines') the following parameters were recorded:

- the start time of the flight observation;
- the duration of the flight observation;
- the lateral flight path taken through the Site and/or nearby land;
- the species and number of individuals;
- the sexes of all individuals (where possible);
- the likely purpose of the flight (e.g., foraging, displaying, commuting); and

- the approximate flight height in metres, including the time spent in each of the following flight height categories: 0-20 m, 20-50 m, 50-100 m, 100-180 m, >180 m, and non-flight.

Flight observations for target species recorded during the VP surveys are presented on **Figure 4** (breeding season) and **Figure 5** (non-breeding season). The flight lines shown on these figures are indicative of the observations made in the field and do not always represent the start and end locations of the flights made by birds, and in some instances a single flight line may represent multiple birds that were observed at the same time. They should therefore be viewed as indicative representations of the level of bird activity within the Site, with more accurate accounts provided in the data tables within this report.

Some flight observations recorded during the VP surveys were entirely within the WFA. For these observations, the entirety of the flight time at collision risk height was included in collision risk modelling. Where flight observations were partially within the WFA (i.e., birds flew into or out of the WFA, only the proportion of flight time observed within the WFA at collision risk height was included in collision risk modelling. To ensure a suitably precautionary approach was adopted, where only a small proportion (i.e., <10%) of the flight line was outside of the WFA, the entirety of the flight time recorded at collision risk height was included in collision risk modelling. Similarly, where birds were circling near the WFA boundary and occasionally leaving the WFA, the entirety of the flight time recorded at collision risk height was included in collision risk modelling.

Based on the turbine parameters described in Section 2.2, flight records included within collision risk modelling (i.e., flights at 'collision risk height' and therefore included within the 'flight risk volume' where they extended through the WFA) were those recorded in the 20-50 m, 50-100 m and 100-180 m flight height categories.

3.3 Key ornithological Features

Selection of target species to be recorded during VP surveys and subsequently considered within collision risk modelling was informed by the following characteristics:

- their known or likely presence within or in close proximity to the Site;
- their potential sensitivity to the Project (particularly their potential collision risk and/or susceptibility to disturbance from new wind turbines);
- their level of legislative protection and/or conservation concern; and
- their relevance to any nearby designated sites (e.g., SPAs, IBAs).

Based on these characteristics, species identified as target species for this study included all waterfowl, raptor, owl, grouse, wader and gull species. Target species requiring particular consideration due to their conservation status, potential sensitivity and/or relevance to nearby designated sites are summarised in **Table 4**.

Table 4. Target species for particular consideration

Target species	Conservation status
Black-headed gull (*Chroicocephalus ridibundus*)	BoCCI Amber listed / Wildlife Acts / SPA Special Conservation Interest
Buzzard (*Buteo buteo*)	BoCCI Green listed / Wildlife Acts
Cormorant (*Phalacrocorax carbo*)	BoCCI Amber listed / Wildlife Acts / SPA Selection Species
Curlew (*Numenius arquata*)	BoCCI Red listed / Wildlife Acts / SPA Selection Species
Golden plover (*Pluvialis apricaria*)	Annex 1 EU Birds Directive / BoCCI Red listed / Wildlife Acts / SPA Selection Species
Hen harrier (*Circus cyaneus*)	Annex 1 EU Birds Directive / BoCCI Amber listed / Wildlife Acts / IBA Selection Species
Kestrel (*Falco tinnunculus*)	BoCCI Red listed / Wildlife Acts
Lapwing (*Vanellus vanellus*)	BoCCI Red listed / Wildlife Acts / SPA Selection Species
Lesser black-backed gull (*Larus fuscus*)	BoCCI Amber listed / Wildlife Acts
Little egret (*Egretta garzetta*)	Annex 1 EU Birds Directive / BoCCI Green listed / Wildlife Acts
Merlin (*Falco columbarius*)	Annex 1 EU Birds Directive / BoCCI Amber listed / Wildlife Acts
Mute swan (*Cygnus olor*)	BoCCI Amber listed / Wildlife Acts
Peregrine (*Falco peregrinus*)	Annex 1 EU Birds Directive / BoCCI Green listed / Wildlife Acts
Snipe (*Gallinago gallinago*)	BoCCI Red listed / Wildlife Acts
Sparrowhawk (*Accipiter nisus*)	BoCCI Green listed / Wildlife Acts
Teal (*Anas crecca*)	BoCCI Amber listed / Wildlife Acts / SPA Selection Species
Whooper swan (*Cygnus cygnus*)	Annex 1 EU Birds Directive / BoCCI Amber listed / Wildlife Acts / SPA Selection Species
Wigeon (*Mareca penelope*)	BoCCI Amber listed / Wildlife Acts / SPA Selection Species

Selection of target species recorded during the VP surveys for detailed collision risk modelling to assess potential impacts (referred to as 'Key Ornithological Features') was based on the following factors:

- their level of legal protection (e.g., inclusion on Annex 1 of the Birds Directive) and/or conservation concern (e.g., inclusion on the Birds of Conservation Concern in Ireland (BoCCI) Red or Amber Lists (Gilbert *et al*., 2021));
- their relevance to any nearby designated sites;
- the assessed importance of the Site to the species at an international, national, regional or local level; and
- their level of flight activity recorded with the flight risk volume during VP surveys.

As such, a total of 11 species were identified as Key Ornithological Features requiring detailed collision risk modelling, as detailed in **Table 5**. Considering the above factors, no other species were identified as Key Ornithological Features requiring detailed collision risk modelling.

Table 5. Key Ornithological Features for collision risk modelling

Species	Reasons for selection
Black-headed gull (*Chroicocephalus ridibundus*)	Widespread species in Ireland included on the BoCCI Amber List. Relevant to the designation of multiple SPAs in Ireland (e.g., River Shannon and River Fergus Estuaries SPA). High quantities of flight seconds were recorded within the WFA during the non-breeding season, potentially including individuals also using River Shannon and River Fergus Estuaries SPA.
Buzzard (*Buteo buteo*)	Whilst a common and widespread species in Ireland, reflected by its inclusion on the BoCCI Green List, high quantities of flight seconds were recorded within the WFA during the breeding and non-breeding seasons.
Cormorant (*Phalacrocorax carbo*)	Widespread species in Ireland included on the BoCCI Amber list. High quantities of flight seconds were recorded within the WFA during the breeding and non-breeding seasons, potentially including individuals belonging to the population roosting within the Blackwater River SAC.
Golden plover (*Pluvialis apricaria*)	Regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List, and included on Annex 1 of the Birds Directive. Limited records of golden plover but large quantity of flight seconds in the non-breeding season within the WFA.
Kestrel (*Falco tinnunculus*)	A species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. Large quantities of flight seconds were consistently recorded within the WFA during the breeding and non-breeding seasons.
Lapwing (*Vanellus vanellus*)	A species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. Limited records but significant quantity of flight seconds within the WFA in the non-breeding seasons.
Lesser black-backed gull (*Larus fuscus*)	Widespread species in Ireland during the non-breeding season, listed on the BoCCI Amber List as a species of conservation concern. Included due to high quantities of flight seconds within the WFA throughout the survey period and conservation status.
Mallard (*Anas platyrhynchos*)	Widespread and abundant species in Ireland during the breeding and non-breeding seasons, listed on the BoCCI Amber List as a species of conservation concern. Included due to high quantities of flight seconds within the WFA throughout the survey period and conservation status.
Peregrine (*Falco peregrinus*)	Locally common and increasing species in Ireland, reflected by its inclusion on the BoCCI Green List. Afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. Identified as a species of importance within Ballyhoura Mountains SAC, which has been identified as supporting one pair. Peregrine flight seconds recorded within the WFA were low throughout the breeding and non-breeding seasons. Selected as a Key Ornithological Feature on account of its legal status and relevance to Ballyhoura Mountains SAC.
Snipe (*Gallinago gallinago*)	A species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. Limited records but high quantities of flight seconds recorded throughout the breeding and non-breeding seasons.
Wigeon (*Mareca penelope*)	Widespread species in Ireland during the breeding and non-breeding season, listed on the BoCCI Amber List as a species of conservation concern and listed as a qualifying interest for the River Shannon and River Fergus Estuaries SPA. Single record of a flock of 300 individuals produced high quantities of flight seconds within the WFA during the non-breeding season.

An additional 24 target species recorded during the VP surveys would potentially merit inclusion in collision risk modelling on account of their conservation status, relevance to nearby designated sites and/or potential sensitivity to the Project: specifically, barn owl (*Tyto alba*), black-tailed godwit (*Limosa limosa*), cattle egret (*Bubulcus ibis*), common gull (*Larus canus*), curlew, gadwall (*Mareca strepera*), great black-backed gull (*Larus marinus*), green sandpiper (*Tringa ochropus*), grey heron, greylag goose (*Anser anser*), hen harrier, herring gull (*Larus argentatus*), little egret, Mediterranean gull (*Ichthyaetus melanocephalus*), merlin, moorhen (*Gallinula chloropus*), mute swan, short-eared owl (*Asio flammeus*), shoveler (*Spatula clypeata*), sparrowhawk (*Accipiter nisus*), teal (*Anas crecca*), whimbrel (*Numenius phaeopus*), white-tailed eagle (*Haliaeetus albicilla*) and yellow-legged gull (*Larus michahellis*). However, flight activity by these species recorded during the VP surveys was either at a very low level in the context of their population statuses, and/or outside of the flight risk volume. These species were therefore not selected as Key Ornithological Features for inclusion in collision risk modelling.

To maximise the accuracy of collision risk modelling outputs, collision risk calculations were undertaken for a duration of time appropriate to the species in question; specifically:

- For species which exhibited consistent activity levels within and adjacent to the Site throughout the year, and/or would be expected to exhibit similar activity levels within the Site throughout the year (e.g., buzzard, kestrel and peregrine), the potential number of collisions was modelled for the entire survey period (comprising four breeding seasons and four non-breeding seasons).
- For species which exhibited significantly different activity levels within and adjacent to the Site at different times of year, and/or would be expected to show significantly different activity levels at different times of year, the potential number of collisions was modelled separately for these times of year, and an average was taken from the seasons surveyed. For example, black-headed gull activity levels within and near the Site were much higher during the non-breeding season.

Collision risk modelling requires the typical measurements and flight parameters of modelled bird species to be known. Typical measurements and flight parameters for Key Ornithological Features are detailed in **Table 6**, based on available literature. In line with SNH guidance, where flight speed data for a species were not available, published flight data for a similar species were used.

Table 6. Measurements and flight parameters for Key Ornithological Features

Species	Average body length (m)	Average wingspan (m)	Average flight speed (m/s)	Data sources
Black-headed gull	0.38	1.00	11.90	Alerstam *et al.* (2007), BTO BirdFacts (2023)

Species	Average body length (m)	Average wingspan (m)	Average flight speed (m/s)	Data sources
Buzzard	0.54	1.20	9.45	Snow & Perrins (1998); Bruderer & Boldt (2001); Robinson (2005); Hawk & Owl Trust (2022); BTO BirdFacts (2022);
Cormorant	0.85	1.35	15.20	Alerstam *et al.* (2007); Collins (2023)
Golden plover	0.28	0.72	17.90*	Alerstam *et al.* (2007); Hawk & Owl Trust (2022); BTO BirdFacts (2022)
Kestrel	0.34	0.76	9.95	Snow & Perrins (1998); Bruderer & Boldt (2001); Taylor *et al.* (2003); Robinson (2005); Hawk & Owl Trust (2022); BTO BirdFacts (2022)
Lapwing	0.30	0.70	12.30	Bruderer & Boldt (2001); Alerstam *et al.* (2007); Collins (2023)
Lesser black-backed gull	0.52	1.26	12.40	Bruderer & Boldt (2001); Alerstam *et al.* (2007); Collins (2023)
Mallard	0.55	0.88	20.00**	Bruderer & Boldt (2001); Alerstam *et al.* (2007); Collins (2023)
Peregrine	0.42	1.02	12.10	Cochrain & Applegate (1986), Alerstam *et al.* (2007); BTO BirdFacts (2022)
Snipe	0.26	0.42	16.20	Bruderer & Boldt (2001); Alerstam *et al.* (2007); Collins (2023)
Wigeon	0.48	0.8	20.6	Bruderer & Boldt (2001); Alerstam *et al.* (2007); Collins (2023)

* Taken as the flight speed for grey plover (*Pluvialis squatarola*) (Alerstam *et al.*, 2007).

** Average taken between Bruderer & Boldt (2001) and Alerstam *et al.* (2007).

3.4 Model selection

SNH has published two models for calculation of collision risk. These models are appropriate for different scenarios, depending on how Key Ornithological Features are using the WFA:

- The 'Airspace' Model applies where birds are typically recorded within the airspace of the WFA; for example, birds with breeding territories or observed foraging within the WFA.
- The 'Fly Through' Model applies where birds are typically recorded using regular commuting routes across the WFA.

Observations of ten Key Ornithological Features during the VP surveys were typically of birds hunting, circling, soaring and perching within the WFA, or birds circling or flying over the Site. The Airspace Model was therefore selected as being most appropriate for collision risk modelling of black-headed gull, buzzard, cormorant, golden plover, kestrel, lapwing, lesser black-backed gull, mallard, peregrine, snipe and wigeon.

Airspace models are generated on the basis of bird occupancy within a 'flight risk volume' (vW); specifically, the two-dimensional WFA multiplied by the turbine height. As such, bird occupancy is modelled using the number of birds observed within this volume multiplied by the time in seconds spent flying within this volume. Bird flight lines recorded outside of this flight risk volume, either because flight height exceeded the maximum blade height or was below the minimum blade height, or because of lateral movement outside of the WFA, were excluded from the model.

Observations of one Key Ornithological Feature, black-headed gull, were of birds flying within the airspace and also directly through the WFA, potentially representing commuting or migration routes. As such, an additional Fly Through Model was selected as also being appropriate for collision risk modelling of black-headed gull to adequately assess the estimated mortality rate of individuals that could be commuting to the River Shannon and River Fergus Estuaries SPA. Rather than identifying a flight risk volume (as for airspace models above), a 'risk window' equal to the width of the windfarm across the general flight direction observed for the species, and the maximum and minimum blade heights, is identified.

3.5 Avoidance rates

The third stage of collision risk modelling takes account of the understanding that birds will often take action to avoid collision with wind turbines, either by avoiding the wind farm entirely (i.e., displacement), by flying above or below turbines, or by performing 'emergency' manoeuvres to avoid moving turbine blades.

Avoidance rates are generally derived by comparing data on actual observed collisions with the predicted no-avoidance collision estimate. SNH *Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model* (SNH, 2018) collates species-specific estimates of avoidance rates from multiple information sources to determine avoidance rate estimates that should be used for Key Ornithological Features.

Avoidance rates used for collision risk modelling of the eleven Key Ornithological Features are indicated in **Table 7**. As per SNH guidance, a default avoidance rate of 98% has been applied for species for which a specific avoidance rate is not specified.

Table 7. Avoidance rates for Key Ornithological Features (SNH, 2018)

Species	Avoidance rate
Black-headed gull	98% (default value)
Buzzard	98% (default value)
Cormorant	98% (default value)
Golden plover	98% (default value)
Kestrel	95%
Lapwing	98% (default value)
Lesser black-backed gull	98% (default value)

Species	Avoidance rate
Mallard	98% (default value)
Peregrine	98% (default value)
Snipe	98% (default value)
Wigeon	98% (default value)

3.6 Limitations and assumptions

Collision risk modelling assumes all turbines are turning constantly throughout the modelled period. In reality this will not be the case, as turbines will not be turning at certain times (e.g., at wind speeds below the minimum cut-in speed or above the maximum cut-out speed, or during maintenance periods). In addition, collision risk modelling assumes all bird collisions with turbines will be fatal, which may not necessarily be the case.

On a precautionary basis, all birds flying between 20 and 180 m within the WFA have been included within collision risk modelling, despite the proposed turbines for the Project having a maximum height of 170 m.

As stated in Section 2.1, to account for potential errors when recording the precise locations of birds in flight during VP surveys, a 100 m buffer was adopted around turbine bases (in addition to the turbine blade span) when generating the WFA. This is based on the typical proximity of surveyors to the birds recorded (due to the number of VP locations surveyed from), and the Site topography, which included boundary features aiding precise mapping of flight lines. As such, this buffer is considered appropriate to ensure all relevant flight lines were included in collision risk modelling.

The overlap in viewsheds from different VP locations means that part of the WFA was subject to duplication of effort (i.e., a greater number of effective hours were surveyed than is implied by the total number of hours of observation undertaken at each VP). Rather than increasing the total number of survey hours modelled (and thus diluting the number of bird flight seconds recorded within the survey period), the models presented in this report have been calculated on the basis of non-overlapping coverage of the WFA.

Collision risk modelling assumes bird activity observed during the baseline surveys is representative of bird activity at the Site, in the absence of the Project. It does not account for any displacement of birds which may result from the physical presence of the turbines and other associated infrastructure, which could reduce bird activity levels within the WFA whilst the Project is in operation.

For these reasons, collision risk modelling presented in this report provides presents a precautionary scenario of anticipated collision fatalities.

Where collision risk modelling incorporates relatively few observations, individual ‘outlier’ observations (i.e., observations which drastically differ to any others recorded and are atypical of the activity recorded for the Key Ornithological Feature) can have a significant impact on the modelled number of collision fatalities. Any such influence from outlier observations on is identified in this report and should be taken into consideration within impact assessment.

4.0 RESULTS

Flight times for Key Ornithological Features within the flight risk volume (vW) were calculated as the number of birds observed within the flight risk volume, multiplied by the flight duration in seconds within the flight risk volume. For example, two birds flying within the WFA at a height of 80 m for 15 seconds would constitute 30 flight seconds within the flight risk volume.

The total flight seconds for each Key Ornithological Feature recorded within the vW between 2020 and 2024 inclusive are presented in **Table 8**. Cells shaded in grey indicate that no flight seconds within the flight risk volume were recorded during that period for the species in question. Golden plover was recorded twice in September Flight activity data from VP surveys included in the collision risk modelling are detailed in **Annex A**.

Table 8. Flight seconds for Key Ornithological Features included in collision risk modelling

Species	Seasonal relevance	Season	
		Breeding	Non-breeding
Black-headed gull	NB		5,516
Buzzard	B/NB	2,426	1,668
Cormorant	B/NB	1,390	3,093
Golden plover	NB		9,700
Kestrel	B/NB	2,268	1,308
Lapwing	B/NB		2,566
Lesser black-backed gull	B/NB	13,459	8,302
Mallard	B/NB	2,005	619
Peregrine	B/NB	27	147
Snipe	B/NB	5,405	62
Wigeon	B/NB		16,619

Species-specific collision risk models for each Key Ornithological Feature are summarised below. Collision risk probability calculations are provided in **Annex B**. Collision risk modelling analysis is provided in **Annex C**.

4.1 Black-headed gull

Black-headed gull is a resident species in Ireland, however breeding populations are isolated to colonies present along the coast with migration inland only occurring in the non-breeding season with an increase in the population with individuals on migration from continental Europe. Within the context of the Site location, black-headed gull is considered a non-breeding species in this assessment. Risk modelling in the context of the Site for this species is therefore appropriate for the non-breeding season.

Black-headed gull was recorded within the WFA at risk height during the non-breeding season in 2022/23 and 2023/24. Considering the presence of the species during the non-breeding season, collision risk has been calculated based on a modelled period of half a year (i.e., October to March inclusive).

Based on the measurements and flight parameters for black-headed gull described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions is 5.5%.

A distinct north-south flight trend was recorded in black-headed gull flights across the Site between 2020 and 2024. Considering this, and to inform subsequent impact assessment, two collision risk models were run in relation to black-headed gull:

- An Airspace model for general flight activity in various directions within the Site airspace, including circling flocks and birds moving across the Site; and
- A Fly Through model for flight activity directly northwards and southwards over the Site, potentially to/from the direction of River Shannon and River Fergus Estuaries SPA, accounting for birds potentially forming part of the SCI population for the SPA.

Airspace model

In the absence of any avoiding actions, the estimated number of black-headed gull collision fatalities within the modelled period based on the 2020-2024 survey data is 43.46 birds. The estimated annual number of black-headed gull collision fatalities based on the 2020-2024 survey data is 10.87 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of black-headed gull collision fatalities based on the 2020-2024 survey data is 0.22 birds (equating to 7.61 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for black-headed gull is summarised in **Table 9**.

Table 9. Black-headed gull airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.217	7.606

Flythrough model

For this model, no data within risk height was recorded during the 2020/21 and 2021/22 non-breeding seasons. In the absence of any avoiding actions, the estimated number of black-headed gull fatalities for flights through the WFA in the direction to/from River Shannon and River Fergus Estuaries SPA is as follows for the seasons assessed:

- 12.03 birds per non-breeding season based on 2022/23 survey data; and
- 44.10 birds per non-breeding season based on 2023/24 survey data.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated number of black-headed gull collision fatalities per non-breeding season and over the anticipated lifespan of the wind farm (35 years) due to flights through the WFA in the direction to/from River Shannon and River Fergus Estuaries SPA is summarised in **Table 10**. Based on an average of the four non-breeding seasons surveyed, taking avoiding actions into account, estimated black-headed gull collision fatalities would be 0.28 birds per non-breeding season, equating to 9.82 collision fatalities over the operational lifespan of the wind farm.

Table 10. Black-headed gull fly through collision risk model summary

Survey period	Avoidance rate	Estimated collision fatalities	
		Per non-breeding season	35 years
October 2020-March 2021	98% (default value)	0.000	0.000
October 2021-March 2022		0.000	0.000
October 2022-March 2023		0.241	8.420
October 2023-March 2024		0.882	30.872
Average		**0.281**	**9.823**

4.2 Buzzard

Buzzard is a common resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for buzzard described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 7.0%.

Therefore, in the absence of any avoiding actions, the estimated number of buzzard collision fatalities within the modelled period based on the 2020-2024 survey data is 28.74 birds respectively. Whilst the estimated annual number of buzzard collision fatalities based on the 2020-2024 survey data is 7.18 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of buzzard collision fatalities based on the 2020-2024 survey data is 0.14 birds (equating to 5.03 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for buzzard is summarised in **Table 11**.

Table 11. Buzzard airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.144	5.029

4.3 Cormorant

Cormorant is a common resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for cormorant described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 6.9%.

Therefore, in the absence of any avoiding actions, the estimated number of cormorant collision fatalities within the modelled period based on the 2020-2024 survey data is 49.88 birds. Whilst the estimated annual number of cormorant collision fatalities based on the 2020-2024 survey data is 12.47 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of cormorant collision fatalities based on the 2020-2024 survey data is 0.25 birds (equating to 8.73 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for cormorant is summarised in **Table 12**.

Table 12. Cormorant airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.249	8.730

4.4 Golden plover

Golden plover is a resident species to Ireland present within the breeding and non-breeding season. The species breeds in upland habitats and winters along in flocks foraging inland or along the coast. Two observations of birds on passage migration were recorded in September 2023 through the WFA within the breeding season defined in this assessment. Despite this, in the context of the Site location and habitat, golden plover is considered to be a non-breeding species. Risk modelling for this species is therefore only appropriate for the non-breeding season.

Based on the measurements and flight parameters for golden plover described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 4.4%.

Therefore, in the absence of any avoiding actions, the estimated number of golden plover collision fatalities within the modelled period based on the 2020-2024 survey data is 79.89 birds. Whilst the estimated annual number of golden plover collision fatalities based on the 2020-2024 survey data is 19.97 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of golden plover collision fatalities based on the 2020-2024 survey data is 0.40 birds (equating to 13.98 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for golden plover is summarised in **Table 13**.

Table 13. Golden plover airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.399	13.980

4.5 Kestrel

Kestrel is a common resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for kestrel described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.6%.

Therefore, in the absence of any avoiding actions, the estimated number of kestrel collision fatalities within the modelled period based on the 2020-2024 survey data is 21.14 birds. Whilst the estimated annual number of kestrel collision fatalities based on the 2020-2024 survey data is 5.28 birds.

Taking into consideration an avoidance rate of 95% (in line with SNH guidance), the estimated annual number of kestrel collision fatalities based on the 2020-2024 survey data is 0.26 birds (equating to 9.25 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for kestrel is summarised in **Table 14**.

Table 14. Kestrel airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.264	9.248

4.6 Lapwing

Lapwing is a resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for lapwing described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.0%.

Therefore, in the absence of any avoiding actions, the estimated number of lapwing collision fatalities within the modelled period based on the 2020-2024 survey data is 16.75 birds. Whilst the estimated annual number of lapwing collision fatalities based on the 2020-2024 survey data is 4.19 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of lapwing collision fatalities based on the 2020-2024 survey data is 0.08 birds (equating to 2.93 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for lapwing is summarised in **Table 15**.

Table 15. Lapwing airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.084	2.931

4.7 Lesser black-backed gull

Lesser black-backed gull is a resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for lesser black-backed gull described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 6.0%.

Therefore, in the absence of any avoiding actions, the estimated number of lesser black-backed gull collision fatalities within the modelled period based on the 2020-2024 survey data is 171.81 birds. Whilst the estimated annual number of lesser black-backed gull collision fatalities based on the 2020-2024 survey data is 42.95 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of buzzard collision fatalities based on the 2020-2024 survey data is 0.86 birds (equating to 30.07 collision fatalities over the anticipated lifespan of the wind farm. Collision risk modelling for lesser black-backed gull is summarised in **Table 16**.

Table 16. Lesser black-backed gull airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.859	30.067

4.8 Mallard

Mallard is a common resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for kestrel described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.4%.

Therefore, in the absence of any avoiding actions, the estimated number of mallard collision fatalities within the modelled period based on the 2020-2024 survey data is 30.07 birds. Whilst the estimated annual number of mallard collision fatalities based on the 2020-2024 survey data is 7.52 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of mallard collision fatalities based on the 2020-2024 survey data is 0.15 birds (equating to 5.26 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for mallard is summarised in **Table 17**.

Table 17. Mallard airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.150	5.263

4.9 Peregrine

Peregrine is resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for peregrine described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.7%.

Therefore, in the absence of any avoiding actions, the estimated number of peregrine collision fatalities within the modelled period based on the 2020-2024 survey data is 1.27 birds respectively. Whilst the estimated annual number of peregrine collision fatalities based on the 2020-2024 survey data is 0.32 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of peregrine collision fatalities based on the 2020-2024 survey data is 0.06 birds (equating to 0.22 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for peregrine is summarised in **Table 18**.

Table 18. Peregrine airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.006	0.223

4.10 Snipe

Snipe is a resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for snipe described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 4.4%.

Therefore, in the absence of any avoiding actions, the estimated number of snipe collision fatalities within the modelled period based on the 2020-2024 survey data is 41.10. Whilst the estimated annual number of snipe collision fatalities based on the 2020-2024 survey data is 10.27 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of snipe collision fatalities based on the 2020-2024 survey data is 0.21 birds (equating to 7.19 collision fatalities over the anticipated lifespan of the wind farm). Collision risk modelling for snipe is summarised in **Table 19**.

Table 19. Snipe airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.205	7.192

4.11 Wigeon

Wigeon is a common resident species within Ireland and would be present within the Site year-round. Collision risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Based on the measurements and flight parameters for snipe described in **Table 6**, and the turbine specifications described in **Table 2**, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.0%.

Therefore, in the absence of any avoiding actions, the estimated number of wigeon collision fatalities within the modelled period based on the 2020-2024 survey data is 181.65 birds. Whilst the estimated annual number of wigeon collision fatalities based on the 2020-2024 survey data is 45.41 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of wigeon collision fatalities based on the 2020-2024 survey data is 0.91 birds (equating to 31.79 collision fatalities over the anticipated lifespan of the wind farm). It should be noted that wigeon data included two records consisting of 11,700 and 4,446 flight seconds respectively which is equivalent to 70.4% and 26.8% of the modelled data for this species respectively. In the absence of these records from the data set, mortality across the life span of the wind farm decreases to 0.91 birds. Collision risk modelling for wigeon is summarised in **Table 20.**

Table 20. Wigeon airspace collision risk model summary

Model survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020 – September 2024	98% (default value)	0.908	31.789

5.0 CONCLUSION

Based on the VP survey data recorded at the Site between October 2020 and September 2024 inclusive, 11 Key Ornithological Features were identified as being potentially susceptible to collision impacts with the proposed wind turbines: specifically buzzard, cormorant, kestrel, lapwing, lesser black-backed gull, mallard, peregrine, snipe and wigeon during the entire year, and black-headed gull and golden plover during the non-breeding season only.

Estimated collision risk fatalities for these species as a result of the proposed turbines, both annually and for the anticipated operational lifespan of the Project (35 years), are presented in Section 4.

It should be noted that, for the reasons specified in Section 3.6 and Section 4, these calculations represent a precautionary scenario for collision fatalities from the Project.

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FIGURES

Figure 1 – Site location;

Figure 2 – Designated sites;

Figure 3 – VP locations;

Figure 4 – Flight observations from VP surveys for target species during the breeding season; and

Figure 5 – Flight observations from VP surveys for target species during the non-breeding season.

ANNEX A – FLIGHT ACTIVITY DATA

Table A.1. Model flight activity data

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Flythrough records									
Black-headed gull	NB 2022/2023	8	04/11/2022	21	50	20-40	50	32	672
Black-headed gull	NB 2022/2023	8	07/12/2022	1	18	20-50	18	18	18
Black-headed gull	NB 2022/2023	8	17/01/2023	2	98	20-50	98	25	50
Black-headed gull	NB 2022/2023	2	13/02/2023	13	60	20-50	60	18	234
Black-headed gull	NB 2022/2023	7	13/02/2023	13	10	20-50	10	7	91
Black-headed gull	NB 2022/2023	1	13/02/2023	20	136	100-200	136	1	20
Black-headed gull	**Non-breeding season 2022/2023**						**372**	**101**	**1085**
Black-headed gull	NB 2023/2024	2	10.01.2024	6	80	20-50	80	29	173
Black-headed gull	NB 2023/2024	2	10.01.2024	77	94	20-50	94	32	2461
Black-headed gull	NB 2023/2024	2	12.12.2023	3	50	20-50	50	3	8
Black-headed gull	NB 2023/2024	2	14.11.2023	1	14	20-50	14	1	1
Black-headed gull	NB 2023/2024	6	13.12.2023	5	93	50-100	93	11	56
Black-headed gull	NB 2023/2024	8	10.01.2024	8	40	20-50	40	40	320
Black-headed gull	NB 2023/2024	8	10.01.2024	7	30	20-50	30	30	210
Black-headed gull	NB 2023/2024	8	12.12.2023	24	40	20-50	40	26	624

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Black-headed gull	**Non-breeding season 2023/2024**						**441**	**172**	**3852**
Black-headed gull	**2020-2024**						**813**	**273**	**4937**
Airspace records									
Black-headed gull	NB 2020/2021	2	17/02/2021	Mixed	600	80-100	600	150	150
Black-headed gull	**Non-breeding season 2020/ 2021**						**600**	**150**	**150**
Black-headed gull	NB 2022/2023	8	04/11/2022	21	50	20-40	50	32	672
Black-headed gull	NB 2022/2023	8	07/12/2022	1	18	20-50	18	18	18
Black-headed gull	NB 2022/2023	8	17/01/2023	2	98	20-50	98	25	50
Black-headed gull	NB 2022/2023	2	13/02/2023	13	60	20-50	60	18	234
Black-headed gull	NB 2022/2023	7	13/02/2023	13	10	20-50	10	7	91
Black-headed gull	NB 2022/2023	1	13/02/2023	20	136	100-200	136	1	20
Black-headed gull	**Non-breeding season 2022/2023**						**372**	**101**	**1085**
Black-headed gull	NB 2023/2024	2	10.01.2024	6	80	20-50	80	29	173
Black-headed gull	NB 2023/2024	2	10.01.2024	77	94	20-50	94	32	2461
Black-headed gull	NB 2023/2024	2	12.12.2023	3	50	20-50	50	3	8
Black-headed gull	NB 2023/2024	2	12.12.2023	3	58	50-100	58	33	99
Black-headed gull	NB 2023/2024	2	12.12.2023	2	55	20-50	55	36	72
Black-headed gull	NB 2023/2024	2	12.12.2023	4	222	100-180	222	64	258
Black-headed gull	NB 2023/2024	2	14.11.2023	1	14	20-50	14	1	1
Black-headed gull	NB 2023/2024	6	13.12.2023	5	93	50-100	93	11	56
Black-headed gull	NB 2023/2024	8	10.01.2024	8	40	20-50	40	40	320
Black-headed gull	NB 2023/2024	8	10.01.2024	7	30	20-50	30	30	210

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Black-headed gull	NB 2023/2024	8	12.12.2023	24	40	20-50	40	26	624
Black-headed gull	**Non-breeding season 2023/2024**						**776**	**305**	**4281**
Black-headed gull	**2020-2024**						**1748**	**556**	**5516**
Buzzard	B 2021	2	13/07/2021	1	35	40	35	11	11
Buzzard	B 2021	2	21/07/2021	1	36	40	36	32	32
Buzzard	**Breeding season 2021**						**71**	**43**	**43**
Buzzard	NB 2021/2022	2	29/03/2022	1	120	50	120	24	120
Buzzard	**Non-breeding season 2021/2022**						**120**	**24**	**120**
Buzzard	B 2022	2	20/04/2022	1	2	25	2	0	0
Buzzard	B 2022	2	20/04/2022	1	10	0-20, 20, 30	9	6	6
Buzzard	B 2022	2	20/04/2022	1	4	40	4	2	2
Buzzard	B 2022	2	20/04/2022	1	60	30-40	60	9	9
Buzzard	**Breeding season 2022**						**75**	**17**	**17**
Buzzard	NB 2022/2023	8	07/10/2022	1	130	40	130	104	104
Buzzard	NB 2022/2023	7	07/10/2022	1	60	40-80	60	12	12
Buzzard	NB 2022/2023	8	04/11/2022	1	44	30-60	44	31	31
Buzzard	NB 2022/2023	2	17/01/2023	1	93	20-50	93	47	47
Buzzard	NB 2022/2023	2	17/01/2023	1	82	50-100	82	82	82
Buzzard	NB 2022/2023	7	13/02/2023	1	8	20-50	8	8	8
Buzzard	NB 2022/2023	2	13/02/2023	1	20	20-50	20	1	1
Buzzard	**Non-breeding season 2023**						**437**	**285**	**285**
Buzzard	B 2023	2	09.05.2023	1	100	100-180	100	45	45

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Buzzard	B 2023	2	10.08.2023	1	88	20-50	88	74	0
Buzzard	B 2023	2	10.08.2023	1	144	0-50	55	30	0
Buzzard	B 2023	2	13.04.2023	1	50	20-50	50	36	36
Buzzard	B 2023	5	10.08.2023	1	88	50-100	88	28	28
Buzzard	B 2023	6	10.08.2023	1	60	20-100	60	42	42
Buzzard	B 2023	6	13.04.2023	1	168	100-180	168	144	144
Buzzard	B 2023	6	14.09.2023	1	120	50-100	120	100	100
Buzzard	B 2023	7	09.05.2023	1	204	100-180	204	184	184
Buzzard	B 2023	7	13.04.2023	1	240	50-100	240	175	175
Buzzard	B 2023	7	13.04.2023	1	104	50-100	104	104	104
Buzzard	B 2023	7	13.04.2023	1	71	20-50	71	71	71
Buzzard	B 2023	7	13.04.2023	1	120	50-100	120	6	6
Buzzard	B 2023	8	13.04.2023	1	110	20-50	110	99	99
Buzzard	**Breeding season 2023**						**1578**	**1138**	**1034**
Buzzard	NB 2023/2024	1	19.02.2024	1	158	100-180	158	126	126
Buzzard	NB 2023/2024	2	12.12.2023	1	72	0-50	52	35	35
Buzzard	NB 2023/2024	2	14.03.2024	1	334	20-180	334	234	234
Buzzard	NB 2023/2024	6	19.02.2024	2	45	20-50	45	16	32
Buzzard	NB 2023/2024	6	19.02.2024	1	115	20-50	115	33	33
Buzzard	NB 2023/2024	6	19.03.2024	2	580	100-180	580	400	800
Buzzard	NB 2023/2024	7	19.02.2024	1	5	20-50	5	2	2
Buzzard	**Non-breeding season 2024**						**1289**	**847**	**1263**

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Buzzard	B 2024	1	12.06.2024	1	30	20-50	30	30	30
Buzzard	B 2024	2	09.05.2024	1	70	50-100	70	0	0
Buzzard	B 2024	2	11.06.2024	1	176	0-50	136	27	27
Buzzard	B 2024	2	11.06.2024	1	458	0-180	448	193	193
Buzzard	B 2024	2	11.06.2024	1	475	50-180	475	181	181
Buzzard	B 2024	6	10.07.2024	1	30	20-50	30	4	4
Buzzard	B 2024	6	12.06.2024	1	236	50-180	236	111	111
Buzzard	B 2024	6	12.06.2024	2	530	0-180	445	22	45
Buzzard	B 2024	6	12.06.2024	2	166	50-100	166	5	10
Buzzard	B 2024	7	12.06.2024	1	810	50-100	810	381	381
Buzzard	B 2024	7	12.06.2024	1	95	100-180	95	74	74
Buzzard	B 2024	7	12.06.2024	1	25	20-50	25	15	15
Buzzard	B 2024	8	09.05.2024	1	31	20-50	31	8	8
Buzzard	B 2024	8	09.05.2024	1	188	20-50	188	132	132
Buzzard	B 2024	8	11.06.2024	1	100	100-180	100	82	82
Buzzard	B 2024	8	11.06.2024	2	15	50-100	15	8	16
Buzzard	B 2024	8	11.06.2024	1	50	20-50	50	27	27
Buzzard	**Breeding season 2024**						**3350**	**1298**	**1333**
Buzzard	**2020-2024**						**6920**	**3651**	**4094**
Cormorant	NB 2020/2021	2	23/10/2020	3	55	50	55	33	99
Cormorant	NB 2020/2021	2	22/03/2021	2	38	60	38	6	12
Cormorant	**Non-breeding season 2020/2021**						**93**	**39**	**111**

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	**Season**	**VP**	**Date**	**No. birds**	**Total flight time**	**Flight height**	**Flight time at risk height**	**Flight time in vW**	**Bird flight seconds in vW**
Cormorant	B 2021	2	17/07/2021	2	30	40	30	18	36
Cormorant	B 2021	2	21/07/2021	1	40	30	40	40	40
Cormorant	B 2021	2	17/08/2021	1	35	40	35	12	12
Cormorant	**Breeding season 2021**						**105**	**70**	**88**
Cormorant	NB 2021/2022	1	18/12/2021	6	110	20-50	110	66	396
Cormorant	NB 2021/2022	2	21/02/2022	1	10	20-50	10	7	7
Cormorant	**Non-breeding season 2021/2022**						**120**	**73**	**403**
Cormorant	NB 2022/2023	6	07/10/2022	1	50	50	50	50	50
Cormorant	NB 2022/2023	2	04/11/2022	1	5	20-50	5	1	1
Cormorant	NB 2022/2023	2	04/11/2022	1	10	20-50	10	2	2
Cormorant	NB 2022/2023	8	04/11/2022	1	20	10-30	10	6	6
Cormorant	NB 2022/2023	8	04/11/2022	1	35	10-50	30	30	30
Cormorant	NB 2022/2023	8	04/11/2022	1	30	30-50	30	30	30
Cormorant	NB 2022/2023	2	07/12/2022	1	110	20-50	110	94	94
Cormorant	NB 2022/2023	2	07/12/2022	1	40	20-50	40	10	10
Cormorant	NB 2022/2023	8	17/01/2023	2	136	20-50	136	88	176
Cormorant	NB 2022/2023	2	17/01/2023	5	20	20-50	20	1	5
Cormorant	NB 2022/2023	1	17/01/2023	1	31	20-50	31	28	1
Cormorant	NB 2022/2023	6	17/01/2023	1	10	20-50	10	8	8
Cormorant	NB 2022/2023	1	17/01/2023	1	120	20-50	120	78	78
Cormorant	NB 2022/2023	6	17/01/2023	1	10	20-50	10	1	1
Cormorant	NB 2022/2023	2	17/01/2023	11	25	20-50	25	25	225

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Cormorant	NB 2022/2023	2	13/02/2023	9	120	20-50	120	120	1080
Cormorant	NB 2022/2023	3	13/02/2023	2	30	20-50	30	30	60
Cormorant	**Non-breeding season 2022/2023**						**787**	**602**	**1857**
Cormorant	B 2023	1	09.05.2023	1	29	20-50	29	15	15
Cormorant	B 2023	1	09.05.2023	1	58	0-50	28	2	2
Cormorant	B 2023	1	09.05.2023	1	40	50-180	40	0	0
Cormorant	B 2023	2	09.05.2023	1	18	20-50	18	7	7
Cormorant	B 2023	2	13.04.2023	3	10	20-50	10	10	30
Cormorant	B 2023	2	13.06.2023	3	20	20-50	20	20	60
Cormorant	B 2023	2	13.07.2023	1	151	20-50	151	50	50
Cormorant	B 2023	2	13.07.2023	1	74	20-50	74	74	74
Cormorant	B 2023	2	14.09.2023	1	65	20-50	65	27	27
Cormorant	B 2023	6	09.05.2023	1	7	20-50	7	6	6
Cormorant	B 2023	7	13.06.2023	3	40	20-50	40	16	48
Cormorant	B 2023	8	09.05.2023	1	90	20-50	90	37	37
Cormorant	B 2023	8	09.05.2023	3	103	20-50	103	68	204
Cormorant	B 2023	8	09.05.2023	1	132	20-50	132	84	84
Cormorant	B 2023	8	10.08.2023	1	70	0-50	60	49	49
Cormorant	B 2023	8	13.04.2023	1	30	0-50	5	5	5
Cormorant	B 2023	8	13.04.2023	3	58	0-50	29	15	44
Cormorant	B 2023	8	13.07.2023	1	70	20-50	70	45	45
Cormorant	B 2023	8	14.09.2023	1	17	20-50	17	14	14

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Cormorant	B 2023	8	14.09.2023	1	130	20-50	130	30	30
Cormorant	B 2023	8	14.09.2023	5	20	20-50	20	18	90
Cormorant	**Breeding season 2023**						**1138**	**592**	**921**
Cormorant	NB 2023/2024	1	11.01.2024	1	76	20-100	76	15	15
Cormorant	NB 2023/2024	1	11.01.2024	2	29	20-50	29	9	19
Cormorant	NB 2023/2024	1	11.01.2024	2	57	20-50	57	5	9
Cormorant	NB 2023/2024	2	10.01.2024	1	67	20-50	67	7	7
Cormorant	NB 2023/2024	2	10.01.2024	1	52	20-50	52	52	52
Cormorant	NB 2023/2024	2	11.10.2023	2	8	20-50	8	4	9
Cormorant	NB 2023/2024	2	12.12.2023	2	32	20-50	32	30	61
Cormorant	NB 2023/2024	2	15.02.2024	1	20	20-50	20	7	7
Cormorant	NB 2023/2024	6	15.11.2023	1	30	20-50	30	11	11
Cormorant	NB 2023/2024	6	15.11.2023	1	25	20-50	25	4	4
Cormorant	NB 2023/2024	7	11.01.2024	1	30	50-100	30	30	30
Cormorant	NB 2023/2024	7	11.01.2024	1	20	20-50	20	20	20
Cormorant	NB 2023/2024	7	11.01.2024	1	25	20-50	25	5	5
Cormorant	NB 2023/2024	7	13.12.2023	1	30	20-50	30	30	30
Cormorant	NB 2023/2024	7	18.03.2024	4	50	20-50	50	50	200
Cormorant	NB 2023/2024	7	18.03.2024	1	35	20-50	35	35	35
Cormorant	NB 2023/2024	7	19.02.2024	2	10	50-100	10	4	8
Cormorant	NB 2023/2024	7	19.02.2024	1	20	20-50	20	20	20
Cormorant	NB 2023/2024	8	10.01.2024	1	40	20-50	40	21	21

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	**Season**	**VP**	**Date**	**No. birds**	**Total flight time**	**Flight height**	**Flight time at risk height**	**Flight time in vW**	**Bird flight seconds in vW**
Cormorant	NB 2023/2024	8	10.10.2023	1	93	20-50	93	48	48
Cormorant	NB 2023/2024	8	12.12.2023	1	20	20-50	20	1	1
Cormorant	NB 2023/2024	8	12.12.2023	1	40	20-50	40	2	2
Cormorant	NB 2023/2024	8	12.12.2023	1	20	20-50	20	18	18
Cormorant	NB 2023/2024	8	14.03.2024	1	40	20-50	40	28	28
Cormorant	NB 2023/2024	8	14.03.2024	1	40	20-50	40	16	16
Cormorant	NB 2023/2024	8	15.11.2023	1	60	20-50	60	45	45
Cormorant	**Non-breeding season 2023/2024**						**969**	**519**	**722**
Cormorant	B 2024	2	06.09.2024	1	19	0-50	10	10	10
Cormorant	B 2024	2	06.09.2024	1	37	20-100	37	30	30
Cormorant	B 2024	2	06.09.2024	1	18	20-50	18	18	18
Cormorant	B 2024	2	08.04.2024	1	97	20-50	97	97	97
Cormorant	B 2024	2	08.04.2024	1	12	20-50	12	12	12
Cormorant	B 2024	2	08.08.2024	1	22	20-50	22	11	11
Cormorant	B 2024	2	09.05.2024	1	50	20-50	50	50	50
Cormorant	B 2024	2	09.07.2024	1	15	20-50	15	15	15
Cormorant	B 2024	2	09.07.2024	2	29	20-50	29	23	47
Cormorant	B 2024	2	09.07.2024	1	28	20-50	28	7	7
Cormorant	B 2024	6	09.09.2024	1	6	20-50	6	0	0
Cormorant	B 2024	6	09.09.2024	1	8	20-50	8	0	0
Cormorant	B 2024	6	12.06.2024	2	50	20-50	50	12	23
Cormorant	B 2024	7	07.08.2024	1	28	20-50	28	5	5

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Cormorant	B 2024	7	07.08.2024	1	24	20-50	24	17	17
Cormorant	B 2024	7	10.07.2024	1	8	20-50	8	3	3
Cormorant	B 2024	7	10.07.2024	2	8	20-50	8	8	16
Cormorant	B 2024	7	11.04.2024	1	8	20-50	8	7	7
Cormorant	B 2024	7	12.06.2024	1	40	20-50	40	9	9
Cormorant	B 2024	8	09.07.2024	1	64	0-50	8	4	4
Cormorant	**Breeding season 2024**						**506**	**338**	**381**
Cormorant	**2020-2024**						**3718**	**2233**	**4482**
Golden plover	NB 2020/2021	2	18/02/2021	42	180	150-200	180	117	4914
Golden plover	**Non-breeding season 2020/2021**						**180**	**117**	**4914**
Golden plover	NB 2022/2023	8	07/10/2022	32	200	1-50	150	143	4576
Golden plover	**Non-breeding season 2022/2023**						**150**	**143**	**4576**
Golden plover	B 2023	8	14.09.2023	1	17	20-50	17	15	15
Golden plover	B 2023	8	14.09.2023	6	25	20-50	25	24	144
Golden plover	**Breeding season 2023**						**42**	**39**	**159**
Golden plover	NB 2023/2024	8	10.01.2024	1	15	20-50	15	5	5
Golden plover	NB 2023/2024	8	10.10.2023	14	50	0-50	30	3	46
Golden plover	**Non-breeding season 2024**						**45**	**8**	**51**
Golden plover	**2020-2024**						**417**	**307**	**9700**
Kestrel	NB 2020/2021	2	23/10/2020	1	300	60-70	300	90	90
Kestrel	**Non-breeding season 2020/2021**						**300**	**90**	**90**
Kestrel	B 2021	2	17/08/2021	1	20	30	20	6	6

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Kestrel	B 2021	2	19/08/2021	1	180	25	180	54	54
Kestrel	**Breeding season 2021**						**200**	**60**	**60**
Kestrel	NB 2021/2022	2	04/11/2021	1	240	0-40	120	1	1
Kestrel	NB 2021/2022	1	25/11/2021	1	30	0-20	25	1	1
Kestrel	NB 2021/2022	1	18/12/2021	1	330	20-50	330	33	33
Kestrel	NB 2021/2022	2	23/01/2022	1	20	50-100	20	4	4
Kestrel	NB 2021/2022	2	21/02/2022	1	60	20-50	60	60	60
Kestrel	NB 2021/2022	2	21/02/2022	1	180	50-100	180	81	81
Kestrel	NB 2021/2022	2	25/02/2022	1	120	50-100	120	108	108
Kestrel	**Non-breeding season 2021/2022**						**855**	**288**	**288**
Kestrel	B 2022	2	23/09/2022	1	227	20-80	170	170	170
Kestrel	**Breeding season 2022**						**170**	**170**	**170**
Kestrel	NB 2022/2023	2	07/10/2022	1	11	30	11	2	2
Kestrel	NB 2022/2023	8	07/10/2022	1	100	30	100	45	45
Kestrel	NB 2022/2023	7	07/10/2022	1	240	15-25	120	102	102
Kestrel	NB 2022/2023	2	04/11/2022	1	10	10-50	10	8	8
Kestrel	**Non-breeding season 2022/2023**						**241**	**157**	**157**
Kestrel	B 2023	1	09.05.2023	1	50	20-50	50	50	50
Kestrel	B 2023	1	13.04.2023	1	35	50-100	35	25	25
Kestrel	B 2023	2	09.05.2023	1	28	20-50	28	28	28
Kestrel	B 2023	2	13.07.2023	1	116	20-50	116	5	5
Kestrel	B 2023	2	13.07.2023	1	209	20-50	209	140	140

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Kestrel	B 2023	6	10.08.2023	1	25	20-50	25	7	7
Kestrel	B 2023	7	13.04.2023	1	40	20-50	40	40	40
Kestrel	B 2023	7	13.04.2023	1	220	20-50	220	220	220
Kestrel	B 2023	7	13.07.2023	1	70	0-50	30	23	23
Kestrel	B 2023	7	13.07.2023	1	280	20-50	280	274	274
Kestrel	B 2023	7	13.07.2023	1	380	0-50	350	336	336
Kestrel	B 2023	8	10.08.2023	1	190	0-50	60	18	18
Kestrel	B 2023	8	13.06.2023	1	432	20-180	432	130	130
Kestrel	B 2023	8	13.07.2023	1	100	20-50	100	84	84
Kestrel	B 2023	8	13.07.2023	1	135	20-50	135	104	104
Kestrel	**Breeding season 2023**						**2110**	**1483**	**1483**
Kestrel	NB 2023/2024	1	19.02.2024	1	135	0-50	115	16	16
Kestrel	NB 2023/2024	2	14.03.2024	1	276	0-50	236	189	189
Kestrel	NB 2023/2024	2	14.03.2024	1	127	0-50	97	87	87
Kestrel	NB 2023/2024	6	11.10.2023	1	20	20-50	20	16	16
Kestrel	NB 2023/2024	6	15.11.2023	1	50	20-50	50	16	16
Kestrel	NB 2023/2024	7	18.03.2024	1	20	20-50	20	20	20
Kestrel	NB 2023/2024	7	18.03.2024	1	145	20-50	145	145	145
Kestrel	NB 2023/2024	7	19.02.2024	1	5	20-50	5	2	2
Kestrel	NB 2023/2024	7	19.02.2024	1	240	20-100	240	240	240
Kestrel	NB 2023/2024	8	15.02.2024	1	127	20-50	127	24	24
Kestrel	NB 2023/2024	8	15.11.2023	1	25	20-50	25	18	18

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Kestrel	**Non-breeding season 2023/2024**						**1080**	**773**	**773**
Kestrel	B 2024	2	08.08.2024	1	360	50-100	360	30	30
Kestrel	B 2024	2	08.08.2024	1	600	20-100	600	144	144
Kestrel	B 2024	8	08.08.2024	1	208	0-50	178	141	141
Kestrel	B 2024	8	08.08.2024	1	212	20-50	212	61	61
Kestrel	B 2024	8	09.07.2024	2	155	20-50	155	34	68
Kestrel	B 2024	8	11.06.2024	1	65	20-50	65	65	65
Kestrel	B 2024	8	11.06.2024	1	45	20-50	45	45	45
Kestrel	**Breeding season 2024**						**1615**	**521**	**555**
Kestrel	**2020-2024**						**6571**	**3541**	**3575**
Lapwing	NB 2022/2023	6	04/11/2022	1	48	30	48	38	38
Lapwing	NB 2022/2023	2	07/12/2022	24	180	0-60	110	88	2112
Lapwing	**Non-breeding season 2022/2023**						**158**	**126**	**2150**
Lapwing	NB 2023/2024	2	10.01.2024	2	56	20-50	56	6	12
Lapwing	NB 2023/2024	2	14.11.2023	24	24	20-50	24	17	403
Lapwing	**Non-breeding season 2023/2024**						**80**	**23**	**416**
Lapwing	**2020-2024**						**238**	**149**	**2566**
Lesser black-backed gull	NB 2020/2021	2	17/02/2021	1	600	80-100	600	150	150
Lesser black-backed gull	**Non-breeding season 2020/2021**						**600**	**150**	**150**
Lesser black-backed gull	B 2021	2	15/09/2021	25	480	80-30	320	320	8000
Lesser black-backed gull	**Breeding season 2021**						**320**	**320**	**8000**
Lesser black-backed gull	NB 2021/2022	1	18/12/2021	21	34	50-100	34	5	105

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Lesser black-backed gull	NB 2021/2022	2	25/02/2022	8	30	50-100	30	29	232
Lesser black-backed gull	**Non-breeding season 2021/2022**						**64**	**34**	**337**
Lesser black-backed gull	NB 2022/2023	7	07/10/2022	1	43	20-40	43	43	43
Lesser black-backed gull	NB 2022/2023	8	07/10/2022	1	190	20-80	140	14	14
Lesser black-backed gull	NB 2022/2023	7	07/10/2022	1	50	30-60	50	50	50
Lesser black-backed gull	NB 2022/2023	6	04/11/2022	2	152	40-50	152	8	16
Lesser black-backed gull	NB 2022/2023	6	04/11/2022	3	76	30-40	76	19	57
Lesser black-backed gull	NB 2022/2023	2	04/11/2022	6	7	50-100	7	3	18
Lesser black-backed gull	NB 2022/2023	6	04/11/2022	2	53	20-25	53	1	2
Lesser black-backed gull	NB 2022/2023	8	17/01/2023	1	65	50-100	65	26	26
Lesser black-backed gull	NB 2022/2023	5	13/02/2023	1	70	100-130	70	18	18
Lesser black-backed gull	**Non-breeding season 2022/2023**						**656**	**182**	**244**
Lesser black-backed gull	B 2023	1	13.06.2023	1	333	50-100	333	167	167
Lesser black-backed gull	B 2023	1	13.06.2023	6	213	20-50	213	138	831
Lesser black-backed gull	B 2023	2	09.05.2023	1	132	50-100	132	74	74
Lesser black-backed gull	B 2023	2	13.06.2023	4	70	0-50	50	35	140
Lesser black-backed gull	B 2023	2	13.06.2023	34	60	0-50	30	23	796
Lesser black-backed gull	B 2023	2	13.07.2023	1	589	0-50	480	132	132
Lesser black-backed gull	B 2023	2	14.09.2023	6	50	100-180	50	4	24
Lesser black-backed gull	B 2023	6	14.09.2023	11	278	20-100	278	147	1621
Lesser black-backed gull	B 2023	6	14.09.2023	7	92	20-50	92	65	457
Lesser black-backed gull	B 2023	6	14.09.2023	3	267	20-50	267	123	368

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Lesser black-backed gull	B 2023	7	14.09.2023	1	38	50-100	38	33	33
Lesser black-backed gull	B 2023	7	14.09.2023	2	52	20-50	52	25	51
Lesser black-backed gull	B 2023	8	09.05.2023	1	146	0-50	20	19	19
Lesser black-backed gull	B 2023	8	14.09.2023	11	170	20-100	170	0	0
Lesser black-backed gull	B 2023	8	14.09.2023	7	130	20-50	130	46	319
Lesser black-backed gull	B 2023	8	14.09.2023	1	18	20-50	18	13	13
Lesser black-backed gull	**Breeding season 2023**						**2353**	**1044**	**5043**
Lesser black-backed gull	NB 2023/2024	2	10.01.2024	8	230	100-180	230	186	1490
Lesser black-backed gull	NB 2023/2024	2	12.12.2023	6	95	50-100	95	52	314
Lesser black-backed gull	NB 2023/2024	2	12.12.2023	28	94	50-100	94	86	2421
Lesser black-backed gull	NB 2023/2024	2	12.12.2023	17	90	50-100	90	90	1530
Lesser black-backed gull	NB 2023/2024	2	12.12.2023	5	222	100-180	222	42	211
Lesser black-backed gull	NB 2023/2024	6	13.12.2023	4	82	100-180	82	18	72
Lesser black-backed gull	NB 2023/2024	6	19.03.2024	4	128	100-180	128	59	236
Lesser black-backed gull	NB 2023/2024	7	18.03.2024	3	95	20-50	95	79	237
Lesser black-backed gull	NB 2023/2024	8	12.12.2023	30	90	20-50	90	35	1053
Lesser black-backed gull	NB 2023/2024	8	12.12.2023	1	30	20-50	30	7	7
Lesser black-backed gull	**Non-breeding season 2023/2024**						**1156**	**655**	**7571**
Lesser black-backed gull	B 2024	1	10.07.2024	2	62	20-100	62	37	74
Lesser black-backed gull	B 2024	2	08.08.2024	5	50	50-100	50	41	203
Lesser black-backed gull	B 2024	6	10.07.2024	1	68	20-50	68	36	36
Lesser black-backed gull	B 2024	7	10.07.2024	1	6	50-100	6	6	6

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Lesser black-backed gull	B 2024	8	06.09.2024	1	168	0-50	108	43	43
Lesser black-backed gull	B 2024	8	08.08.2024	6	82	20-50	82	9	54
Lesser black-backed gull	**Breeding season 2024**						**376**	**172**	**416**
Lesser black-backed gull	**2020-2024**						**5525**	**2558**	**21761**
Mallard	B 2021	2	09/06/2021	2	35	60	35	18	36
Mallard	B 2021	2	21/07/2021	3	24	50	24	24	72
Mallard	B 2021	2	20/09/2021	4	38	80	38	19	76
Mallard	**Breeding season 2021**						**97**	**61**	**184**
Mallard	B 2022	2	20/04/2022	1	40	25-30	40	24	24
Mallard	B 2022	2	20/04/2022	3	120	40	120	114	342
Mallard	B 2022	2	20/04/2022	1	20	35	20	16	16
Mallard	B 2022	2	20/04/2022	3	50	35	50	43	129
Mallard	B 2022	2	20/04/2022	3	60	30	60	48	144
Mallard	B 2022	2	20/04/2022	1	60	25-30	60	42	42
Mallard	B 2022	2	23/09/2022	3	64	10-30	64	26	78
Mallard	**Breeding season 2022**						**414**	**313**	**775**
Mallard	NB 2022/2023	2	17/01/2023	2	47	0-80	32	24	48
Mallard	**Non-breeding season 2022/2023**						**32**	**24**	**48**
Mallard	B 2023	1	13.04.2023	1	19	0-50	15	14	14
Mallard	B 2023	1	13.06.2023	2	117	20-50	117	117	234
Mallard	B 2023	2	09.05.2023	1	25	20-50	25	0	0
Mallard	B 2023	2	10.08.2023	1	58	50-100	58	4	4

RSK biocensus
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Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	**Season**	**VP**	**Date**	**No. birds**	**Total flight time**	**Flight height**	**Flight time at risk height**	**Flight time in vW**	**Bird flight seconds in vW**
Mallard	B 2023	2	13.07.2023	1	90	20-50	90	68	68
Mallard	B 2023	6	09.05.2023	3	3	20-50	3	1	4
Mallard	B 2023	6	13.04.2023	1	93	20-50	93	3	3
Mallard	B 2023	7	13.04.2023	7	30	20-50	30	22	153
Mallard	B 2023	7	13.07.2023	1	55	20-50	55	50	50
Mallard	B 2023	8	10.08.2023	1	40	0-50	30	20	20
Mallard	B 2023	8	13.04.2023	1	40	20-100	40	8	8
Mallard	B 2023	8	13.07.2023	1	40	20-50	40	24	24
Mallard	B 2023	8	13.07.2023	1	70	20-50	70	69	69
Mallard	B 2023	8	13.07.2023	1	40	20-50	40	34	34
Mallard	B 2023	8	13.07.2023	1	20	20-50	20	16	16
Mallard	B 2023	8	14.09.2023	1	10	20-50	10	5	5
Mallard	B 2023	8	14.09.2023	2	40	20-50	40	21	42
Mallard	**Breeding season 2023**						**776**	**476**	**749**
Mallard	NB 2023/2024	2	11.10.2023	4	6	50-100	6	5	19
Mallard	NB 2023/2024	2	11.10.2023	5	9	50-100	9	3	14
Mallard	NB 2023/2024	2	12.12.2023	2	62	0-50	32	20	39
Mallard	NB 2023/2024	7	13.12.2023	2	20	20-50	20	10	20
Mallard	NB 2023/2024	7	18.03.2024	3	40	20-50	40	40	120
Mallard	NB 2023/2024	8	12.12.2023	9	40	20-50	40	26	230
Mallard	NB 2023/2024	8	12.12.2023	3	30	20-50	30	24	71
Mallard	NB 2023/2024	8	12.12.2023	2	15	20-50	15	8	15

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	**Season**	**VP**	**Date**	**No. birds**	**Total flight time**	**Flight height**	**Flight time at risk height**	**Flight time in vW**	**Bird flight seconds in vW**
Mallard	NB 2023/2024	8	15.11.2023	2	35	0-50	15	8	15
Mallard	NB 2023/2024	8	15.11.2023	7	20	0-50	5	4	27
Mallard	**Non-breeding season 2023/2024**						**212**	**145**	**571**
Mallard	B 2024	6	12.06.2024	2	54	100-180	54	25	51
Mallard	B 2024	7	10.07.2024	2	10	20-50	10	8	16
Mallard	B 2024	8	08.04.2024	6	68	20-50	68	7	41
Mallard	B 2024	8	09.05.2024	1	36	20-50	36	11	11
Mallard	B 2024	8	09.05.2024	3	100	20-50	100	60	180
Mallard	**Breeding season 2024**						**268**	**111**	**298**
Mallard	**2020-2024**						**1799**	**1131**	**2624**
Peregrine	NB 2022/2023	8	07/10/2022	1	30	20	30	30	30
Peregrine	NB 2022/2023	7	07/10/2022	1	180	20-60	180	18	18
Peregrine	NB 2022/2023	8	07/12/2022	1	85	20-50	85	9	9
Peregrine	**Non-breeding season 2022/2023**						**295**	**57**	**57**
Peregrine	B 2023	8	09.05.2023	1	104	20-50	104	27	27
Peregrine	**Breeding season 2023**						**104**	**27**	**27**
Peregrine	NB 2023/2024	8	10.01.2024	2	45	20-50	45	45	90
Peregrine	**Non-breeding season 2023 - 2024**						**45**	**45**	**90**
Peregrine	**2020-2024**						**444**	**129**	**174**
Snipe	B 2021	2	20/09/2021	10	420	50-100	420	315	3150
Snipe	**Breeding season 2021**						**420**	**315**	**3150**
Snipe	B 2022	2	23/09/2022	29	90	30	90	59	1711

Flight activity by Key Ornithological Features within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Snipe	**Breeding season 2022**						**90**	**59**	**1711**
Snipe	NB 2022/2023	8	07/12/2022	1	62	20-50	62	62	62
Snipe	**Non-breeding season 2022/2023**						**62**	**62**	**62**
Snipe	B 2023	8	14.09.2023	13	40	20-50	40	39	510
Snipe	**Breeding season 2023**						**40**	**39**	**510**
Snipe	B 2024	8	06.09.2024	1	46	50-100	46	34	34
Snipe	**Breeding season 2024**						**46**	**34**	**34**
Snipe	**2020-2024**						**612**	**475**	**5433**
Wigeon	NB 2023/2024	8	12.12.2023	4	30	20-50	30	3	12
Wigeon	NB 2023/2024	8	12.12.2023	18	40	20-50	40	26	461
Wigeon	NB 2023/2024	8	12.12.2023	300	130	50-100	130	39	11700
Wigeon	NB 2023/2024	8	14.03.2024	65	760	50-100	760	68	4446
Wigeon	**Non-breeding season 2023/2024**						**960**	**136**	**16619**
Wigeon	**2020-2024**						**960**	**136**	**16619**

ANNEX B – COLLISION PROBABILITY CALCULATIONS

Black-headed gull

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

Calculation of alpha and p(collision) as a function of radius

Parameter	Value	Unit	r/R radius	c/C chord	α alpha	Upwind: collide length	Upwind: p(collision)	Upwind: contribution from radius r	Downwind: collide length	Downwind: p(collision)	Downwind: contribution from radius r
K: [1D or [3D] (0 or 1)	1										
NoBlades	3										
MaxChord	4.2	m									
Pitch (degrees)	6										
BirdLength	0.38	m	0.025	0.575	4.81	16.61	0.88	0.00110	16.10	0.85	0.00107
Wingspan	1	m	0.075	0.575	1.60	5.70	0.30	0.00227	5.20	0.28	0.00207
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.96	4.09	0.22	0.00271	3.47	0.18	0.00230
			0.175	0.860	0.69	3.53	0.19	0.00327	2.78	0.15	0.00257
Bird speed	11.9	m/sec	0.225	0.994	0.53	3.19	0.17	0.00380	2.32	0.12	0.00276
RotorDiam	150	m	0.275	0.947	0.44	2.58	0.14	0.00376	1.75	0.09	0.00255
RotationPeriod	4.76	sec	0.325	0.899	0.37	2.16	0.11	0.00372	1.37	0.07	0.00237
			0.375	0.851	0.32	1.89	0.10	0.00376	1.15	0.06	0.00228
			0.425	0.804	0.28	1.68	0.09	0.00379	0.98	0.05	0.00220
			0.475	0.756	0.25	1.51	0.08	0.00380	0.85	0.04	0.00213
Bird aspect ratio: β	0.38		0.525	0.708	0.23	1.37	0.07	0.00380	0.75	0.04	0.00208
			0.575	0.660	0.21	1.25	0.07	0.00380	0.67	0.04	0.00203
			0.625	0.613	0.19	1.14	0.06	0.00378	0.60	0.03	0.00200
			0.675	0.565	0.18	1.05	0.06	0.00375	0.55	0.03	0.00197
			0.725	0.517	0.17	0.97	0.05	0.00371	0.51	0.03	0.00196
			0.775	0.470	0.16	0.89	0.05	0.00365	0.48	0.03	0.00196
			0.825	0.422	0.15	0.82	0.04	0.00359	0.45	0.02	0.00197
			0.875	0.374	0.14	0.76	0.04	0.00352	0.43	0.02	0.00199

0.925	0.327	0.13	0.70	0.04	0.00343	0.41	0.02	0.00203
0.975	0.279	0.12	0.65	0.03	0.00334	0.40	0.02	0.00207
	Overall p(collision) =			**Upwind**	**6.8%**		**Downwind**	**4.2%**
					Average	**5.5%**		

Buzzard

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.2	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.54	m	0.025	0.575	3.82	12.34	0.82	0.00103	11.83	0.79	0.00099
Wingspan	1.2	m	0.075	0.575	1.27	4.28	0.29	0.00214	3.78	0.25	0.00189
F: Flapping (0) or gliding (+1)	1		0.125	0.702	0.76	3.13	0.21	0.00261	2.51	0.17	0.00209
			0.175	0.860	0.55	2.75	0.18	0.00321	2.00	0.13	0.00233
Bird speed	9.45	m/sec	0.225	0.994	0.42	2.74	0.18	0.00411	1.87	0.12	0.00280
RotorDiam	150	m	0.275	0.947	0.35	2.33	0.16	0.00427	1.50	0.10	0.00275
RotationPeriod	4.76	sec	0.325	0.899	0.29	2.04	0.14	0.00442	1.25	0.08	0.00271
			0.375	0.851	0.25	1.82	0.12	0.00455	1.07	0.07	0.00268
			0.425	0.804	0.22	1.65	0.11	0.00467	0.94	0.06	0.00267
			0.475	0.756	0.20	1.51	0.10	0.00477	0.84	0.06	0.00267
Bird aspect ratio: β	0.45		0.525	0.708	0.18	1.39	0.09	0.00486	0.77	0.05	0.00269
			0.575	0.660	0.17	1.29	0.09	0.00494	0.71	0.05	0.00272
			0.625	0.613	0.15	1.20	0.08	0.00500	0.66	0.04	0.00276
			0.675	0.565	0.14	1.12	0.07	0.00505	0.63	0.04	0.00282

0.725	0.517	0.13	1.05	0.07	0.00508	0.60	0.04	0.00289
0.775	0.470	0.12	0.99	0.07	0.00511	0.58	0.04	0.00297
0.825	0.422	0.12	0.93	0.06	0.00511	0.56	0.04	0.00307
0.875	0.374	0.11	0.87	0.06	0.00511	0.55	0.04	0.00319
0.925	0.327	0.10	0.82	0.05	0.00508	0.54	0.04	0.00335
0.975	0.279	0.10	0.78	0.05	0.00505	0.55	0.04	0.00357

Overall p(collision) = **Upwind** **8.6%** **Downwind** **5.4%**

Average **7.0%**

Cormorant

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.85	m
Wingspan	1.35	m
F: Flapping (0) or gliding (+1)	1	
Bird speed	15.2	m/sec
RotorDiam	150	m
RotationPeriod	4.76	sec

Calculation of alpha and p(collision) as a function of radius

			Upwind:			Downwind:		
r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	6.14	20.28	0.84	0.00105	19.78	0.82	0.00102
0.075	0.575	2.05	6.93	0.29	0.00215	6.42	0.27	0.00200
0.125	0.702	1.23	4.96	0.21	0.00257	4.35	0.18	0.00225
0.175	0.860	0.88	4.28	0.18	0.00311	3.53	0.15	0.00256
0.225	0.994	0.68	3.86	0.16	0.00360	2.98	0.12	0.00278
0.275	0.947	0.56	3.47	0.14	0.00396	2.64	0.11	0.00301
0.325	0.899	0.47	3.02	0.13	0.00407	2.23	0.09	0.00300
0.375	0.851	0.41	2.68	0.11	0.00417	1.93	0.08	0.00300
0.425	0.804	0.36	2.42	0.10	0.00426	1.71	0.07	0.00301
0.475	0.756	0.32	2.20	0.09	0.00434	1.54	0.06	0.00303

Bird aspect ratio: β	0.63		0.525	0.708	0.29	2.03	0.08	0.00441	1.40	0.06	0.00306
			0.575	0.660	0.27	1.88	0.08	0.00447	1.30	0.05	0.00309
			0.625	0.613	0.25	1.75	0.07	0.00453	1.21	0.05	0.00314
			0.675	0.565	0.23	1.63	0.07	0.00458	1.14	0.05	0.00319
			0.725	0.517	0.21	1.53	0.06	0.00461	1.08	0.04	0.00325
			0.775	0.470	0.20	1.44	0.06	0.00464	1.03	0.04	0.00332
			0.825	0.422	0.19	1.36	0.06	0.00466	0.99	0.04	0.00340
			0.875	0.374	0.18	1.29	0.05	0.00468	0.96	0.04	0.00348
			0.925	0.327	0.17	1.22	0.05	0.00468	0.93	0.04	0.00358
			0.975	0.279	0.16	1.16	0.05	0.00467	0.91	0.04	0.00368
				Overall p(collision) =			**Upwind**	**7.9%**		**Downwind**	**5.9%**
								Average	**6.9%**		

Golden plover

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.2	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.27	m	0.025	0.575	7.23	21.67	0.76	0.00095	21.17	0.75	0.00093
Wingspan	0.56	m	0.075	0.575	2.41	7.39	0.26	0.00195	6.89	0.24	0.00182
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.45	5.36	0.19	0.00236	4.74	0.17	0.00209
			0.175	0.860	1.03	4.67	0.16	0.00288	3.91	0.14	0.00241
Bird speed	17.9	m/sec	0.225	0.994	0.80	4.22	0.15	0.00335	3.35	0.12	0.00265
RotorDiam	150	m	0.275	0.947	0.66	3.38	0.12	0.00328	2.55	0.09	0.00247

RotationPeriod	4.76	sec	0.325	0.899	0.56	2.80	0.10	0.00320	2.01	0.07	0.00230
			0.375	0.851	0.48	2.36	0.08	0.00311	1.61	0.06	0.00213
			0.425	0.804	0.43	2.05	0.07	0.00307	1.35	0.05	0.00201
			0.475	0.756	0.38	1.80	0.06	0.00302	1.14	0.04	0.00191
Bird aspect ratio: β	0.48		0.525	0.708	0.34	1.60	0.06	0.00296	0.98	0.03	0.00181
			0.575	0.660	0.31	1.43	0.05	0.00289	0.85	0.03	0.00172
			0.625	0.613	0.29	1.28	0.05	0.00282	0.74	0.03	0.00163
			0.675	0.565	0.27	1.15	0.04	0.00273	0.65	0.02	0.00155
			0.725	0.517	0.25	1.04	0.04	0.00264	0.58	0.02	0.00149
			0.775	0.470	0.23	0.93	0.03	0.00255	0.52	0.02	0.00142
			0.825	0.422	0.22	0.84	0.03	0.00244	0.47	0.02	0.00137
			0.875	0.374	0.21	0.76	0.03	0.00233	0.43	0.02	0.00132
			0.925	0.327	0.20	0.68	0.02	0.00221	0.39	0.01	0.00128
			0.975	0.279	0.19	0.61	0.02	0.00209	0.36	0.01	0.00125
				Overall p(collision) =			**Upwind**	**5.3%**		**Downwind**	**3.6%**
								Average	**4.4%**		

Kestrel

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.2	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.34	m	0.025	0.575	4.02	12.96	0.82	0.00103	12.46	0.79	0.00099
Wingspan	0.76	m	0.075	0.575	1.34	4.49	0.28	0.00213	3.98	0.25	0.00189
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.80	3.28	0.21	0.00259	2.66	0.17	0.00211

			0.175	0.860	0.57	2.88	0.18	0.00319	2.12	0.13	0.00235
Bird speed	9.95	m/sec	0.225	0.994	0.45	2.63	0.17	0.00375	1.76	0.11	0.00251
RotorDiam	150	m	0.275	0.947	0.37	2.20	0.14	0.00383	1.37	0.09	0.00239
RotationPeriod	4.76	sec	0.325	0.899	0.31	1.90	0.12	0.00390	1.11	0.07	0.00228
			0.375	0.851	0.27	1.67	0.11	0.00396	0.92	0.06	0.00218
			0.425	0.804	0.24	1.49	0.09	0.00400	0.78	0.05	0.00210
			0.475	0.756	0.21	1.34	0.08	0.00403	0.68	0.04	0.00203
Bird aspect ratio: β	0.45		0.525	0.708	0.19	1.22	0.08	0.00405	0.60	0.04	0.00198
			0.575	0.660	0.17	1.11	0.07	0.00405	0.53	0.03	0.00194
			0.625	0.613	0.16	1.02	0.06	0.00404	0.48	0.03	0.00191
			0.675	0.565	0.15	0.94	0.06	0.00402	0.44	0.03	0.00190
			0.725	0.517	0.14	0.87	0.05	0.00398	0.41	0.03	0.00189
			0.775	0.470	0.13	0.80	0.05	0.00393	0.39	0.02	0.00191
			0.825	0.422	0.12	0.74	0.05	0.00387	0.37	0.02	0.00193
			0.875	0.374	0.11	0.68	0.04	0.00379	0.36	0.02	0.00197
			0.925	0.327	0.11	0.63	0.04	0.00370	0.34	0.02	0.00202
			0.975	0.279	0.10	0.58	0.04	0.00360	0.34	0.02	0.00211
				Overall p(collision) =			**Upwind**	**7.1%**		**Downwind**	**4.0%**
								Average	**5.6%**		

Lapwing

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.2	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r

BirdLength	0.3	m	0.025	0.575	4.97	15.67	0.80	0.00100	15.16	0.78	0.00097
Wingspan	0.7	m	0.075	0.575	1.66	5.39	0.28	0.00207	4.89	0.25	0.00188
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.99	3.92	0.20	0.00251	3.30	0.17	0.00211
			0.175	0.860	0.71	3.43	0.18	0.00307	2.67	0.14	0.00239
Bird speed	12.3	m/sec	0.225	0.994	0.55	3.12	0.16	0.00359	2.24	0.11	0.00259
RotorDiam	150	m	0.275	0.947	0.45	2.52	0.13	0.00355	1.69	0.09	0.00238
RotationPeriod	4.76	sec	0.325	0.899	0.38	2.13	0.11	0.00355	1.34	0.07	0.00223
			0.375	0.851	0.33	1.85	0.09	0.00356	1.10	0.06	0.00212
			0.425	0.804	0.29	1.63	0.08	0.00356	0.93	0.05	0.00202
			0.475	0.756	0.26	1.46	0.07	0.00355	0.79	0.04	0.00193
Bird aspect ratio: β	0.43		0.525	0.708	0.24	1.31	0.07	0.00353	0.69	0.04	0.00185
			0.575	0.660	0.22	1.19	0.06	0.00349	0.61	0.03	0.00179
			0.625	0.613	0.20	1.08	0.06	0.00345	0.54	0.03	0.00173
			0.675	0.565	0.18	0.98	0.05	0.00340	0.49	0.02	0.00168
			0.725	0.517	0.17	0.90	0.05	0.00333	0.44	0.02	0.00165
			0.775	0.470	0.16	0.82	0.04	0.00326	0.41	0.02	0.00162
			0.825	0.422	0.15	0.75	0.04	0.00317	0.38	0.02	0.00161
			0.875	0.374	0.14	0.69	0.04	0.00308	0.36	0.02	0.00160
			0.925	0.327	0.13	0.63	0.03	0.00297	0.34	0.02	0.00161
			0.975	0.279	0.13	0.57	0.03	0.00285	0.33	0.02	0.00163
				Overall p(collision) =			**Upwind**	**6.3%**		**Downwind**	**3.7%**
								Average	**5.0%**		

Lesser black-backed gull

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1) 1 **Calculation of alpha and p(collision) as a function of radius**

NoBlades 3 Upwind: Downwind:

			r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
MaxChord	4.2	m									
Pitch (degrees)	6										
BirdLength	0.52	m	0.025	0.575	5.01	16.30	0.83	0.00104	15.80	0.80	0.00100
Wingspan	1.26	m	0.075	0.575	1.67	5.60	0.28	0.00214	5.10	0.26	0.00194
F: Flapping (0) or gliding (+1)	1		0.125	0.702	1.00	4.05	0.21	0.00257	3.43	0.17	0.00218
			0.175	0.860	0.72	3.52	0.18	0.00313	2.77	0.14	0.00246
Bird speed	12.4	m/sec	0.225	0.994	0.56	3.20	0.16	0.00365	2.32	0.12	0.00266
RotorDiam	150	m	0.275	0.947	0.46	2.58	0.13	0.00361	1.75	0.09	0.00245
RotationPeriod	4.76	sec	0.325	0.899	0.39	2.36	0.12	0.00390	1.57	0.08	0.00260
			0.375	0.851	0.33	2.08	0.11	0.00397	1.33	0.07	0.00254
			0.425	0.804	0.29	1.86	0.09	0.00402	1.16	0.06	0.00250
			0.475	0.756	0.26	1.68	0.09	0.00407	1.02	0.05	0.00246
Bird aspect ratio: β	0.41		0.525	0.708	0.24	1.54	0.08	0.00410	0.91	0.05	0.00244
			0.575	0.660	0.22	1.41	0.07	0.00412	0.83	0.04	0.00243
			0.625	0.613	0.20	1.30	0.07	0.00414	0.76	0.04	0.00243
			0.675	0.565	0.19	1.21	0.06	0.00414	0.71	0.04	0.00244
			0.725	0.517	0.17	1.12	0.06	0.00413	0.67	0.03	0.00245
			0.775	0.470	0.16	1.04	0.05	0.00411	0.63	0.03	0.00249
			0.825	0.422	0.15	0.97	0.05	0.00408	0.60	0.03	0.00253
			0.875	0.374	0.14	0.91	0.05	0.00404	0.58	0.03	0.00258
			0.925	0.327	0.14	0.85	0.04	0.00399	0.56	0.03	0.00264
			0.975	0.279	0.13	0.79	0.04	0.00393	0.55	0.03	0.00271
				Overall p(collision) =			**Upwind**	**7.3%**		**Downwind**	**4.8%**
								Average	**6.0%**		

Mallard

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

W Band 24/10/2024

Calculation of alpha and p(collision) as a function of radius

						Upwind:			Downwind:		
K: [1D or [3D] (0 or 1)	1										
NoBlades	3										
MaxChord	4.1	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.42	m	0.025	0.575	8.03	27.27	0.95	0.00119	26.78	0.94	0.00117
Wingspan	1.02	m	0.075	0.575	2.68	9.26	0.32	0.00243	8.76	0.31	0.00230
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.61	6.53	0.23	0.00286	5.93	0.21	0.00259
			0.175	0.860	1.15	5.56	0.19	0.00340	4.83	0.17	0.00295
Bird speed	20	m/sec	0.225	0.994	0.89	4.96	0.17	0.00390	4.10	0.14	0.00323
RotorDiam	136	m	0.275	0.947	0.73	3.97	0.14	0.00382	3.16	0.11	0.00304
RotationPeriod	4.29	sec	0.325	0.899	0.62	3.28	0.11	0.00373	2.51	0.09	0.00285
			0.375	0.851	0.54	2.77	0.10	0.00363	2.04	0.07	0.00268
			0.425	0.804	0.47	2.37	0.08	0.00353	1.69	0.06	0.00251
			0.475	0.756	0.42	2.06	0.07	0.00342	1.41	0.05	0.00234
Bird aspect ratioo: β	0.41		0.525	0.708	0.38	1.83	0.06	0.00336	1.22	0.04	0.00224
			0.575	0.660	0.35	1.64	0.06	0.00330	1.08	0.04	0.00217
			0.625	0.613	0.32	1.49	0.05	0.00325	0.96	0.03	0.00210
			0.675	0.565	0.30	1.35	0.05	0.00318	0.86	0.03	0.00204
			0.725	0.517	0.28	1.23	0.04	0.00311	0.78	0.03	0.00198
			0.775	0.470	0.26	1.12	0.04	0.00303	0.71	0.02	0.00194
			0.825	0.422	0.24	1.02	0.04	0.00294	0.66	0.02	0.00190
			0.875	0.374	0.23	0.93	0.03	0.00285	0.61	0.02	0.00187
			0.925	0.327	0.22	0.85	0.03	0.00275	0.57	0.02	0.00184
			0.975	0.279	0.21	0.77	0.03	0.00264	0.53	0.02	0.00182
				Overall p(collision) =			**Upwind**	**6.2%**		**Downwind**	**4.6%**

		Average	5.4%

Peregrine

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**										
NoBlades	3						Upwind:			Downwind:			
MaxChord	4.2	m	r/R	c/C	α	collide		contribution	collide		contribution		
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r		
BirdLength	0.42	m	0.025	0.575	4.89	16.98	0.88	0.00111	16.48	0.86	0.00107		
Wingspan	1.02	m	0.075	0.575	1.63	5.83	0.30	0.00228	5.32	0.28	0.00208		
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.98	4.17	0.22	0.00272	3.55	0.19	0.00231		
			0.175	0.860	0.70	3.60	0.19	0.00328	2.84	0.15	0.00259		
Bird speed	12.1	m/sec	0.225	0.994	0.54	3.25	0.17	0.00381	2.37	0.12	0.00278		
RotorDiam	150	m	0.275	0.947	0.44	2.63	0.14	0.00376	1.80	0.09	0.00257		
RotationPeriod	4.76	sec	0.325	0.899	0.38	2.23	0.12	0.00377	1.44	0.07	0.00243		
			0.375	0.851	0.33	1.95	0.10	0.00381	1.21	0.06	0.00235		
			0.425	0.804	0.29	1.74	0.09	0.00385	1.03	0.05	0.00229		
			0.475	0.756	0.26	1.56	0.08	0.00387	0.90	0.05	0.00223		
Bird aspect ratio: β	0.41		0.525	0.708	0.23	1.42	0.07	0.00388	0.80	0.04	0.00218		
			0.575	0.660	0.21	1.30	0.07	0.00388	0.72	0.04	0.00215		
			0.625	0.613	0.20	1.19	0.06	0.00387	0.65	0.03	0.00212		
			0.675	0.565	0.18	1.10	0.06	0.00385	0.60	0.03	0.00211		
			0.725	0.517	0.17	1.01	0.05	0.00382	0.56	0.03	0.00210		
			0.775	0.470	0.16	0.94	0.05	0.00378	0.52	0.03	0.00211		
			0.825	0.422	0.15	0.87	0.05	0.00372	0.50	0.03	0.00213		
			0.875	0.374	0.14	0.80	0.04	0.00366	0.47	0.02	0.00216		

0.925	0.327	0.13	0.74	0.04	0.00358	0.46	0.02	0.00220
0.975	0.279	0.13	0.69	0.04	0.00350	0.44	0.02	0.00225

Overall p(collision) = **Upwind** **7.0%** **Downwind** **4.4%**

Average **5.7%**

Snipe

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.26	m
Wingspan	0.42	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	16.2	m/sec
RotorDiam	150	m
RotationPeriod	4.76	sec
Bird aspect ratio: β	0.62	

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	α alpha	Upwind: collide length	Upwind: p(collision)	Upwind: contribution from radius r	Downwind: collide length	Downwind: p(collision)	Downwind: contribution from radius r
0.025	0.575	6.55	18.72	0.73	0.00091	18.22	0.71	0.00089
0.075	0.575	2.18	6.41	0.25	0.00187	5.90	0.23	0.00172
0.125	0.702	1.31	4.69	0.18	0.00228	4.08	0.16	0.00198
0.175	0.860	0.94	4.13	0.16	0.00281	3.37	0.13	0.00230
0.225	0.994	0.73	3.76	0.15	0.00329	2.89	0.11	0.00253
0.275	0.947	0.60	3.03	0.12	0.00324	2.20	0.09	0.00235
0.325	0.899	0.50	2.55	0.10	0.00322	1.76	0.07	0.00222
0.375	0.851	0.44	2.19	0.09	0.00319	1.44	0.06	0.00210
0.425	0.804	0.39	1.91	0.07	0.00315	1.20	0.05	0.00198
0.475	0.756	0.34	1.68	0.07	0.00310	1.02	0.04	0.00188
0.525	0.708	0.31	1.49	0.06	0.00305	0.87	0.03	0.00178
0.575	0.660	0.28	1.34	0.05	0.00299	0.76	0.03	0.00169
0.625	0.613	0.26	1.20	0.05	0.00292	0.66	0.03	0.00161
0.675	0.565	0.24	1.08	0.04	0.00284	0.58	0.02	0.00153
0.725	0.517	0.23	0.97	0.04	0.00275	0.52	0.02	0.00147

0.775	0.470	0.21	0.88	0.03	0.00265	0.47	0.02	0.00141
0.825	0.422	0.20	0.79	0.03	0.00255	0.42	0.02	0.00136
0.875	0.374	0.19	0.72	0.03	0.00244	0.39	0.02	0.00132
0.925	0.327	0.18	0.64	0.03	0.00232	0.36	0.01	0.00129
0.975	0.279	0.17	0.58	0.02	0.00219	0.33	0.01	0.00126

Overall p(collision) = **Upwind** **5.4%** **Downwind** **3.5%**

Average **4.4%**

Wigeon

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

W Band 24/10/2024

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.2	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.48	m	0.025	0.575	8.32	26.90	0.82	0.00103	26.40	0.81	0.00101
Wingspan	0.8	m	0.075	0.575	2.77	9.14	0.28	0.00210	8.63	0.26	0.00198
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.66	6.52	0.20	0.00249	5.90	0.18	0.00226
			0.175	0.860	1.19	5.60	0.17	0.00300	4.85	0.15	0.00259
Bird speed	20.6	m/sec	0.225	0.994	0.92	5.02	0.15	0.00345	4.14	0.13	0.00285
RotorDiam	150	m	0.275	0.947	0.76	4.01	0.12	0.00338	3.18	0.10	0.00268
RotationPeriod	4.76	sec	0.325	0.899	0.64	3.31	0.10	0.00329	2.52	0.08	0.00251
			0.375	0.851	0.55	2.83	0.09	0.00324	2.08	0.06	0.00239
			0.425	0.804	0.49	2.48	0.08	0.00322	1.77	0.05	0.00230
			0.475	0.756	0.44	2.19	0.07	0.00319	1.53	0.05	0.00223

Bird aspect ratioo: β	0.60	0.525	0.708	0.40	1.96	0.06	0.00315	1.34	0.04	0.00215
		0.575	0.660	0.36	1.77	0.05	0.00311	1.19	0.04	0.00209
		0.625	0.613	0.33	1.60	0.05	0.00306	1.06	0.03	0.00203
		0.675	0.565	0.31	1.46	0.04	0.00301	0.96	0.03	0.00198
		0.725	0.517	0.29	1.33	0.04	0.00294	0.87	0.03	0.00194
		0.775	0.470	0.27	1.21	0.04	0.00288	0.80	0.02	0.00190
		0.825	0.422	0.25	1.11	0.03	0.00280	0.74	0.02	0.00187
		0.875	0.374	0.24	1.02	0.03	0.00272	0.69	0.02	0.00184
		0.925	0.327	0.22	0.93	0.03	0.00263	0.64	0.02	0.00182
		0.975	0.279	0.21	0.85	0.03	0.00254	0.61	0.02	0.00181
				Overall p(collision) =		**Upwind**	**5.7%**		**Downwind**	**4.2%**
							Average	**5.0%**		

ANNEX C – COLLISION RISK MODELLING ANALYSIS

Black-headed gull

Airspace model

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.38
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	734,442.10
(Vr) as % of (Vw) (%)	0.398895%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	717.00
Bird flight seconds within (Vw)	5,516
Average Day length (over period)	11.89
Season days	730
Bird speed (m/sec)	13.7
Probability of collision (p) [model]	5.5%
Flight Seconds/survey hour (bird secs)	7.69317
Flight Seconds/season day (bird secs)	91.47174
Flight Seconds/season (bird secs)	66774.37266
n x (Vr/Vw)	266.35973
Bird transit time through turbine (t)	0.33708
No. of transits through rotor swept vol	790.19668
No. of birds hit by blades/survey period	43.46082
No. of birds hit by blades/year	10.86520

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.86921635
No. of birds hit by blades/survey year	0.217304087
No of birds hit by blades/35 yrs	7.606

Flythrough model

Period modelled: Non-breeding season

Year modelled: 2022-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	Non-breeding season 2022/23	Non-breeding season 2023/24
Number of turbines	9	9
Length of risk window inc. buffer (m)	900.00	900.00
Turbine height (m)	170.00	170.00
Rotor swept area (RSA) (m^2)	17,671.00	17,671.00
Area of the risk window (m2) [W]	153,000.00	153,000.00
Rotor swept area (m2) [A]	159,039.00	159,039.00
(Vr) as % of (Vw) (%)	103.95%	103.95%

STAGE 2 (Birds flying through turbine area)

Detail	Non-breeding season 2022/23	Non-breeding season 2023/24
Birds within the turbine footprint	**21**	**77**
Survey hours	216.00	216.00
Average Day length (over period)	11.89	11.89
Season days	182	182
Probability of collision (p) [model]	5.5%	5.5%
Bird flights within the rotor swept area: n x (A/W)	21.83	80.04
Bird flights/hour	0.10	0.37
Bird flights/day	1.20	4.41
Bird flights/survey period	218.69	801.87
No. of birds hit by blades	12.03	44.10

STAGE 3 (Avoidance)

Detail	Non-breeding season 2022/23	Non-breeding season 2023/24
Avoidance rate (SNH 2018)	98.0%	98.0%

No. of birds hit by blades/season	0.240560145	0.882053865
Estimated casualties over 35 yrs	8.420	30.872

Buzzard

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.54
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	759,888.34
(Vr) as % of (Vw) (%)	0.412716%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	4094
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	9.45
Probability of collision (p) [model]	7.0%
Flight Seconds/survey hour (bird secs)	2.89738
Flight Seconds/season day (bird secs)	34.44987
Flight Seconds/season (bird secs)	50296.80368
n x (Vr/Vw)	207.58279
Bird transit time through turbine (t)	0.50561
No. of transits through rotor swept vol	410.56036
No. of birds hit by blades/survey period	28.73923
No. of birds hit by blades/year	7.18481

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.574784501
No. of birds hit by blades/survey year	0.143696125
No of birds hit by blades/35 yrs	5.029

Cormorant

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.85
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	809,190.43
(Vr) as % of (Vw) (%)	0.439493%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	4482
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	15.2
Probability of collision (p) [model]	6.9%
Flight Seconds/survey hour (bird secs)	3.17197
Flight Seconds/season day (bird secs)	37.71478
Flight Seconds/season (bird secs)	55063.57452
n x (Vr/Vw)	242.00053
Bird transit time through turbine (t)	0.33474
No. of transits through rotor swept vol	722.95756
No. of birds hit by blades/survey period	49.88407
No. of birds hit by blades/year	12.47102

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.997681439
No. of birds hit by blades/survey year	0.24942036
No of birds hit by blades/35 yrs	8.730

Golden plover

Period modelled: Survey duration
Year modelled: 2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.27
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	716,947.81
(Vr) as % of (Vw) (%)	0.389394%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	717.00
Bird flight seconds within (Vw)	9,700
Average Day length (over period)	11.89
Season days	730
Bird speed (m/sec)	17.9
Probability of collision (p) [model]	4.4%
Flight Seconds/survey hour (bird secs)	13.52859
Flight Seconds/season day (bird secs)	160.85495
Flight Seconds/season (bird secs)	117424.11437
n x (Vr/Vw)	457.24190
Bird transit time through turbine (t)	0.25184
No. of transits through rotor swept vol	1815.57896
No. of birds hit by blades/survey period	79.88547
No. of birds hit by blades/year	19.97137

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	1.597709488
No. of birds hit by blades/survey year	0.399427372
No of birds hit by blades/35 yrs	13.980

Kestrel

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.34
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	728,080.54
(Vr) as % of (Vw) (%)	0.395440%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	3575
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	9.95
Probability of collision (p) [model]	5.6%
Flight Seconds/survey hour (bird secs)	2.53008
Flight Seconds/season day (bird secs)	30.08263
Flight Seconds/season (bird secs)	43920.63340
n x (Vr/Vw)	173.67976
Bird transit time through turbine (t)	0.46010
No. of transits through rotor swept vol	377.48221
No. of birds hit by blades/survey period	21.13900
No. of birds hit by blades/year	5.28475

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	95.0%
No. of birds hit by blades/survey period	1.056950198
No. of birds hit by blades/survey year	0.26423755
No of birds hit by blades/35 yrs	9.248

Lapwing

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.30
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	721,718.98
(Vr) as % of (Vw) (%)	0.391985%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	2566
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	12.3
Probability of collision (p) [model]	5.0%
Flight Seconds/survey hour (bird secs)	1.81599
Flight Seconds/season day (bird secs)	21.59217
Flight Seconds/season (bird secs)	31524.57212
n x (Vr/Vw)	123.57155
Bird transit time through turbine (t)	0.36894
No. of transits through rotor swept vol	334.93392
No. of birds hit by blades/survey period	16.74670
No. of birds hit by blades/year	4.18667

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.334933918
No. of birds hit by blades/survey year	0.083733479
No of birds hit by blades/35 yrs	2.931

Lesser black-backed gull

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2023
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.52
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	756,707.56
(Vr) as % of (Vw) (%)	0.410988%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2023
VP survey hours	1,413.00
Bird flight seconds within (Vw)	21761
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	12.4
Probability of collision (p) [model]	6.0%
Flight Seconds/survey hour (bird secs)	15.40057
Flight Seconds/season day (bird secs)	183.11273
Flight Seconds/season (bird secs)	267344.58839
n x (Vr/Vw)	1098.75446
Bird transit time through turbine (t)	0.38371
No. of transits through rotor swept vol	2863.50470
No. of birds hit by blades/survey period	171.81028
No. of birds hit by blades/year	42.95257

STAGE 3 (Avoidance)

Detail	2020-2023
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	3.436205641
No. of birds hit by blades/survey year	0.85905141
No of birds hit by blades/35 yrs	30.067

Mallard

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.55
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	761,478.73
(Vr) as % of (Vw) (%)	0.413579%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	2624
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	20
Probability of collision (p) [model]	5.4%
Flight Seconds/survey hour (bird secs)	1.85704
Flight Seconds/season day (bird secs)	22.08023
Flight Seconds/season (bird secs)	32237.13064
n x (Vr/Vw)	133.32615
Bird transit time through turbine (t)	0.23940
No. of transits through rotor swept vol	556.91792
No. of birds hit by blades/survey period	30.07357
No. of birds hit by blades/year	7.51839

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.601471354
No. of birds hit by blades/survey year	0.150367838
No of birds hit by blades/35 yrs	5.263

Peregrine

Period modelled:	Survey duration
Year modelled:	2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.42
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	740,803.66
(Vr) as % of (Vw) (%)	0.402350%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	174
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	12.1
Probability of collision (p) [model]	5.7%
Flight Seconds/survey hour (bird secs)	0.12314
Flight Seconds/season day (bird secs)	1.46416
Flight Seconds/season (bird secs)	2137.67558
n x (Vr/Vw)	8.60094
Bird transit time through turbine (t)	0.38496
No. of transits through rotor swept vol	22.34251
No. of birds hit by blades/survey period	1.27352
No. of birds hit by blades/year	0.31838

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.025470463
No. of birds hit by blades/survey year	0.006367616
No of birds hit by blades/35 yrs	0.223

Snipe

Period modelled: Survey duration
Year modelled: 2020-2024

STAGE 1 (Probability of birds being hit by a turbine blade)

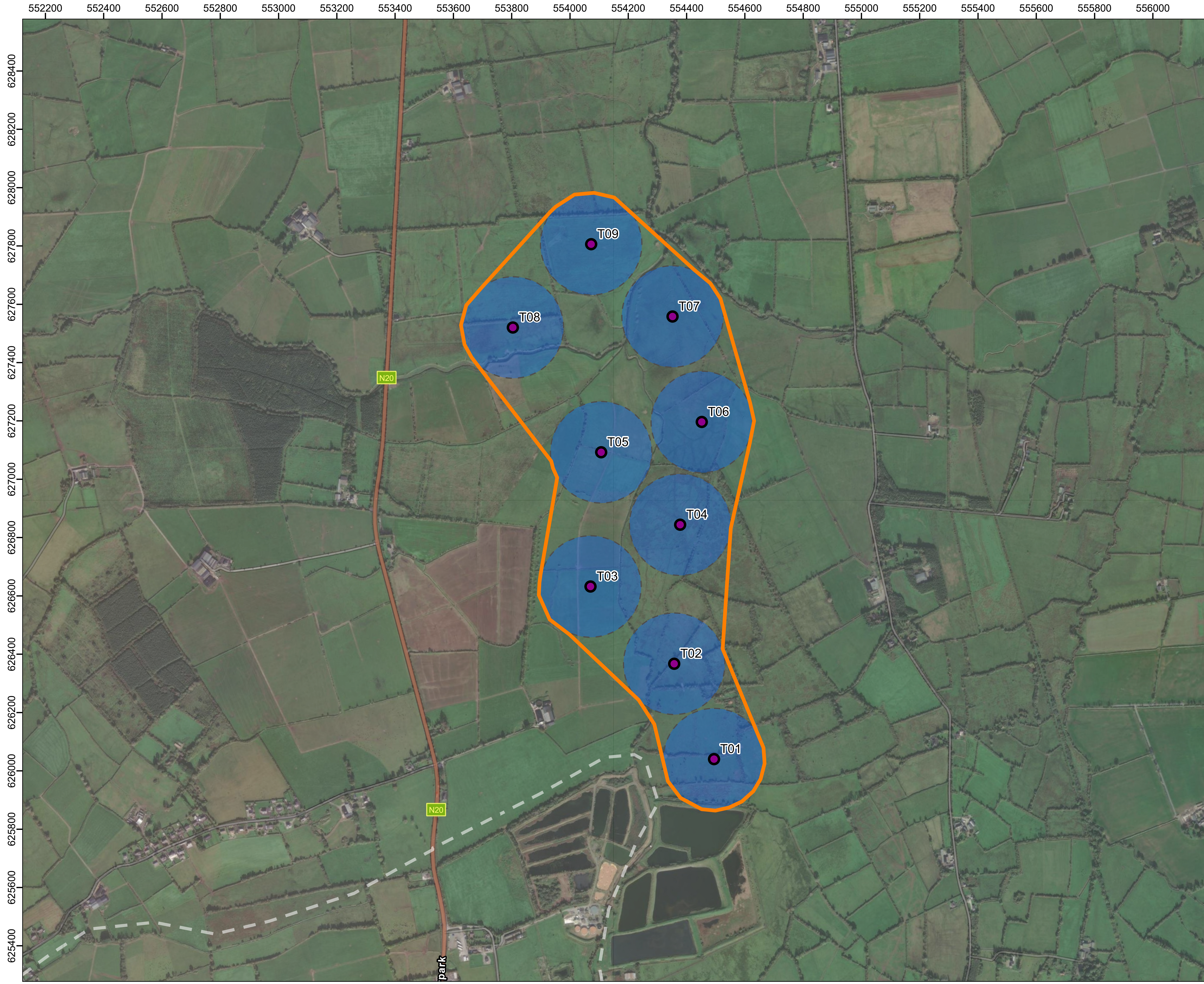
Detail	2020-2024
Number of turbines	9
WFA (m^2)	1227460.597
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.00
Rotor depth (m)	4.24
Bird length (m)	0.26
(Vw) Flight risk volume (m^3)	184,119,089.52
(Vr) Combined vol swept by blades (m^3)	715,357.42
(Vr) as % of (Vw) (%)	0.388530%

STAGE 2 (Birds flying through turbine area)

Detail	2020-2024
VP survey hours	1,413.00
Bird flight seconds within (Vw)	5433
Average Day length (over period)	11.89
Season days	1,460
Bird speed (m/sec)	16.2
Probability of collision (p) [model]	4.4%
Flight Seconds/survey hour (bird secs)	3.84501
Flight Seconds/season day (bird secs)	45.71718
Flight Seconds/season (bird secs)	66747.07728
n x (Vr/Vw)	259.33225
Bird transit time through turbine (t)	0.27765
No. of transits through rotor swept vol	934.01120
No. of birds hit by blades/survey period	41.09649
No. of birds hit by blades/year	10.27412

STAGE 3 (Avoidance)

Detail	2020-2024
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/survey period	0.821929859
No. of birds hit by blades/survey year	0.205482465
No of birds hit by blades/35 yrs	7.192



NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery: Maxar, Microsoft
Hybrid Reference Layer: Esri Community Maps Contributors, Esri UK, Esri, TomTom, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS 2024

Legend:
Wind Farm Area (WFA)
Turbine location
Turbine buffer

01	24/10/2024	2486055	TG	RPH	EP
Rev	**Date**	**Description**	**Drn**	**Chk**	**App**

Bird Survey Garrane Wind Farm

RSK biocensus EXPERTS IN ECOLOGY

TITLE: Figure 1:

Site Location Plan

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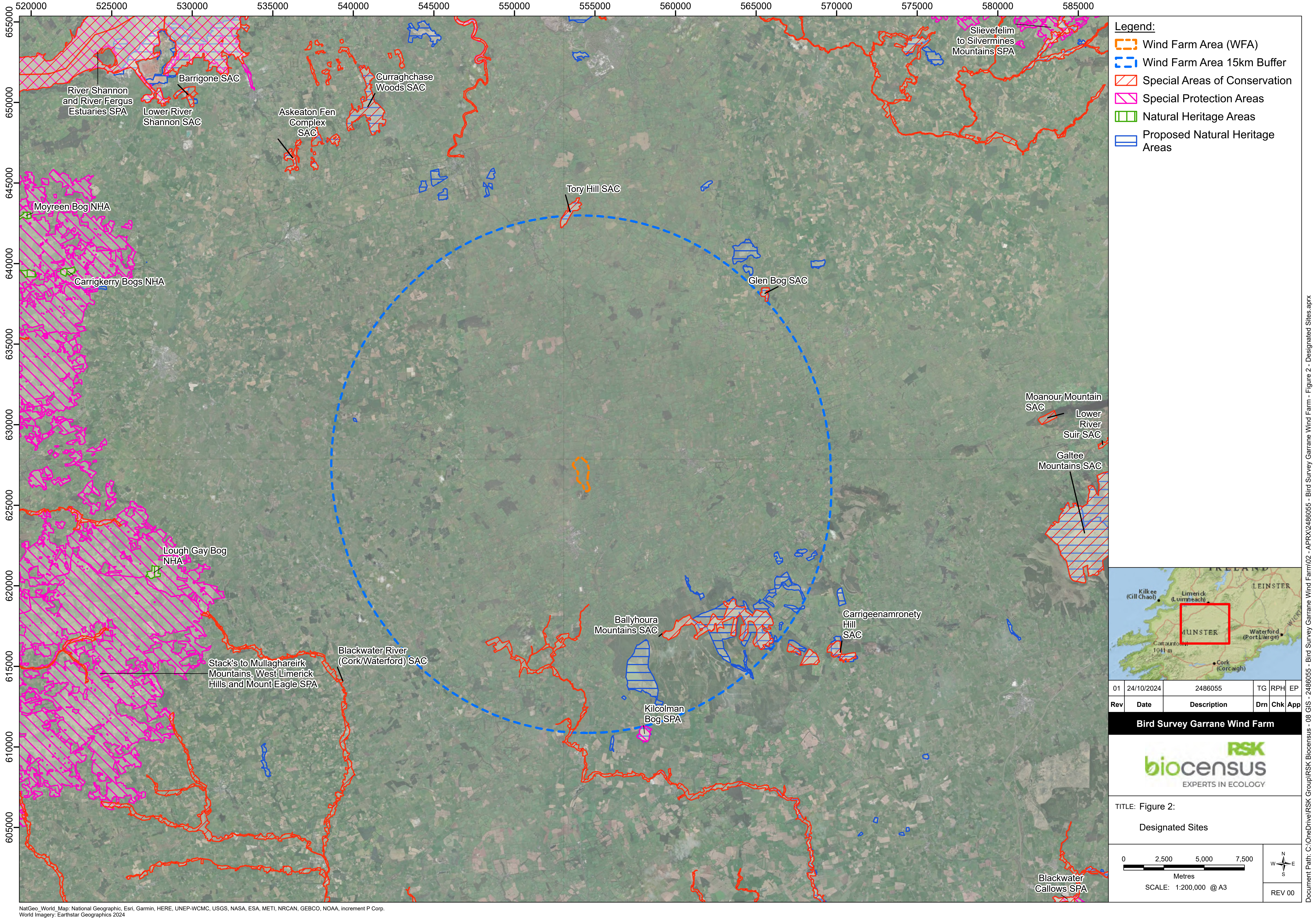

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Lower River Shannon SAC
Askeaton Fen Complex SAC
Curraghchase Woods SAC
Slievefelim to Silvermines Mountains SPA
Tory Hill SAC
Moyreen Bog NHA
Carrigkerry Bogs NHA
Glen Bog SAC
Moanour Mountain SAC
Lower River Suir SAC
Galtee Mountains SAC
Lough Gay Bog NHA
Ballyhoura Mountains SAC
Carrigeenamronety Hill SAC
Blackwater River (Cork/Waterford) SAC
Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA
Kilcolman Bog SPA
Blackwater Callows SPA
Legend:
Wind Farm Area (WFA)
Wind Farm Area 15km Buffer
Special Areas of Conservation
Special Protection Areas
Natural Heritage Areas
Proposed Natural Heritage Areas
IRELAND
Kilkee (Cill Chaoi)
Limerick (Luimneach)
LEINSTER
MUNSTER
Waterford (Port Láirge)
Carrauntoohil 1041 m
Cork (Corcaigh)
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Bird Survey Garrane Wind Farm
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EXPERTS IN ECOLOGY
TITLE: Figure 2:
Designated Sites
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World Imagery: Earthstar Geographics 2024

Legend:
- Wind Farm Area (WFA)
- Vantage Point (VP)

Rev	Date	Description	Drn	Chk	App
01	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 3:

VP Locations

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Metres
SCALE: 1:20,000 @ A3

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NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery (Clarity): Source: Esri, Maxar, Earthstar Geographics, IGN, and the GIS User Community 2024

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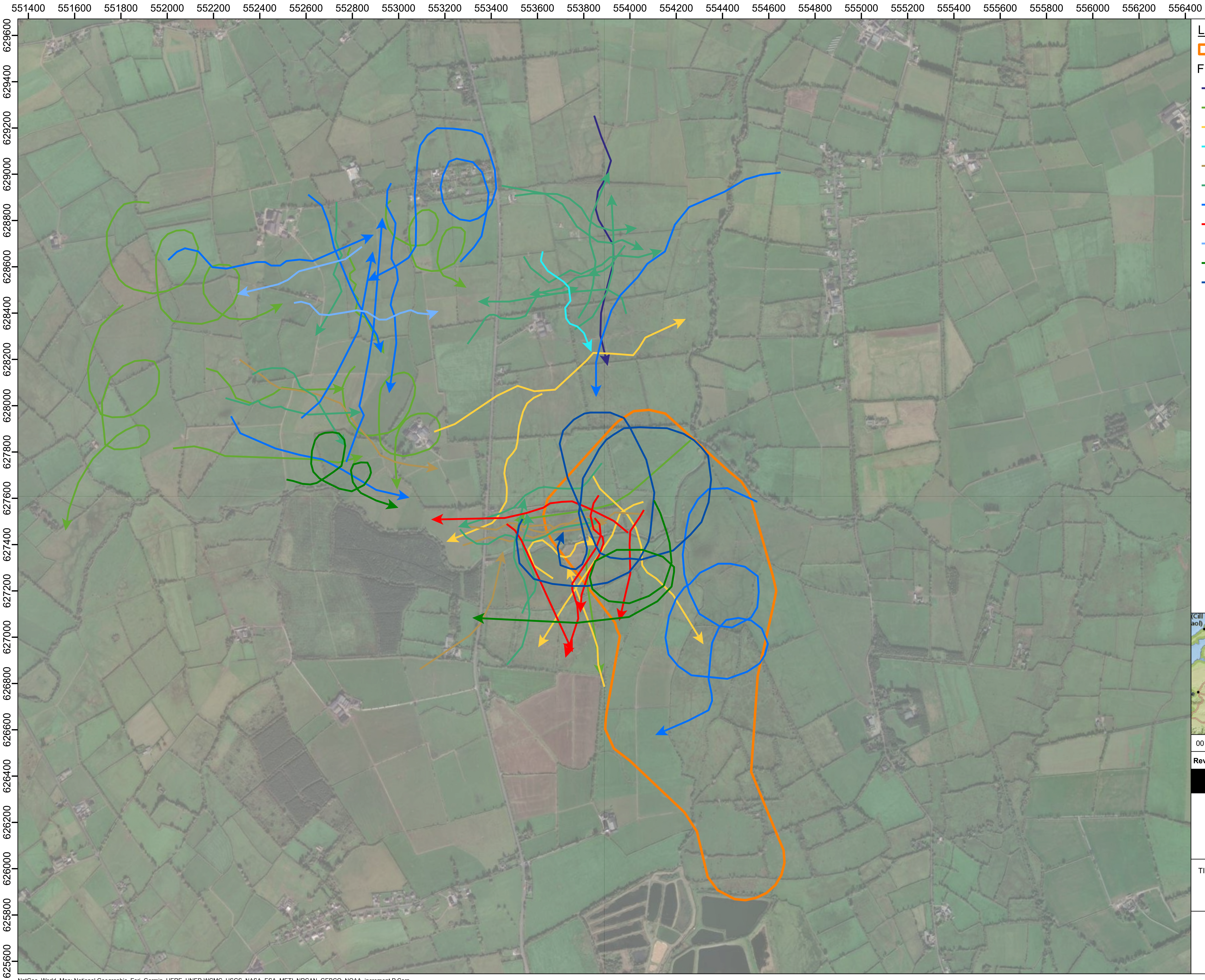

Legend:

- Wind Farm Area (WFA)

Flight observations

- Black-headed gull
- Buzzard
- Cormorant
- Little egret
- Grey heron
- Kestrel
- Lesser black-backed gull
- Mallard
- Peregrine
- Sparrowhawk
- Snipe

Rev	Date	Description	Drn	Chk	App
00	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 4.1:

Breeding 2021 Flight Observations for Target Species

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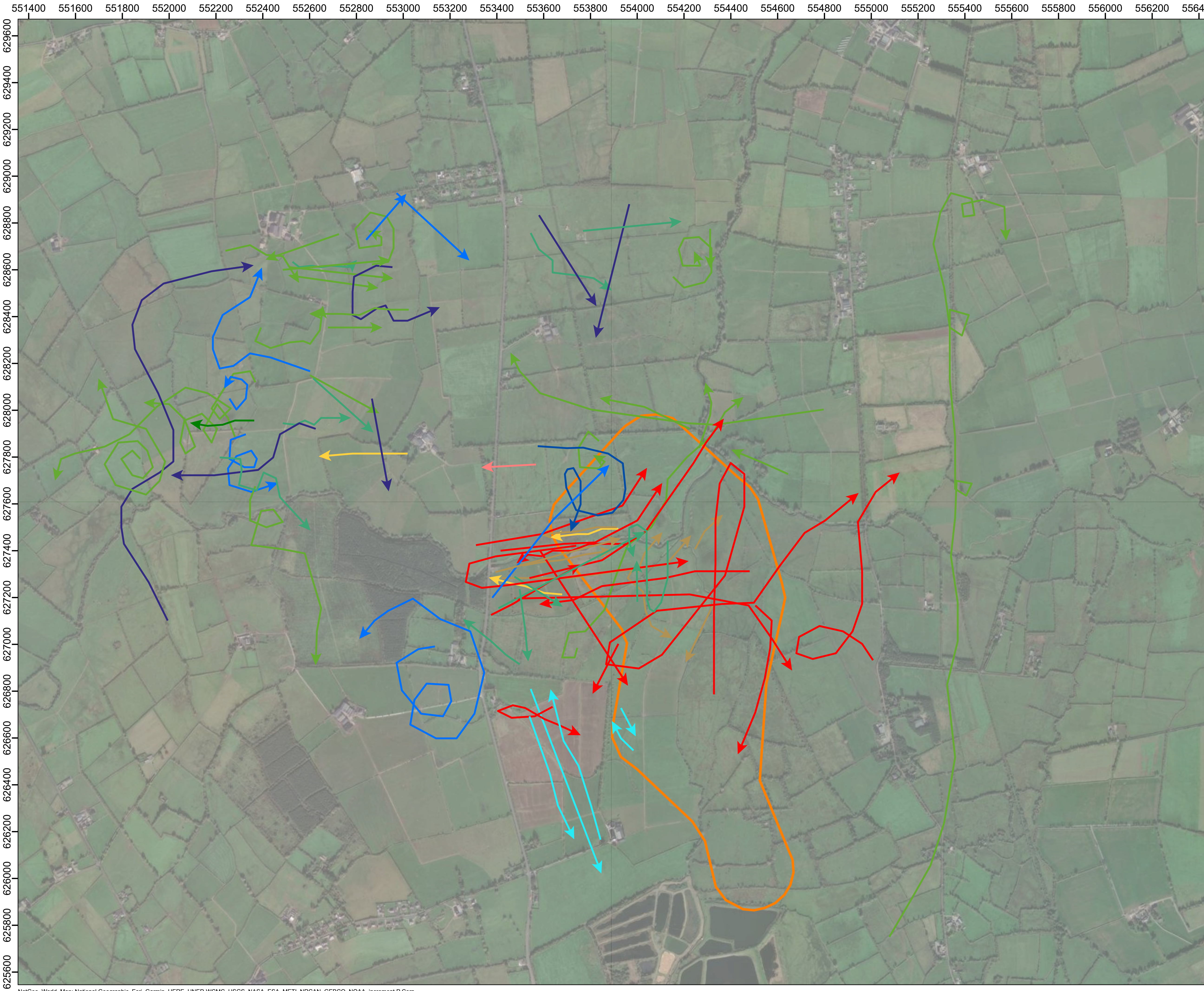


Legend:

Wind Farm Area (WFA)

Flight observations

- Black Headed Gull
- Buzzard
- Cormorant
- Little egret
- Golden plover
- Grey heron
- Kestrel
- Lesser black-backed gull
- Mallard
- Sparrowhawk
- Snipe

Rev	Date	Description	Drn	Chk	App
00	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 4.2:

Breeding 2022 Flight Observations for Target Species

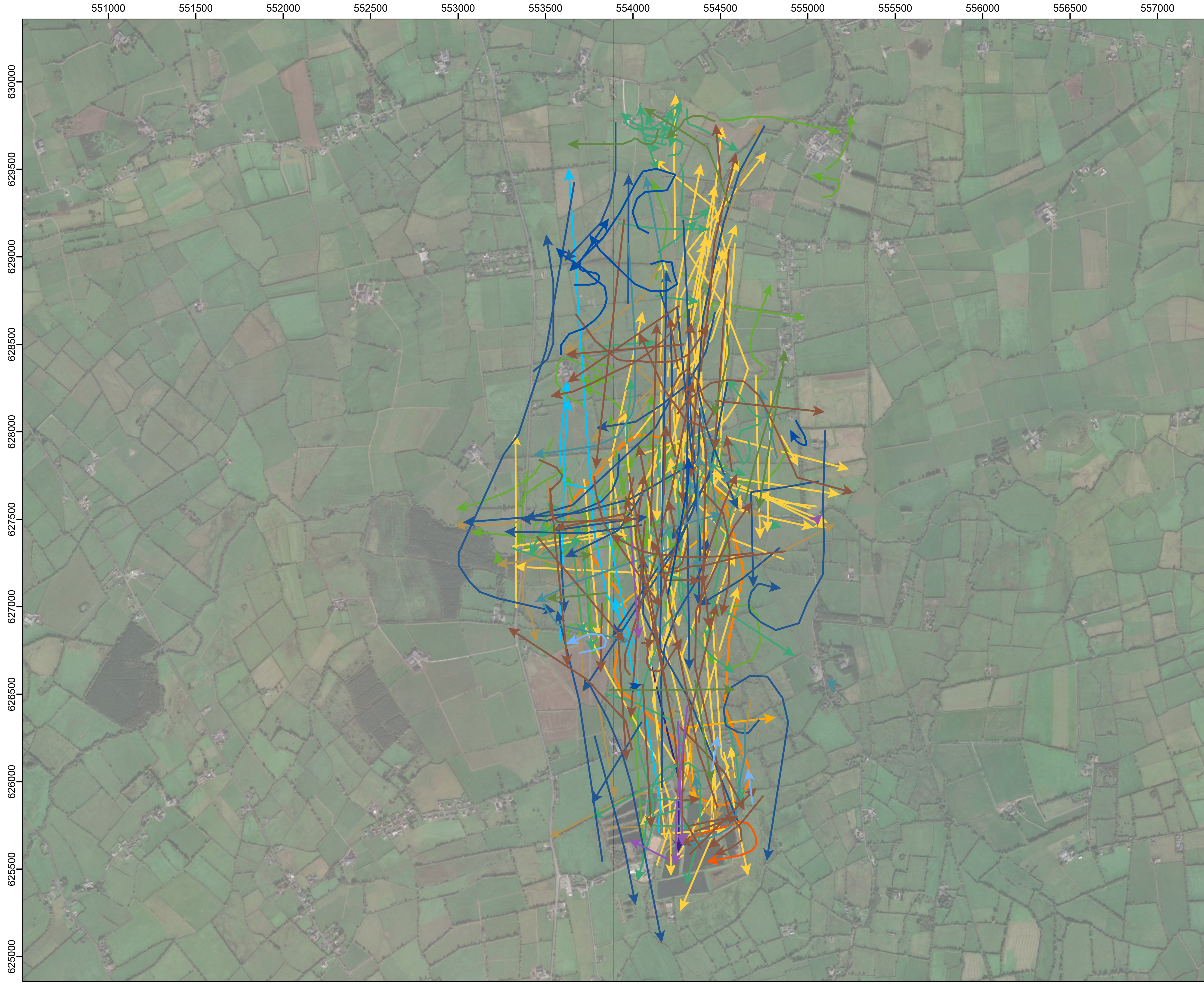
0 190 380 570
Metres

SCALE: 1:15,000 @ A3

N W E S

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 4.2 - Breeding 2022 Flight Observations for Target Species.aprx



Rev	Date	Description	Drn	Chk	App
00	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 4.3:

Breeding 2023 Flight Observations for Target Species

0 250 500 750
Metres
SCALE: 1:20,000 @ A3

N W E S

REV 00

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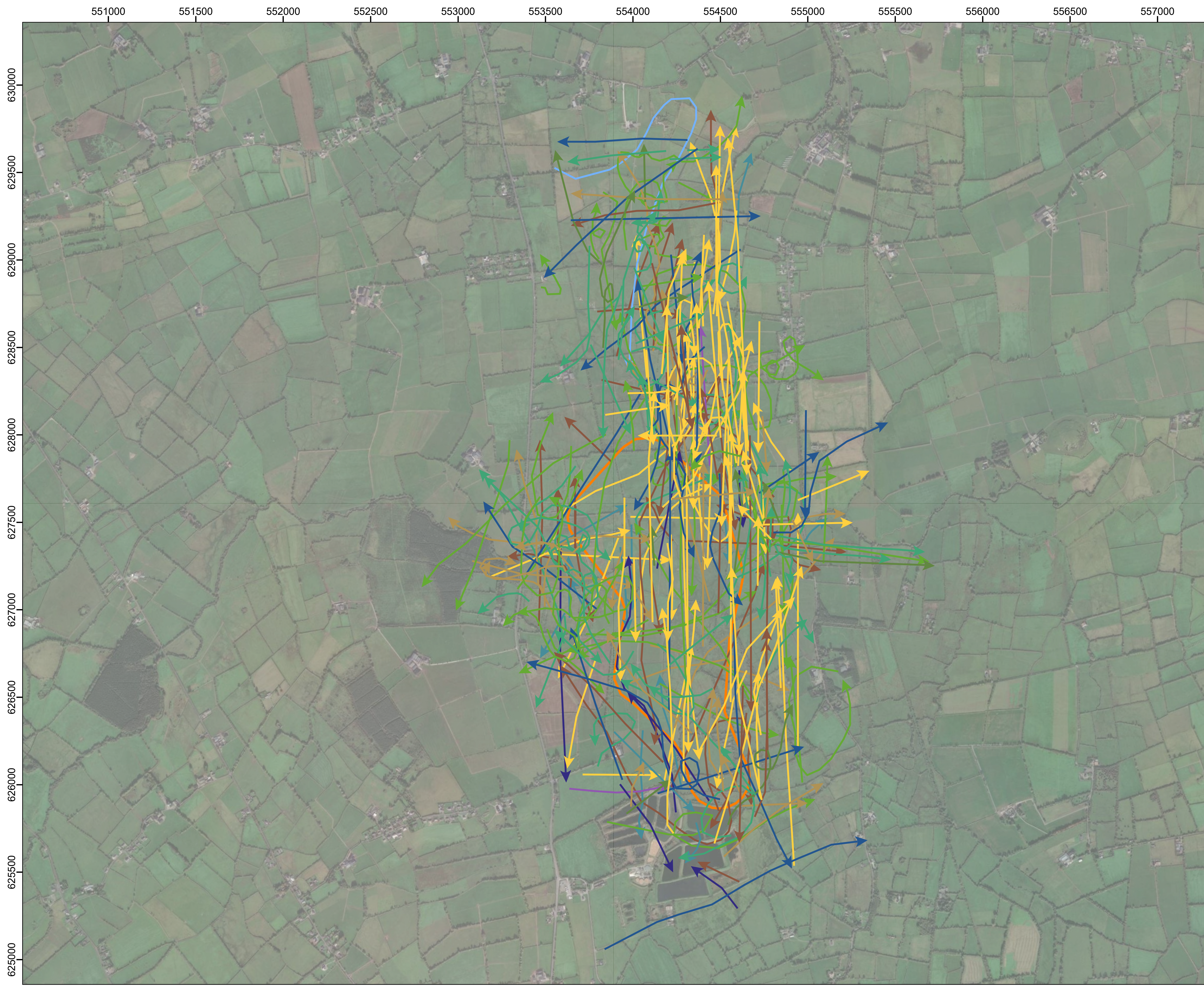
NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery: Maxar, Microsoft 2024



NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery: Maxar, Microsoft 2024

Legend:

- Wind Farm Area (WFA)

Flight observations

- Black-headed gull
- Buzzard
- Cormorant
- Little egret
- Grey heron
- Kestrel
- Lesser black-backed gull
- Mallard
- Mute swan
- Peregrine
- Sparrowhawk

Rev	Date	Description	Drn	Chk	App
00	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 4.4:

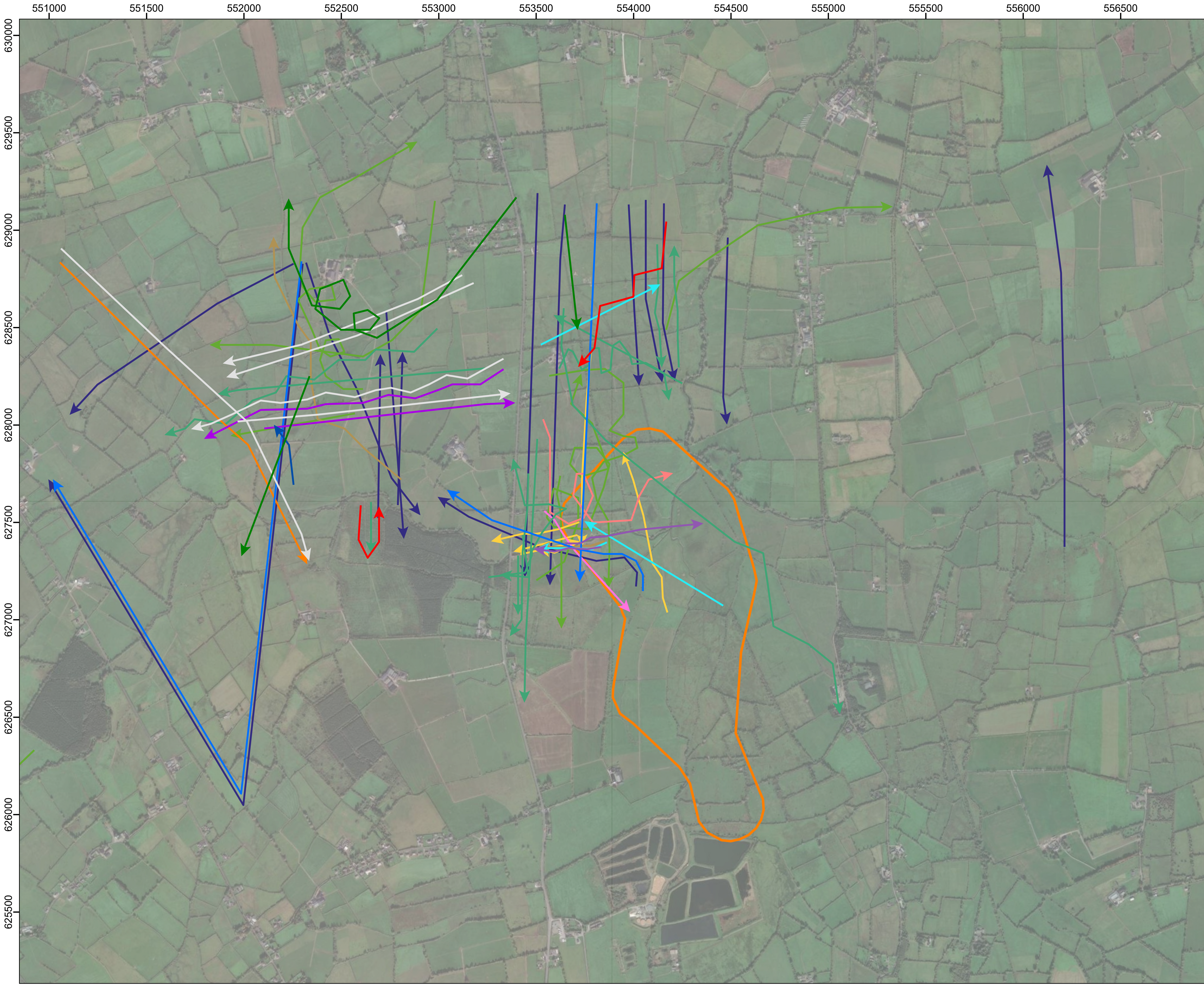
Breeding 2024 Flight Observations for Target Species

0 250 500 750
Metres
SCALE: 1:20,000 @ A3

N W E S

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 4.4 - Breeding 2024 Flight Observations for Target Species.aprx



Legend:

Wind Farm Area (WFA)

Flight observations

- Black-headed gull
- Buzzard
- Cormorant
- Curlew
- Little egret
- Golden plover
- Grey heron
- Kestrel
- Lapwing
- Lesser black-backed gull
- Mallard
- Merlin
- Mute swan
- Peregrine
- Sparrowhawk
- Snipe

Rev	Date	Description	Drn	Chk	App
00	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus

EXPERTS IN ECOLOGY

TITLE: Figure 5.1:

Non-breeding 2020/21 Flight Observations for Target Species

0 230 460 690

Metres

SCALE: 1:18,000 @ A3

N W E S

REV 00

NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery: Maxar, Microsoft 2024

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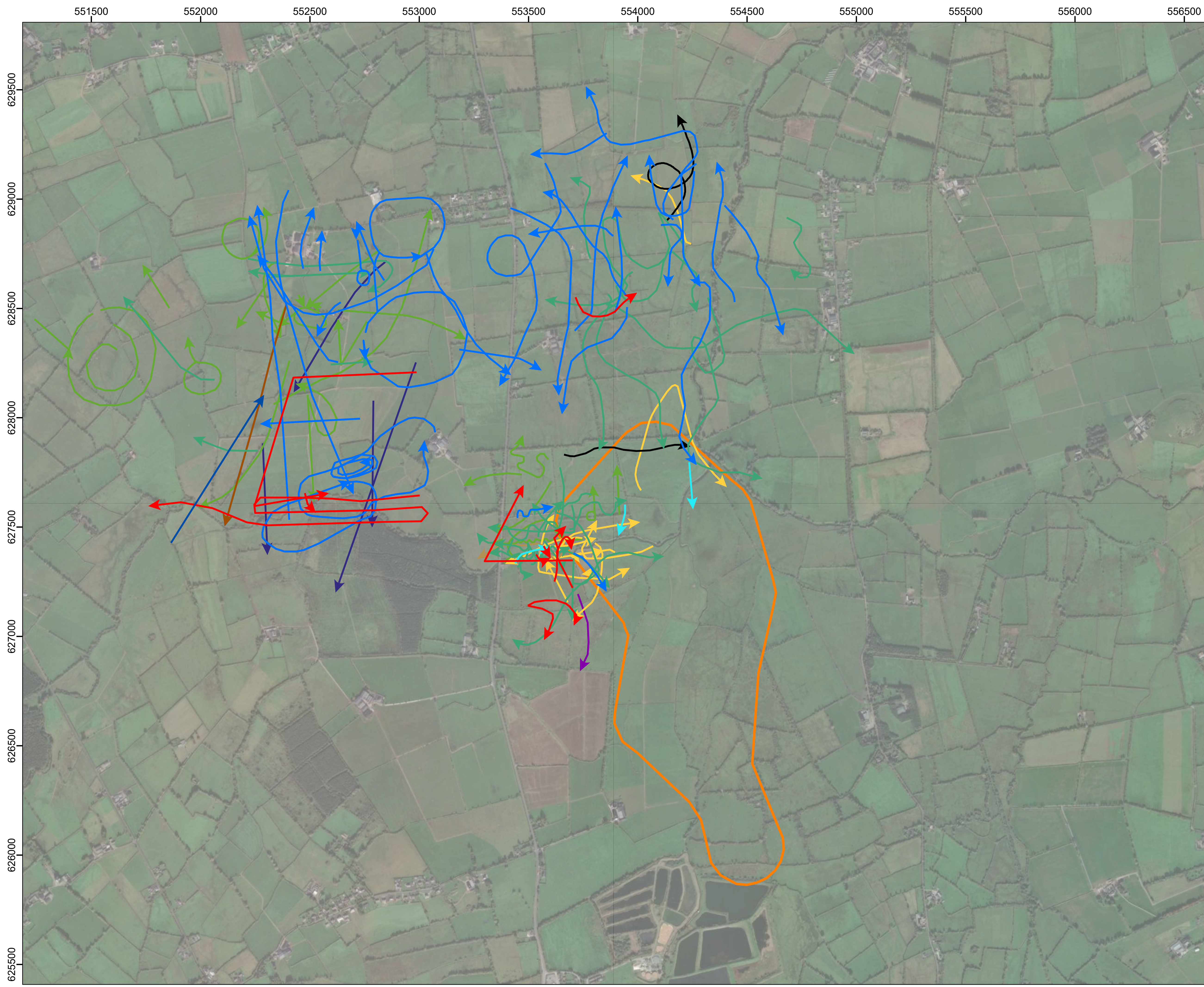


Legend:
- Wind Farm Area (WFA)

Flight observations
- Black-headed gull
- Buzzard
- Cormorant
- Common gull
- Little egret
- Great black-backed gull
- Grey heron
- Herring gull
- Kestrel
- Lesser black-backed gull
- Mallard
- Snipe

Rev	Date	Description	Drn	Chk	App
00	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 5.2:

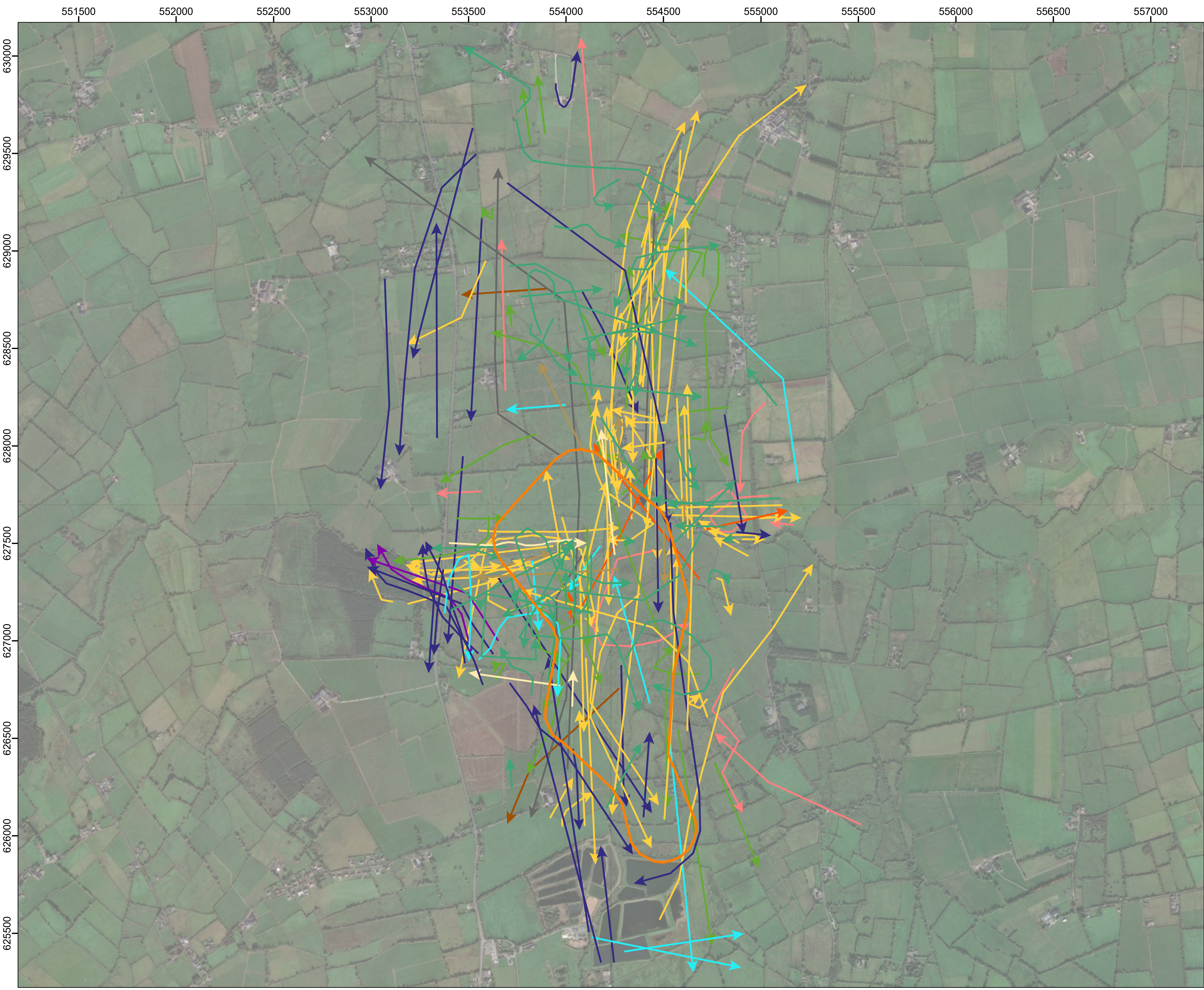
Non-breeding 2021/22 Flight Observations for Target Species

0 200 400 600
Metres
SCALE: 1:16,000 @ A3

N W E S

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 5.2 - Non-breeding 21_22 Flight Observations for Target Species.aprx



Legend:

- Wind Farm Area (WFA)

Flight observations

- Black-headed gull
- Buzzard
- Cormorant
- Common gull
- Little egret
- Greylag goose
- Golden plover
- Grey heron
- Herring gull
- Hen harrier
- Kestrel
- Lapwing

Rev	Date	Description	Drn	Chk	App
01	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 5.3a:

Non-breeding 2022/23 Flight Observations for Target Species

0 230 460 690
Metres
SCALE: 1:18,000 @ A3

N E S W

REV 00

NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery: Maxar, Microsoft 2024

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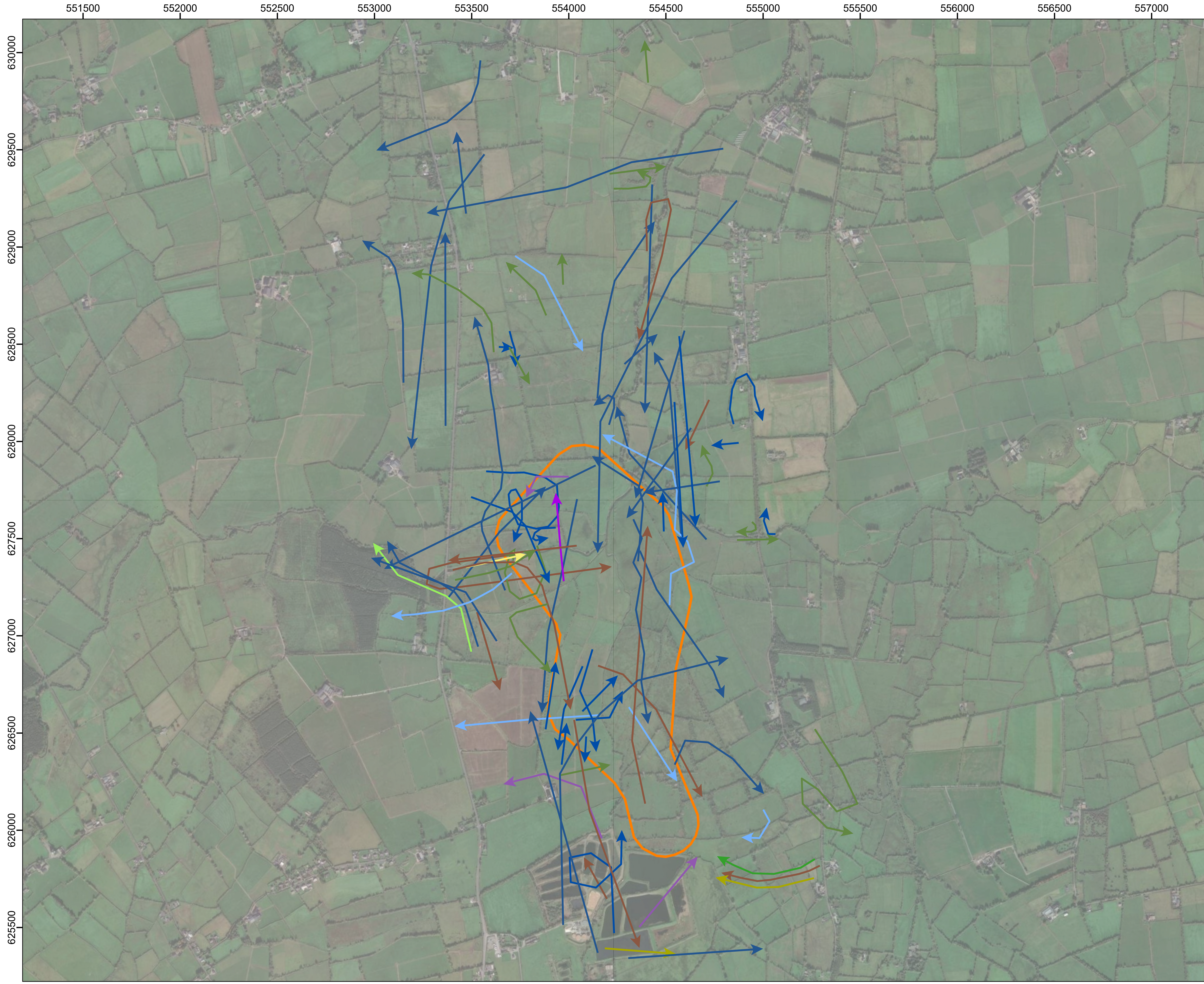


Legend:

- Wind Farm Area (WFA)

Flight observations

- Lesser black-backed gull
- Mallard
- Merlin
- Mute swan
- Mediterranean gull
- Peregrine
- Sparrowhawk
- Snipe
- Shoveler
- Teal
- Wigeon

Rev	Date	Description	Drn	Chk	App
01	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 5.3b:

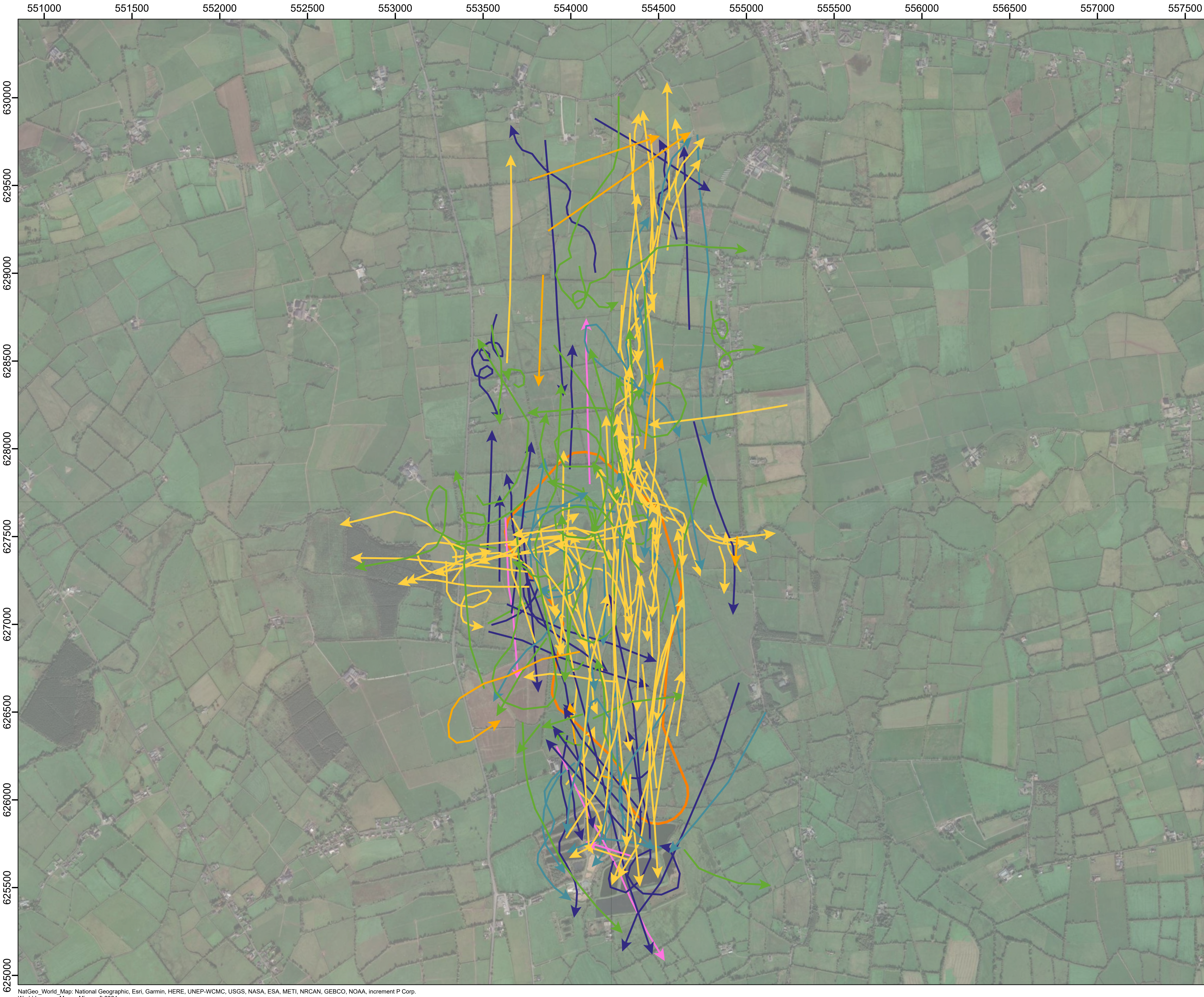
Non-breeding 2022/23 Flight Observations for Target Species

0 230 460 690
Metres
SCALE: 1:18,000 @ A3

N W E S

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 5.3b - Non-breeding 22_23 Flight Observations for Target Species.aprx



Legend:

- Wind Farm Area (WFA)

Flight observations

- Black-headed gull
- Buzzard
- Cormorant
- Common gull
- Little egret
- Golden plover

Rev	Date	Description	Drn	Chk	App
01	24/10/2024	2486055	TG	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus EXPERTS IN ECOLOGY

TITLE: Figure 5.4a:

Non-breeding 2023/24 Flight Observations for Target Species

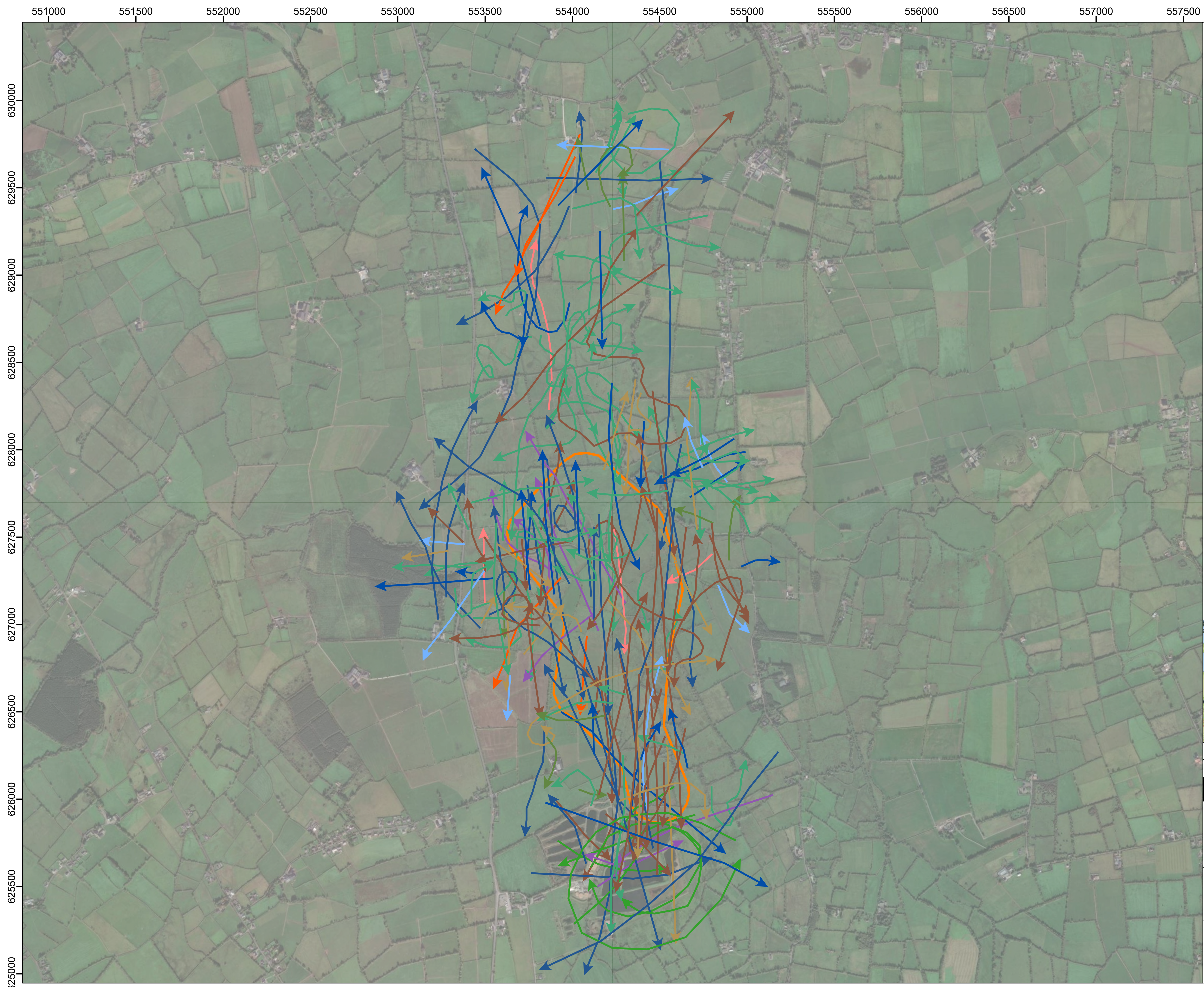
0 250 500 750

Metres

SCALE: 1:20,000 @ A3

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 5.4a - Non-breeding 23_24 Flight Observations for Target Species.aprx



Legend:

Wind Farm Area (WFA)

Flight observations

- Grey heron
- Hen harrier
- Kestrel
- Lapwing
- Lesser black-backed gull
- Mallard
- Mute swan
- Peregrine
- Sparrowhawk
- Snipe
- Wigeon

01	24/10/2024	2486055	TG	RPH	EP
Rev	Date	Description	Drn	Chk	App

Bird Survey Garrane Wind Farm

RSK biocensus EXPERTS IN ECOLOGY

TITLE: Figure 5.4b:

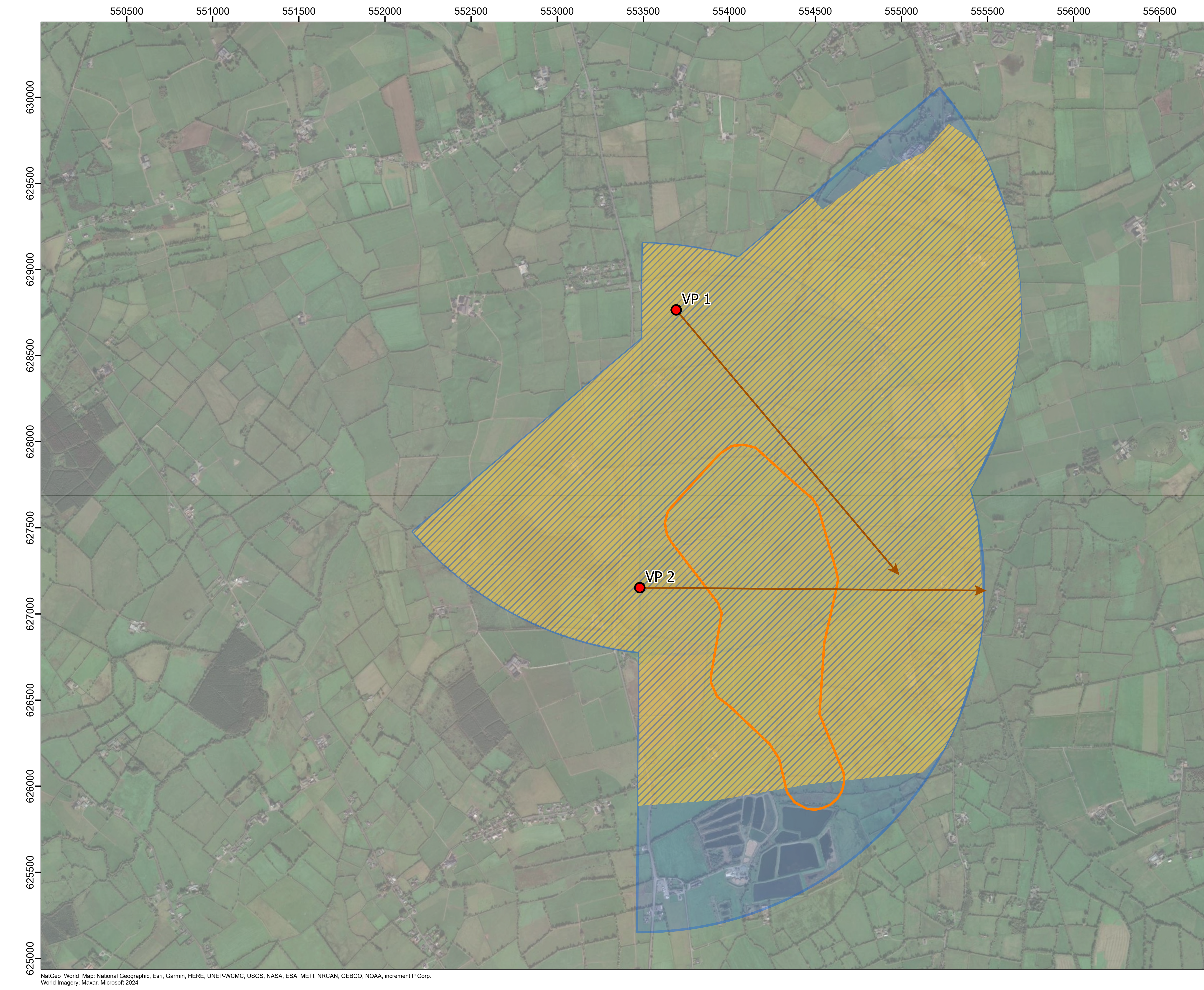
Non-breeding 2023/24 Flight Observations for Target Species

0 250 500 750 Metres

SCALE: 1:20,000 @ A3

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 5.4b - Non-breeding 23_24 Flight Observations for Target Species.aprx



Legend:
- Wind Farm Area (WFA)
- Vantage Point
- Direction of View
- Viewshed area of 18m minimum height from 1.75m
- Field of View (2km limit)

WFA coverage 97.1%

Rev	Date	Description	Drn	Chk	App
02	24/10/2024	2486055	RPH	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

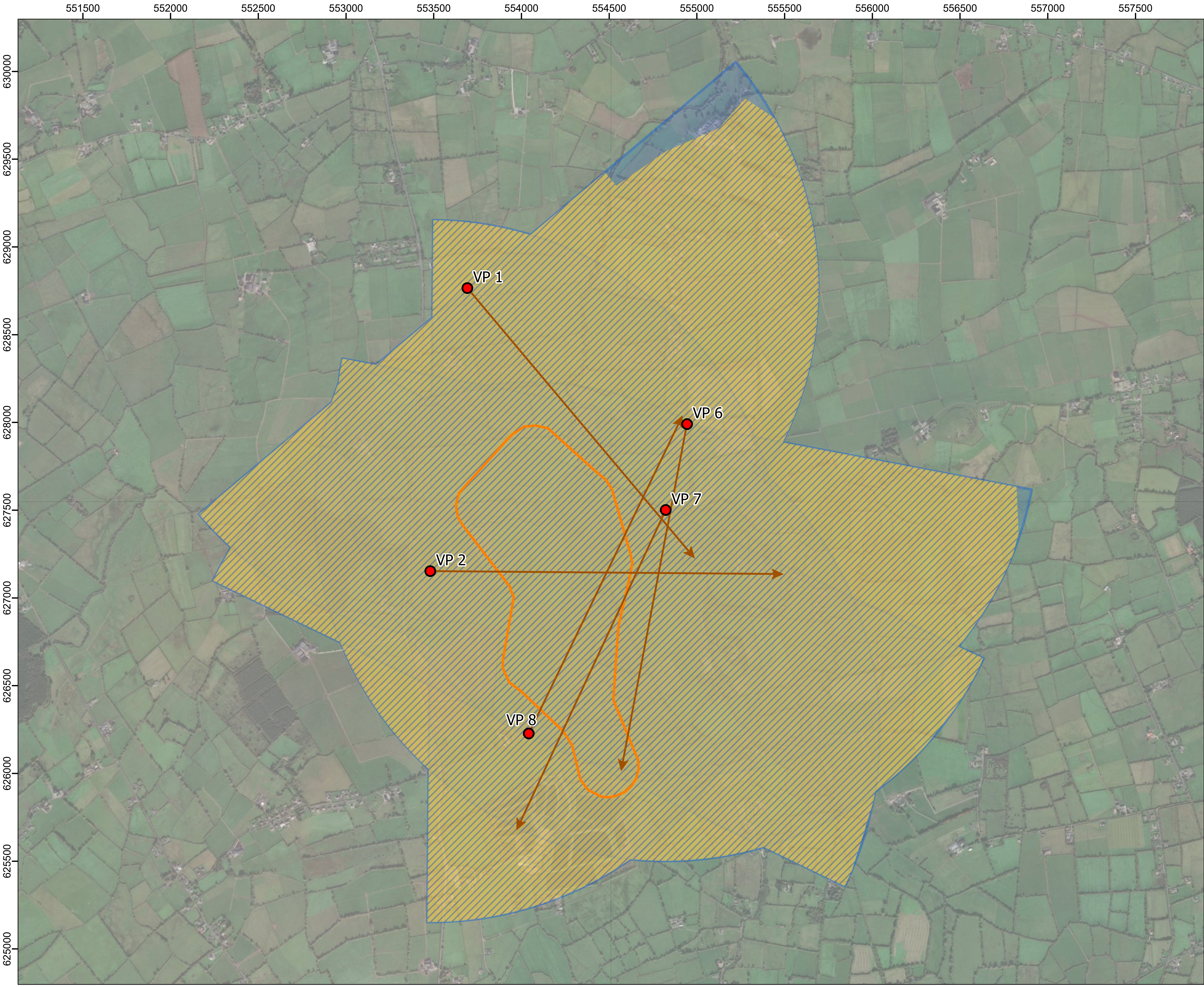
TITLE: Figure 6a:

VP 1-2 Viewshed Analysis

0 250 500 750
Metres
SCALE: 1:20,000 @ A3

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 6a - Viewshed Analysis.aprx



Legend:
- Wind Farm Area (WFA)
- Vantage Point
- Direction of View
- Viewshed area of 18m minimum height from 1.75m
- Field of View (2km limit)

WFA coverage 100%

Rev	Date	Description	Drn	Chk	App
02	24/10/2024	2486055	RPH	RPH	EP

Bird Survey Garrane Wind Farm

RSK biocensus
EXPERTS IN ECOLOGY

TITLE: Figure 6b:

VP 1-2 & 6-8 Viewshed Analysis

0 250 500 750
Metres
SCALE: 1:20,000 @ A3

N W E S

REV 00

Document Path: C:\OneDrive\RSK Group\RSK Biocensus - 08 GIS - 2486055 - Bird Survey Garrane Wind Farm\02 - APRX\2486055 - Bird Survey Garrane Wind Farm - Figure 6b - Viewshed Analysis.aprx

NatGeo_World_Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
World Imagery: Maxar, Microsoft 2024