

Corriegarth 2 Wind Farm

Environmental Impact Assessment Report

Volume 3 - Technical Appendices

January 2021



CORRIEGARTH 2 WIND FARM

EIA Report – Volume 3 – Technical Appendices

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Corriegarth

Habitats, vegetation & GWDTE

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Cover picture: Looking west from the eastern boundary across extensive, eroded blanket bog.

Summary

This report describes the results of habitat survey & assessment of Corriegarth, near Gorthleck, in the Scottish Highlands.

The **aim** of the report is to provide a habitat baseline against which sensitivities can be identified.

Corriegarth encompasses 1,348 ha in the Great Glen, 31 km southwest of Inverness. It is an upland site (>430 m a.s.l.) with extensive peatland habitats. The centre is in operation as a wind farm and the entire area has been managed for sheep grazing & grouse shooting.

There are **no statutory designations** within 5 km from the Corriegarth boundary.

The **Carbon & Peatland Map** predicts extensive peatland across Corriegarth except for the west-centre; and the north-western & north-eastern margins.

A single area of **ancient woodland** contiguous with several other several units extends along the river valley to the northwest of Corriegarth.

Peatland **habitat** is extensive across 1,206.4 ha (89.4 %) of Corriegarth, including blanket bog (1092.6 ha, 81.0 %); wet heath (111.6 ha, 8.3 %); & wet modified bog (2.2 ha, 0.2 %) and an additional 48.8 ha (3.6 %) of mosaics. The blanket bog is highly eroded. Surface water draining from the peatland is associated with acid/neutral flush (20.1 ha, 1.5 %) or marshy grassland (3.1 ha, 0.2 %) and their mosaic (4.3 ha, 0.3 %). Open water habitat is located in the base of 'peat pans' and it accounts for a seasonally variable 0.3 ha (<0.1 %). Infrastructure associated with the current wind turbine array and a pre-existing track includes hard-surfacing across 16.5 ha (1.2 %) and there is 22.4 ha (1.7 %) of disturbed ground dating from construction of the wind farm.

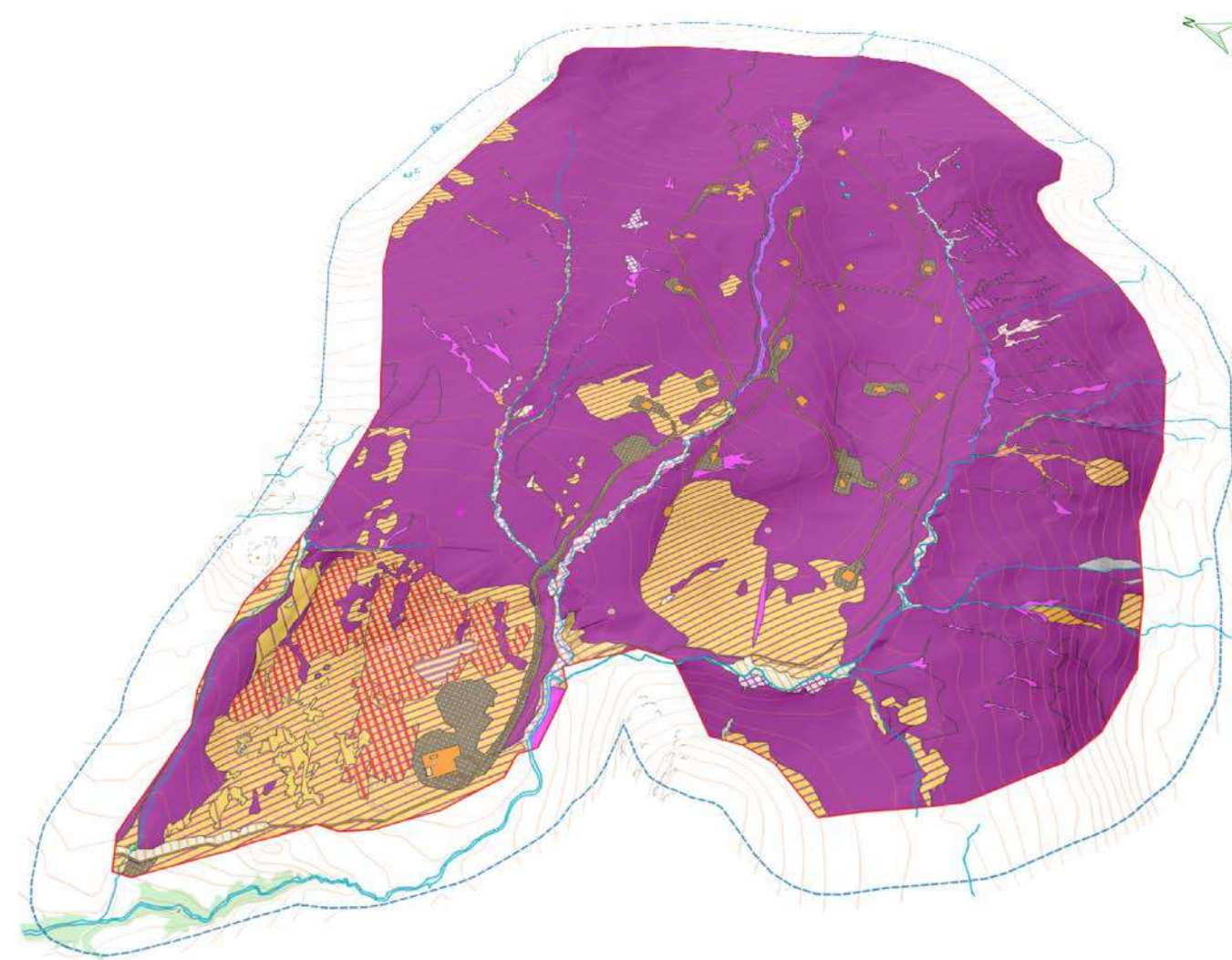
Peatland Condition Assessment identifies that erosion has influenced 1,020 ha (81.4 %) of the blanket bog habitat. The remainder is drained &/or otherwise modified.

The **conservation importance** of the extensive peatland habitats & other mires (acid/neutral & basic flushes, blanket bog, marshy grassland, wet heath & wet modified bog); and most of the dry heath is Local. Some of the dry heath and the 'other habitat' & acid grassland are valued at the Site level.

Groundwater-dependent **GWDTE** are associated with M10a & M32b-type flushes.

The key **constraints** to development are:

- Local importance blanket bog & its related deep peat
- Moderate to high groundwater dependency M10a & M32b-type flushes.



3D representation of the Phase 1 habitats at Corriegarth.
Purple is blanket bog; yellow & purple is wet heath; and red is for areas where bedrock is patchily exposed.

1 Introduction

Remit

- 1.1 This report describes the results of habitat survey & assessment of Corriegarth, near Gorthleck, in the Scottish Highlands.

Aim & objectives

- 1.2 The aim of the report is to provide a habitat baseline against which sensitivities can be identified by meeting the following objectives:
- Phase 1 habitat & National Vegetation Classification survey.
 - Assessment of habitat importance & sensitivity, including Groundwater Dependent Terrestrial Ecosystems (GWDTE).

The site

- 1.3 Corriegarth encompasses 1,348 ha in the Great Glen, 31 km southwest of Inverness. It is an upland site (>430 m a.s.l.) with extensive peatland habitats. The centre is in operation as a wind farm, and the entire area has been managed for sheep grazing & grouse shooting.

2 Approach

- 2.1 In preparation of a baseline to inform assessment, a desk-based study of environmental information was undertaken, to identify known sensitivities, before a field-based survey to map & describe habitats and their constituent vegetation communities. The resulting data is then assessed to identify sensitivities in relation to guidance & legislation. Details on the methods & sources are provided in the following sections.

Survey boundary & buffers

- 2.2 The survey boundary & buffers are defined in Map 1 *et seq.* In these maps, the site boundary is the area in which all habitats & vegetation communities are recorded & mapped. It is surrounded by a 250 m GWDTE buffer to allow for the extension of potential, hydrological effects. Within this buffer, only groundwater dependent GWDTE are mapped. Within the boundary & buffer, distinctive or demonstrative features recorded as 'Target Notes'.

Habitat designations

- 2.3 A desk study was undertaken to identify habitat designations, including:
- SNH's Sitelink¹ to identify nature conservation designations
 - SNH's Carbon & Peatland Map 2016² to identify high value 'Class 1' or 'Class 2' peatland
 - Ancient Woodland Inventory³ to identify native woodlands.

Survey

- 2.4 There are two elements to the survey: a 'Phase 1' habitat survey and more detailed 'National Vegetation Classification' (NVC) of vegetation within the habitats. The data from these is mapped & described and supplemented by field assessment of habitat/vegetation condition & groundwater dependency. The survey methods are described in the following sections.

¹ SNH's SiteLink data, including mapping and site documentation, is available through <https://gateway.snh.gov.uk/>. Accessed 28/08/2019.

² Further details and downloads of the Carbon & Peatland Map 2016 are available at soils.environment.gov.scot/maps/carbon-and-peatland-2016-map/. Accessed 28/08/2019.

³ A guide to understanding the Scottish Ancient Woodland Inventory is available for download at <https://www.nature.scot/guide-understanding-scottish-ancient-woodland-inventory-awi>. The data is available at <https://gateway.snh.gov.uk/natural-spaces/dataset.jsp?dsid=AWI>. Accessed 28/08/2019.

Phase 1 habitat survey

- 2.5 Phase 1 habitat survey was undertaken within the survey boundary according to the standard method⁴ and guidance⁵. As a ‘broad-brush’ approach, Phase 1 habitat survey is now somewhat outdated by current legislation and initiatives but it still provides a well-established & useful overview. Furthermore, it includes habitats not covered by the more detailed National Vegetation Classification described below. In the **Baseline** (Section 3, below), the vegetation communities are grouped and described under the heading of the relevant Phase 1 habitat.

National Vegetation Classification

- 2.6 The National Vegetation Classification (NVC) is more detailed & precise than the Phase 1 habitat method; and is necessary for identifying habitats/plant communities of relevance to modern legislation (such as Annex I of the Habitats Directive, or GWDTE of the Water Framework Directive). It is therefore the primary system to which vegetation (& habitat) is related within this report, for the purposes of identification, description & mapping.
- 2.7 Vegetation is identified, mapped & described according to the five volumes of *British Plant Communities*⁶ in accordance with the standard NVC method (as outlined in the *NVC Users Handbook*⁷). This involves walking the site on a route determined by topography/viewpoints and the need to sample distinctive areas. Homogenous areas are mapped onto rectified aerial photographs overlain with contours & other physical features to ensure accuracy. A single vegetation community or mosaic of more may be mapped, depending upon the scale and patterning of the vegetation. Where mosaics are mapped, the percentage cover of each NVC community is stated in the mapping.
- 2.8 Characteristics of the vegetation (structure, condition & species composition) are recorded as ‘Target Notes’ (see Appendix 1) of specific or representative features. These and the habitat & vegetation descriptions include lists of characteristic species that are semi-quantified using the DAFOR scale⁸.

Notable species

- 2.9 Notable species are those that are subject to nature conservation designation. The 2016 JNCC spreadsheet of taxa designations⁹ defines these species and is used as the main point of reference in addition to the *Highland Biodiversity Action Plan*¹⁰.

⁴ JNCC 2010. *Handbook for phase 1 habitat survey - a technique for environmental audit* and other relevant information available from <http://jncc.defra.gov.uk/page-2468>. Accessed 28/08/2019.

⁵ Chartered Institute of Ecology and Environmental Management 2013. *Guidelines for Preliminary Ecological Appraisal*. Available from <https://www.cieem.net/guidance-on-preliminary-ecological-appraisal-gpea->. Accessed 28/08/2019.

⁶ Rodwell, J.S. 1991-2000. *British plant communities*. 5 Volumes. Cambridge University Press.

⁷ Rodwell, J.S. 2006. *NVC Users' Handbook*. Download available at <http://jncc.defra.gov.uk/page-3724>. Accessed 28/08/2019.

⁸ DAFOR scale: Dominant > Abundant > Frequent > Occasional > Rare.

⁹ The JNCC spreadsheet of taxa designations and further information are available at: <http://jncc.defra.gov.uk/page-3408>. Accessed 28/08/2019.

Nomenclature

- 2.10 Standardised vernacular names are used for the vascular plants (ferns, herbs and trees). Scientific names (italicised within the text) are used for the moss, liverwort and lichen species because although vernacular names are now in existence, they are not in general usage. The standard checklists for vernacular and scientific names are employed¹¹.

Assessment

- 2.11 Assessment of the baseline is undertaken against local, national & international legislation & initiatives to identify priorities for nature conservation and sensitive habitats. The methods described in the following sections have been applied in assessment of the baseline.

Peatland Condition Assessment

- 2.12 Peatland Condition Assessment¹² was employed in the field to determine the condition of the peatland habitat. This classifies the peatland into four classes:
- 1) Near-Natural
 - 2) Modified
 - 3) Drained
 - 4) Actively Eroding.
- 2.13 Field-based assessment of a series of key indicators identifies the appropriate class for each area of peatland. These indicators include features such as the *Sphagnum* cover & vegetation condition; evidence of fire frequency & intensity; bare peat; and scrub/tree invasion¹³.

Conservation priorities

- 2.14 The baseline established by the desk study and survey is assessed against the following to identify priorities for protection & conservation at the European and national (Scottish) scale:
- Peatland & carbon map 2016²
 - Ancient Woodland Inventory³
 - Highland Biodiversity Action Plan¹⁰
 - Annex I of the EU Habitats Directive¹³
 - Scottish Biodiversity List¹⁴

¹⁰ Highland Biodiversity Action Plan 2015-2020. Available for download at <http://www.highlandbiodiversity.com>. Accessed 28/08/2019.

¹¹ BSBI List of British & Irish Vascular Plants and Stoneworts, for higher plants. Available at <http://www.nhm.ac.uk/our-science/data/uk-species/checklists/NHMSYS0000436459/index.html>. For mosses and liverworts: Blockeel, T.L. & Long, D.G. 1998. *A check-list and census catalogue of British and Irish Bryophytes*. British Bryological Society. Accessed 28/08/2019.

¹² SNH 2017. *Peatland Condition Assessment*. Available for download from <http://www.snh.gov.uk/docs/A1916874.pdf>. Accessed 28/08/2019.

¹³ Full list of Habitats Directive Annex I habitats and detailed descriptions available at http://jncc.defra.gov.uk/Publications/JNCC312/UK_habitat_list.asp. Accessed 28/08/2019.

¹⁴ Further details and download of the Scottish Biodiversity List available at <https://www.nature.scot/scotlands-biodiversity/scottish-biodiversity-strategy/scottish-biodiversity-list>. Accessed 28/08/2019.

2.15 The assessment is undertaken according to the Ecological Impact Assessment guidance¹⁵, which recommends that a level of ecological importance is assigned to ecological features using a geographical context. Table 1 summarises the geographical contexts as they relate to the Site.

Table 1: Ecological importance categories.

Importance	Context	Characteristics
International	Europe	• Viable area of habitat included in Annex I of the Habitats Directive.
National	UK\ Scotland	• A viable area of priority habitat listed in the UKBAP. • Habitat area >1% of the national resource. • An area of habitat fulfilling the criteria for designation as an ASSI/SSSI.
Regional	Highland	• Importance more than County but not sufficient for SSSI designation.
County	Sutherland	• County-designated (e.g. Biodiversity Action Plan) habitats. • Habitat area >1% of the county resource. • Semi-natural, ancient woodland >0.25ha in extent.
Local	Site & 2 km buffer	• Habitats that are unique or otherwise significant in the local area. • Areas of habitat that contribute to the local ecological resource.
Site	Site only	• Common, often anthropogenic habitats.

Groundwater dependent terrestrial ecosystems

2.16 Potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) were identified during the NVC survey according to the current SEPA guidance (Guidance Note 31)¹⁶. Their location-specific groundwater dependency is assessed because GWDTE are not always groundwater dependent, so their inappropriate consideration can cause unnecessary constraint. Assessment is based on the physical environment (geology, hydrology & topography) of the potential GWDTE as well as their floristics.

¹⁵ CIEEM 2018. Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.. Download at <https://cieem.net/resource/guidelines-for-ecological-impact-assessment-ecia/>. Accessed 28/08/2019.

¹⁶ Land Use Planning System SEPA Guidance Note 31. Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. Download available at <http://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf>. Accessed 28/08/2019.

3 Baseline

- 3.1 The baseline describes the habitats of the site in relation to its general characteristics, designations, habitats & vegetation communities.

General description

- 3.2 In this section, the physical characteristics of Corriegarth are described. They are illustrated in Map 1.
- 3.3 Corriegarth extends across 1,348 ha on the western edge of the Monadhliath Mountains, to the southeast of Loch Ness. It is centred around three shallow valleys, draining westward, separated by two ridges. The southern ridge is up to 60 m tall and the northern is less well-defined.
- 3.4 Higher ground is located to the north, east & south of Corriegarth, and there is a low summit on the west, so the site occupies something of a hollow within high ground. The altitude ranges from 430 m in the west to up to 770 m on the north, east & south boundaries. Summits to around 800 m lie immediately beyond the latter parts of the boundary; and the low ground of the Great Glen lies to the west.
- 3.5 A typical habitat assemblage for the Monadhliath Mountains is present, with extensive peatland and smaller areas of acid grassland; dry & wet heath; and flush. A 23-turbine wind farm ('Corriegarth') is located in the centre of the site that is otherwise managed for sheep grazing & grouse shooting.

Designations

- 3.6 In this section, statutory & non-statutory designations associated with Corriegarth is identified. The distribution of designated habitats is illustrated in Map 2.

Statutory designations

- 3.7 Statutory designations provide a legal basis to the protection of certain sites and their specified natural heritage features.

Designated sites

- 3.8 There are no statutory designations within 5 km from the Corriegarth boundary. The closest such sites are located at a distance of 5.6 km, in the base of the Great Glen, where they are designated for open water & woodland habitat or species.

Non-statutory designations

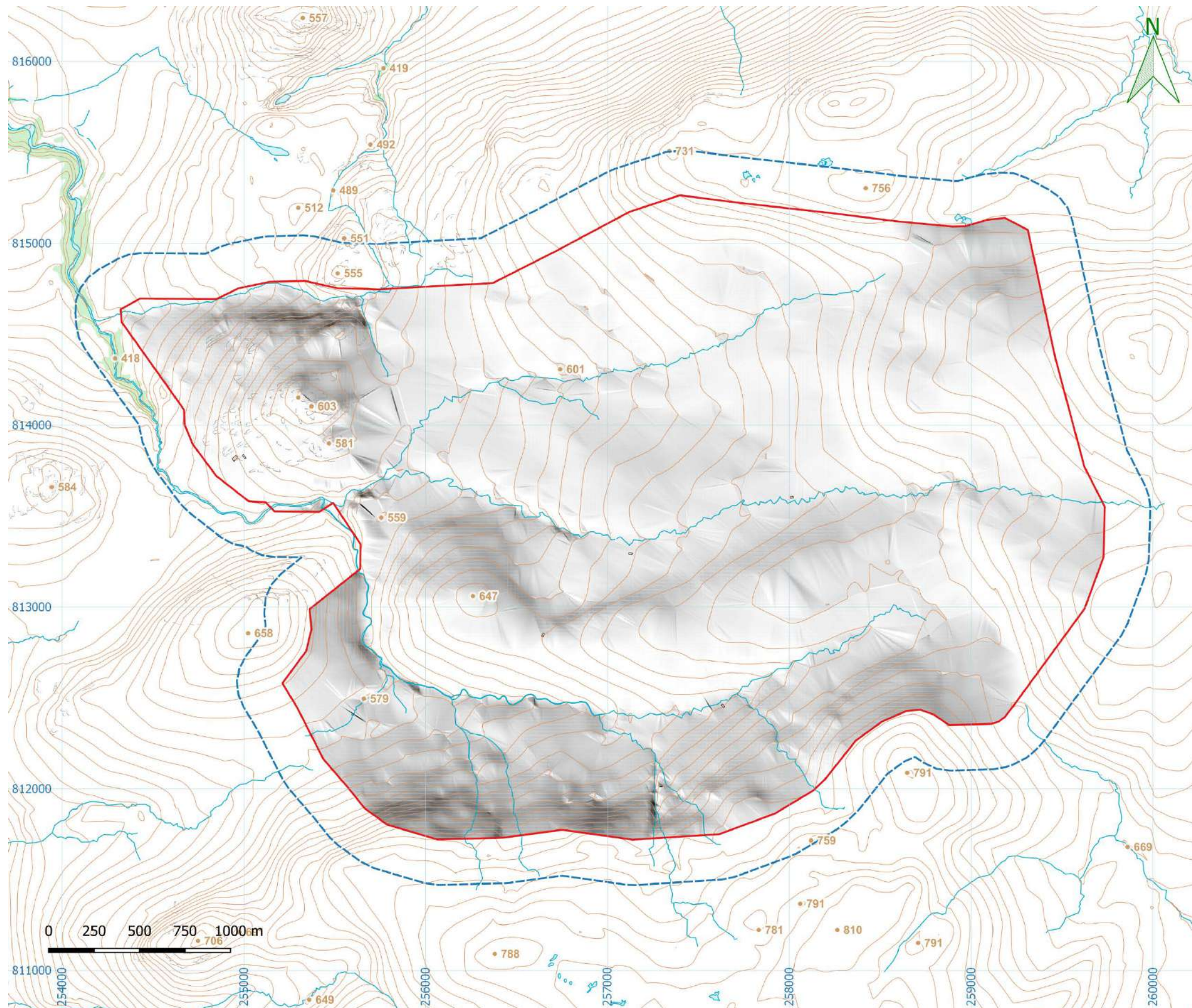
- 3.9 Non-statutory designations do not have the same legal basis as statutory designations. They identify areas of natural heritage importance and assist related planning & management decisions. The non-statutory designations relating to the site are illustrated in Map 2 and described below.

Carbon & Peatland Map

- 3.10 The Carbon & Peatland Map predicts extensive peatland across Corriegarth except for the west-centre; and the north-western & north-eastern margins. This distribution is illustrated in Map 2. In the eastern parts of Corriegarth, the extensive peatland is predicted to be 'Class 1' and in the northwest there is an area of Class 2 around the low summit. Class 1 & 2 peatland defines "nationally important carbon-rich soils, deep peat and priority peatland habitat". They are distinguished from each other by Class 1's likelihood of "high conservation value" and Class 2's "potentially high conservation value and restoration potential."²

Ancient woodland inventory

- 3.11 A single area of ancient woodland contiguous with several other several units extends along the river valley to the northwest of Corriegarth. It does not extend into the site but the upper parts are included within the 250 m GWDTE buffer. This area and the adjoining areas are classified as "Ancient (of semi-natural origin)".



Corriegarth

Physical features

Map 1: Physical features.

Legend

Boundary & buffers

- Site boundary
- GWDTE buffer (250 m)

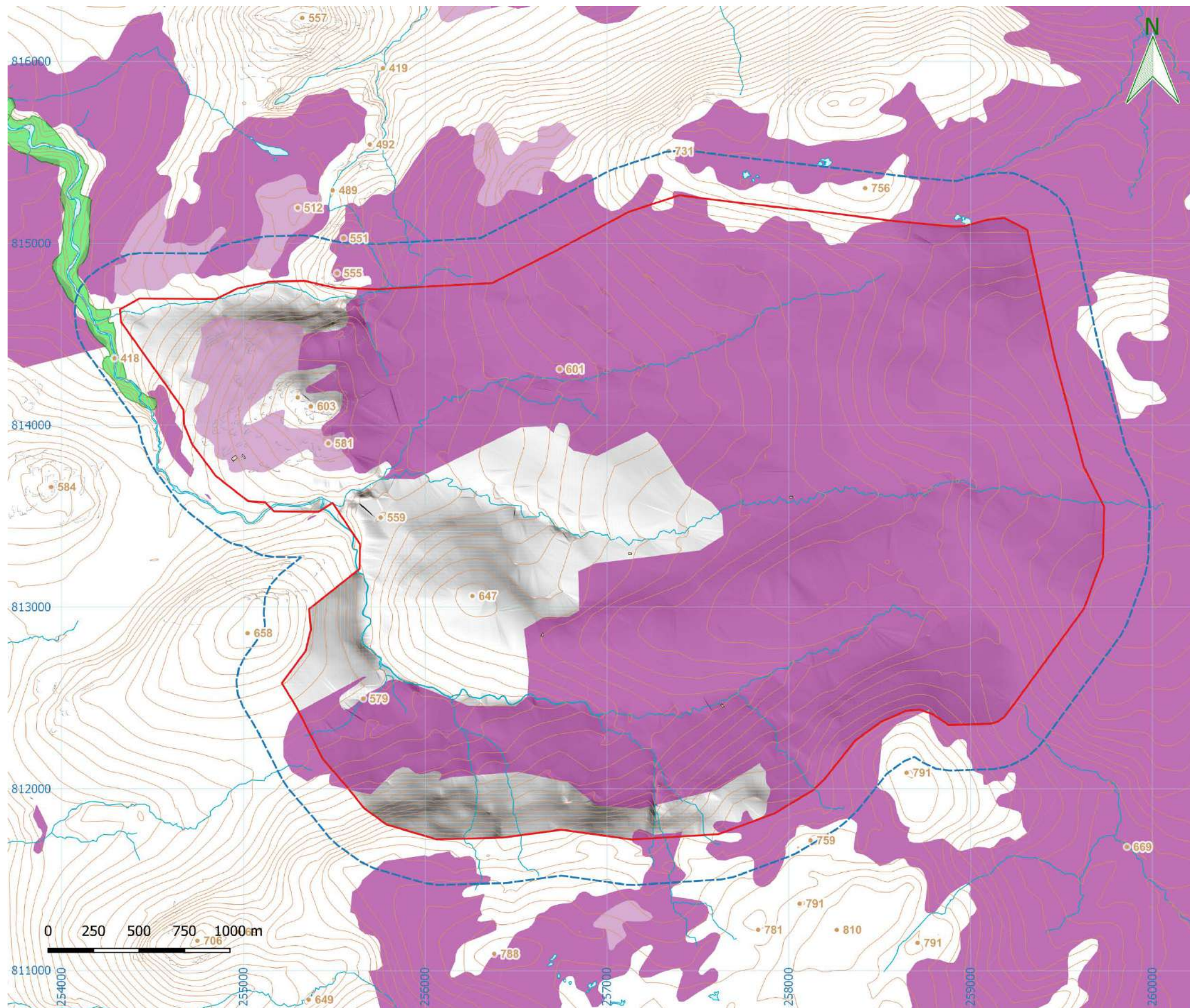
Physical features

- Point height (m)
- Contours (10 m)
- Building
- Crags
- Watercourse
- Waterbody
- Woodland

Scale: 1:22,500 at A3



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Corriegarth

Non-statutory designations

Map 2: Non-statutory designations.

Legend

Boundary & buffers

- Site boundary
- GWDTE buffer (250 m)

Non-statutory designations

- Ancient Woodland Inventory

Carbon & Peatland Map

- Class 1
- Class 2

Physical features

- Point height (m)
- Contours (10 m)
- Building
- Crags
- Watercourse
- Waterbody

Scale: 1:22,500 at A3



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Habitats & vegetation

- 3.12 The conditions & results of the field survey in relation to the ecology & floristics of the habitats & vegetation communities are described in this section. Statistics on the absolute (ha) & relative (%) habitat cover are provided in Table 4. Habitat distribution is illustrated in Maps 3 & 4 and a large-scale map (Map 10) in Appendix 2. This latter map includes Target Notes and labels for the NVC communities within the habitats. Maps 3 & 4 provide habitat details only.

Survey

- 3.13 Survey was undertaken by Dr Andy McMullen (AM), the Principal Botanist at Botanæco¹⁷, in two phases. The central area was surveyed between the 16th to 18th of September, 2019 and the periphery on the 22nd of October, 2019. Although the latter phase is outside the survey season (April to September, inclusive) this not considered to affect the quality of the data because of the perennial nature of the vegetation and the prior, seasonal experience of the site.
- 3.14 The weather during both phases of survey was comparable, albeit cooler in October, and ideal for survey: overcast with occasional mist over the summits surrounding the site; occasional breaks revealing blue sky; very occasional rain showers; and low to moderate wind speeds.

General habitat description

- 3.15 A general overview of the habitats within Corriegarth is provided in this section with more detailed, individual habitat & vegetation accounts in the following sections.
- 3.16 Peatland habitat is extensive across 1,206.4 ha (89.4 %) of Corriegarth, including blanket bog (1092.6 ha, 81.0 %); wet heath (111.6 ha, 8.3 %); & wet modified bog (2.2 ha, 0.2 %). There is also an additional 48.8 ha (3.6 %) of peatland mosaics with each other, acid/neutral flush, bedrock outcrops & dry heath. The extensive & highly eroded blanket bog habitat extends onto relatively steep slopes around the edge of Corriegarth where it often has a slumped, 'blocky' appearance. Wet heath occupies water-shedding ridges & slopes; and the low summit in the west where it is most extensive and widely forms mosaics with bedrock outcrops & small hollows with blanket bog.
- 3.17 Surface water draining from the peatland habitat to shallow depressions, watercourses & eroded channels in the blanket bog is associated with acid/neutral flush. Numerous, linear areas of this habitat type are located at mid-slope and below, especially in the southwest. A total of 20.1 ha (1.5 %) is present. Further upslope, marshy grassland is associated with the same topographic

features, especially in the north and alongside watercourses. It accounts for 3.1 ha (0.2 %) alone, and its mosaics with acid/neutral flush account for an additional 4.3 ha, 0.3 %.

- 3.18 Open water habitat is located in the base of 'peat pans' (extents of eroded, bare peat). The open water is therefore associated with varying degrees of blanket bog vegetation regeneration. It accounts for a seasonally variable 0.3 ha (<0.1 %).
- 3.19 Infrastructure associated with the current wind turbine array and a pre-existing track includes hard-surfacing across 16.5 ha (1.2 %). There is also 22.4 ha (1.7 %) of disturbed ground dating from construction of the wind farm that is a variable mix of bare peat and regenerating vegetation.

Habitat & vegetation descriptions

- 3.20 Habitats & their constituent vegetation communities are described in this section in relation to their distribution, floristic composition, ecology, condition & management.

B1.1 Acid grassland – unimproved

- 3.21 Unimproved acid grassland is typically unenclosed hill-grazing land that is present on acid soils. It is usually species-poor and often grades into wet or dry, dwarf shrub heath. When the cover of heath is greater than 25% the habitat is mapped as D5 dry heath - acid grassland mosaic.

U4a *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland, typical sub-community

- 3.22 The U4a *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* (sheep's-fescue - common bent - heath bedstraw) grassland, Typical sub-community is very variable, but generally species-poor, even & indistinctive. At Corriegarth, the U4a grassland has a closed, grass-dominated sward that includes abundant to frequent common bent, heath bedstraw, sheep's-fescue and sweet vernal grass; and occasional heath bedstraw, ribwort plantain, tormentil, wavy hair-grass & Yorkshire fog. Mosses are locally abundant, especially *Hylocomium splendens*, *Pleurozium schreberi* & *Rhytidiadelphus squarrosus*. Heathland species are locally frequent and suggestive of the grassland's origins. They include: blaeberry, deergrass, heather & *Polytrichum commune*.
- 3.23 Several small areas of U4a acid grassland are located in the west of Corriegarth, on the lowest ground and in well-drained situations. An area of disturbed ground that has regenerated a grass sward is also included in this community (see Target Note 13, in Appendix 1).
- 3.24 Pastoral activity is sustained by the moderately productive U4a grassland. It is therefore grazed preferentially by sheep.

¹⁷ Further background on Dr Andy McMullen is available at <https://botanaeco.co.uk/the-staff>. Accessed 28/08/2019.

Corriegarth

Habitats I

Map 3: Phase 1 habitat overview.

Legend

Boundary & buffers

-  Site boundary
-  GWDTE buffer (250 m)

Phase 1 habitats

-  B1.1 - Acid grassland - unimproved
-  B1.1-B5-E2.1 - Acid/marshy grassland-acid flush
-  B1.1-E2.1 Acid grassland-flush mosaic
-  B5 - Marsh/marshy grassland
-  B5-E2.1 - Marshy grassland-acid flush mosaic
-  D1.1 - Dry dwarf shrub heath - acid
-  D1.1-D2 - Dry-wet heath mosaic
-  D2 - Wet dwarf shrub heath
-  D2-E1.6.1 - Wet heath-blanket bog mosaic
-  D2-I1.4.1 - Wet heath-rock exposure mosaic
-  D5 - Dry heath/acid grassland
-  D6 - Wet heath/acid grassland
-  E1.6.1 - Blanket bog
-  E1.6.1-E2.1 - Blanket bog-acid flush mosaic
-  E1.7 - Wet modified bog
-  E1.7-E2.1 - Modified wet bog-blanket bog mosaic
-  E2.1 - Flush and spring - acid/neutral flush
-  G1.3 - Standing water - oligotrophic
-  J5 - Other habitat
-  Tracks & hard-standing

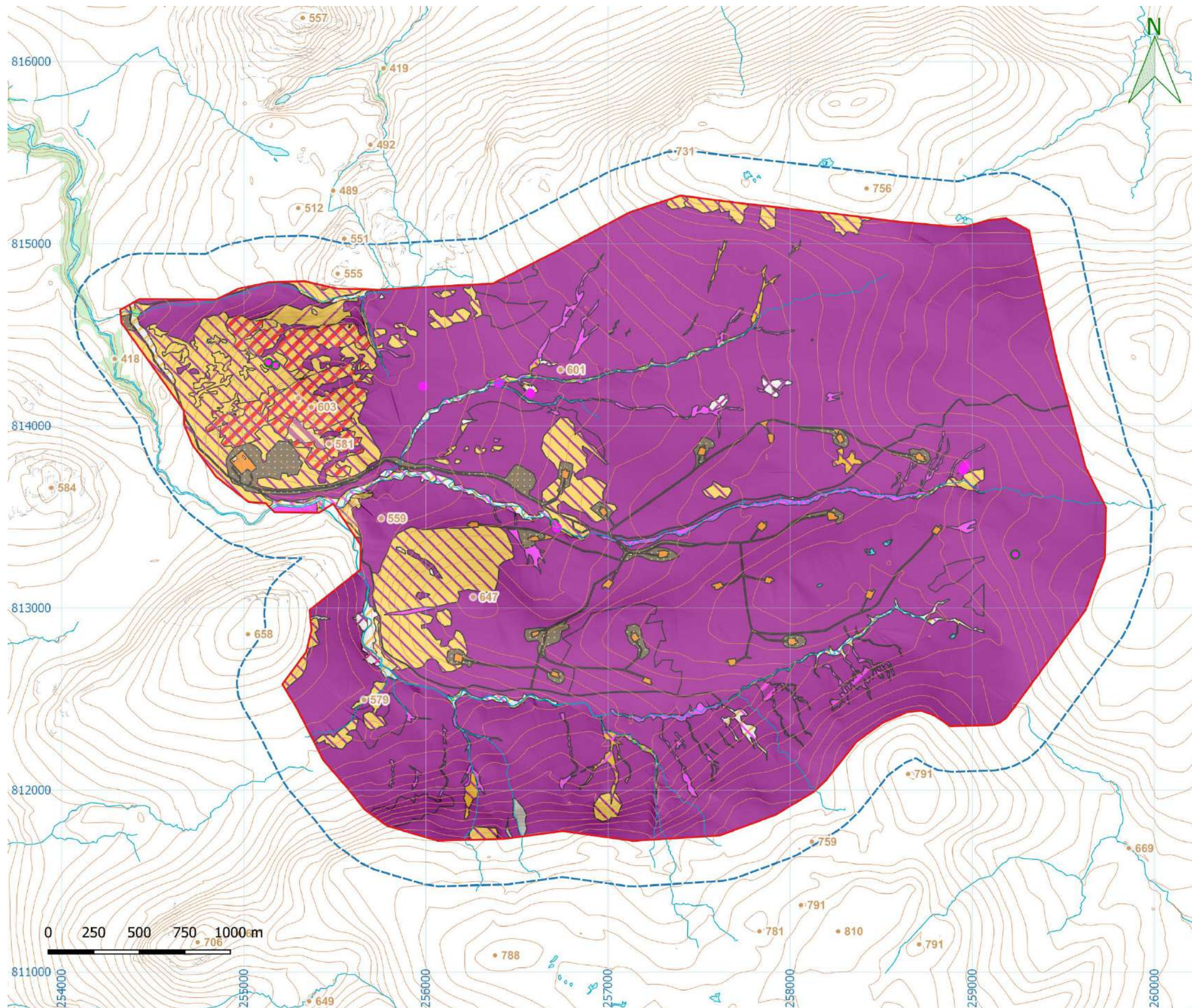
Point features

-  A3.1 - Broadleaved tree
-  E2.1 - Acid/neutral flush (<3 m diam.)
-  E2.2 - Basic flush (<3 m diam.)

Scale: 1:22,500 at A3



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Corriegarth

Habitats II

Map 4:
3D Phase 1 habitat overview.

Legend

Boundary & buffers

-  Site boundary
-  GWDTE buffer (250 m)

Phase 1 habitats

-  B1.1 - Acid grassland - unimproved
-  B1.1-B5-E2.1 - Acid/marshy grassland-acid flush
-  B1.1-E2.1 Acid grassland-flush mosaic
-  B5 - Marsh/marshy grassland
-  B5-E2.1 - Marshy grassland-acid flush mosaic
-  D1.1 - Dry dwarf shrub heath - acid
-  D1.1-D2 - Dry-wet heath mosaic
-  D2 - Wet dwarf shrub heath
-  D2-E1.6.1 - Wet heath-blanket bog mosaic
-  D2-I1.4.1 - Wet heath-rock exposure mosaic
-  D5 - Dry heath/acid grassland
-  D6 - Wet heath/acid grassland
-  E1.6.1 - Blanket bog
-  E1.6.1-E2.1 - Blanket bog-acid flush mosaic
-  E1.7 - Wet modified bog
-  E1.7-E2.1 - Modified wet bog-blanket bog mosaic
-  E2.1 - Flush and spring - acid/neutral flush
-  G1.3 - Standing water - oligotrophic
-  J5 - Other habitat
-  Tracks & hard-standing

Point features

-  A3.1 - Broadleaved tree
-  E2.1 - Acid/neutral flush (<3 m diam.)
-  E2.2 - Basic flush (<3 m diam.)

Scale: 1:22,500 at A3



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Table 2: List of corresponding Phase 1 habitats & National Vegetation Classification plant communities, and mosaics; and their absolute & relative areas.

Phase 1 habitat code & title	Area		National Vegetation Classification code & title	Area	
	Absolute (ha)	Relative (%)		Absolute (ha)	Relative (%)
B1.1 Acid grassland - unimproved	4.69	0.35	U4a <i>Festuca ovina</i> - <i>Agrostis capillaris</i> - <i>Galium saxatile</i> grassland, typical sub-community	2.28	0.17
			U4a-U5a mosaic	0.35	0.03
			U5a <i>Nardus stricta</i> - <i>Galium saxatile</i> grassland, species-poor sub-community	1.99	0.15
			U5b <i>Nardus stricta</i> - <i>Galium saxatile</i> grassland, <i>Agrostis canina</i> - <i>Polytrichum commune</i> sub-community	0.07	0.00
B1.1-B5 mosaic	1.09	0.08	U5b-U6a mosaic	1.09	0.08
B1.1-B5-E2.1 mosaic	2.96	0.22	M6a-M6b-U5a-U6a mosaic	2.96	0.22
B1.1-E2.1 mosaic	14.86	1.10	M6a-M6b-U5a mosaic	4.49	0.33
			M6a-M6c-U5a mosaic	3.77	0.28
			M6a-U4a-U5a mosaic	3.59	0.27
			M6a-U5b-U6a mosaic	1.40	0.10
			M6b-M6c-U5a mosaic	1.61	0.12
B5 Marsh/marshy grassland	3.09	0.23	U6a <i>Juncus squarrosus</i> - <i>Festuca ovina</i> grassland, <i>Sphagnum</i> spp. sub-community	3.09	0.23
B5-D2 mosaic	0.15	0.01	M15b-U5b mosaic	0.15	0.01
B5-E2.1 mosaic	4.11	0.30	M6a-M6b-U6a mosaic	3.87	0.29
			M6c-U6a mosaic	0.24	0.02
D1.1 Dry dwarf shrub heath - acid	1.09	0.08	H16 <i>Calluna vulgaris</i> - <i>Arctostaphylos uva-ursi</i> heath	0.02	0.00
			H-H12a mosaic	0.86	0.06
			H-H14 mosaic	0.22	0.02
D1.1-D2 mosaic	8.85	0.66	H-H12a-M15b mosaic	4.32	0.32
			H-M15b mosaic	4.53	0.34
D2 Wet dwarf shrub heath	111.56	8.27	M15b <i>Trichophorum cespitosum</i> - <i>Erica tetralix</i> wet heath, typical sub-community	63.48	4.71
			M15b-M15c mosaic	38.56	2.86
			M15c <i>Trichophorum cespitosum</i> - <i>Erica tetralix</i> wet heath, <i>Cladonia</i> spp. sub-community	9.52	0.71
D2-E1.6.1 mosaic	1.96	0.15	M15b-M17a mosaic	1.96	0.15
D2-I1.4.1 mosaic	34.90	2.59	M15b-M15c mosaic	34.90	2.59
D5 Dry heath/acid grassland	0.59	0.04	H-H12a-U5a mosaic	0.19	0.01
			H-U4a mosaic	0.40	0.03
D6 Wet heath/acid grassland	2.19	0.16	H-M15b-U5a mosaic	0.96	0.07
			M15c-U4a mosaic	1.24	0.09
E1.6.1 Blanket sphagnum bog	1,092.61	80.98	H-M17b mosaic	4.22	0.31
			M17a <i>Trichophorum cespitosum</i> - <i>Eriophorum vaginatum</i> blanket mire, <i>Drosera rotundifolia</i> - <i>Sphagnum</i> spp. sub-comm.	72.34	5.36
			M17a-M17b mosaic	1,015.55	75.27
			M17b <i>Trichophorum cespitosum</i> - <i>Eriophorum vaginatum</i> blanket mire, <i>Cladonia</i> spp. sub-community	0.24	0.02
			M19 <i>Calluna vulgaris</i> - <i>Eriophorum vaginatum</i> blanket mire	0.27	0.02
E1.6.1-E2.1 mosaic	2.48	0.18	M17a-M2-M6a mosaic	2.48	0.18
E1.7 Wet modified bog	2.20	0.16	M20 <i>Eriophorum vaginatum</i> blanket and raised mire	2.20	0.16
E1.7-E2.1 mosaic	0.61	0.05	M20-M6c mosaic	0.61	0.05

Phase 1 habitat code & title	Area		National Vegetation Classification code & title	Area	
	Absolute (ha)	Relative (%)		Absolute (ha)	Relative (%)
E2.1 Flush and spring - acid/neutral flush	20.08	1.49	M2-M6a mosaic	0.28	0.02
			M2-M6a-M6b mosaic	0.97	0.07
			M32b <i>Philonotis fontana</i> - <i>Saxifraga stellaris</i> spring, <i>Montia fontana</i> - <i>Chrysosplenium oppositifolium</i> sub-community	0.02	0.00
			M4 <i>Carex rostrata</i> - <i>Sphagnum fallax</i> mire	0.10	0.01
			M6a <i>Carex echinata</i> - <i>Sphagnum fallax/denticulatum</i> mire, <i>Carex echinata</i> sub-community	2.51	0.18
			M6a-M6b mosaic	3.74	0.28
			M6a-M6b-M6c mosaic	4.73	0.35
			M6a-M6b-M2 mosaic	2.14	0.16
			M6a-M6c mosaic	2.74	0.20
			M6a-U5a mosaic	0.29	0.02
			M6c <i>Carex echinata</i> - <i>Sphagnum fallax/denticulatum</i> mire, <i>Juncus effusus</i> sub-community	2.56	0.19
E2.2 Flush and spring – basic flush	n.a. (point features)		M10a <i>Carex dioica</i> - <i>Pinguicula vulgaris</i> mire, <i>Carex viridula</i> subsp. <i>oedocarpa</i> - <i>Juncus bulbosus/kochii</i> sub-community	n.a. (point features)	
G1.3 Standing water - oligotrophic	0.31	0.02	n.a.	0.31	0.02
J5 Other habitat	38.85	2.88	Non NVC: Disturbed ground	22.35	1.66
			Non NVC: Tracks & wind farm infrastructure	16.50	1.22
Totals:	1,349.21	100.00	Totals:	1,349.21	100.00

U5a *Nardus stricta*-*Galium saxatile* grassland, species-poor sub-community

- 3.25 Scattered areas of U5a *Nardus stricta*-*Galium saxatile* (mat-grass - heath bedstraw) grassland, species-poor sub-community are associated with the riparian zone (e.g. Target Note 28, in Appendix 1). The community is defined by the dominance of mat-grass and the low cover & number of its associates in species-poor, uneven & indistinctive grassland vegetation. Those associates that are present include species derived from adjoining or mosaic areas of acid/neutral flush, other acid grassland & heath. Only heath bedstraw, *Hylocomium splendens* & tormentil are consistent across all areas.
- 3.26 U5a grassland is associated with steep slopes and the flanks of small watercourses that have cut deeply into the peat. In both types of location, there is drainage & dewatering of the peat that may otherwise remain damp, seasonally at least, as a result of high rainfall & surface water inputs. The dominance of mat grass is therefore likely to relate to cycles of drought & waterlogging.

U5b *Nardus stricta*-*Galium saxatile* grassland, *Agrostis canina*-*Polytrichum commune* sub-comm.

- 3.27 In places where soil conditions are more consistently wet, in the same riparian locations as the U5a sub-community, the abundant to dominant mat-grass is joined by a high cover of frequent to abundant: *Polytrichum commune* &/or *Sphagnum*. *Polytrichum commune* is the most abundant moss but *Hylocomium splendens*, *Sphagnum capillifolium*, *Sphagnum fallax* & *Sphagnum mucronatum* are locally frequent in some stands. Additional associates include heath rush, soft rush, tormentil & velvet bent. This assemblage identifies the U5b *Nardus stricta*-*Galium saxatile*

(mat-grass – heath bedstraw) grassland, *Agrostis canina*-*Polytrichum commune* (velvet bent - moss) sub-community.

- 3.28 U5b acid grassland is concentrated around the larger watercourses in the west of Corriegarth. It is most extensively a mosaic component with other acid grassland & acid/neutral flush vegetation. An intermediate position between these is occupied by the U5b.

B5 Marsh/marshy grassland

- 3.29 Marshy grassland is a poorly-defined habitat including grasslands rich in purple moor-grass, rushes and/or sedges, and pastures in which tall herbs such as meadowsweet and valerian are abundant. They are located on wet, gleyed or peaty soils that are waterlogged rather than covered by water (i.e. 'swamp'). A single related NVC community is present.

U6a *Juncus squarrosus*-*Festuca ovina* grassland, *Sphagnum* spp. sub-community

- 3.30 In the northeast of Corriegarth there are discrete & mosaic areas of dominance by heath rush in species-poor, even & indistinctive vegetation. *Sphagnum fallax* & *Polytrichum commune* are abundant in the field layer; and there is frequent to occasional: *Sphagnum fallax*, *Sphagnum mucronatum* & *Sphagnum girgensohnii*. This assemblage is indicative of the U6a *Juncus squarrosus*-*Festuca ovina* (heath rush-sheep's-fescue) grassland, *Sphagnum* spp. sub-community.

- 3.31 Grazing or post-erosion regeneration is responsible for formation of the heath rush-dominated sward. These factors are also responsible for the low cover & number of associates. See also Target Note 5, in Appendix 1.

D1.1 Dry dwarf shrub heath – acid

- 3.32 Acid, dwarf shrub heath is usually associated with well-drained podsoles and has a greater than 25% cover of heather and other sub-shrubs. It is confined to well-drained situations so at Corriegarth, it is generally located on steep slopes. Four communities were recorded, one of which is not described in the NVC. Each is described in the following sections.

H Non-NVC heath

- 3.33 Indistinctive stands of heather & hypnaceous mosses (*Hylocomium splendens*, *Hypnum cupressiforme/jutlandicum* & *Pleurozium schreberi*) with a very limited number & cover of associates (including include occasional to rare: bell heather, deergrass, green-ribbed sedge, mat-grass & purple moor-grass) is described as 'H' non-NVC heath. The species-poverty is a reflection of the dense, unbroken canopy of heather under which even the mosses are limited in their cover.

H12a *Calluna vulgaris*-*Vaccinium myrtillus* heath, *Calluna vulgaris* sub-community

- 3.34 Dry heath covers the steep, craggy flanks of a minor watercourse crossing the southern boundary (see Target Note 46, in Appendix 1). The short, open, heather canopy is a result of the craginess & exposure; and to a lesser extent: grazing. Associates include frequent: blaeberry, *Cladonia* spp., crowberry, *Hylocomium splendens*, *Pleurozium schreberi*, sheep's-fescue & wavy hair-grass. This species-poor, even & indistinctive assemblage identifies the H12a *Calluna vulgaris*-*Vaccinium myrtillus* (heather-blaeberry) heath, *Calluna vulgaris* (heather) sub-community. Locally distinctive species here include rare: mountain everlasting & oak fern.

H14 *Calluna vulgaris*-*Racomitrium lanuginosum* heath

- 3.35 Scattered amongst the more exposed, rocky outcrops of the low summit in the west of Corriegarth are a low canopy of wind-clipped heather & mounds of the moss *Racomitrium lanuginosum*. This species-poor & indistinctive assemblage is identified as the H14 *Calluna vulgaris*-*Racomitrium lanuginosum* (heather-moss) heath in the absence of additional species. See also Target Note 27 (in Appendix 1).

H16 *Calluna vulgaris*-*Arctostaphylos uva-ursi* heath

- 3.36 A single and poorly-developed area of H16 *Calluna vulgaris*-*Arctostaphylos uva-ursi* (heather-bearberry) heath is located at Target Note 43 (in Appendix 1). It is identified from the association of a dense, low, wind-clipped heather canopy & frequent bearberry. This distinctive vegetation is otherwise species-poor & uneven with occasional bell heather, deergrass, heath rush & pill sedge the only associates. It is apparent that the heather canopy has become closed and that is now threatening the persistence of the bearberry amongst other species.

D2 Wet dwarf shrub heath

- 3.37 Wet dwarf shrub heath has a more than 25% cover of heather and other sub-shrubs but it differs from the dry heath in having a range of mesic peatland species, including *Sphagnum*. The low summit in the west has the most extensive area of wet heath at Corriegarth. Here, it forms a mosaic with bedrock outcrops & blanket bog. Otherwise, the wet heath is associated with steep slopes &/or water-shedding ridges

M15b *Trichophorum cespitosum*-*Erica tetralix* wet heath, typical sub-community

- 3.38 Sheltered stands of wet heath have a variable assemblage of abundant heather &/or deergrass with frequent to occasional blaeberry, *Cladonia* spp., cross-leafed heath, great sundew, heath milkwort, heath rush, *Hylocomium splendens*, *Hypnum jutlandicum*, mat grass, *Pleurozium schreberi*, purple moor-grass, *Rhytidiadelphus squarrosus*, *Sphagnum capillifolium*, *Sphagnum compactum*, *Sphagnum cuspidatum*, *Sphagnum tenellum*, tormentil & velvet bent. This assemblage is identifiable as the M15b *Trichophorum cespitosum*-*Erica tetralix* (deergrass-cross-leafed heath) wet heath, typical sub-community.
- 3.39 Much of the wet heath is influenced by grazing, especially in the west, where the habitat is most extensive. A recent cessation of this influence is apparent in the vigorous regeneration of heather over an estimated 2-3 seasons. See also Target Note 30, in Appendix 1.

M15c *Trichophorum cespitosum*-*Erica tetralix* wet heath, *Cladonia* spp. sub-community

- 3.40 In exposed situations amongst the wet heath, on low mounds & slopes facing the southwest/the prevailing wind, the wet heath has a pale appearance because of the abundance of lichens (*Cladonia portentosa* especially). These are associated with a low, wind-clipped canopy of abundant to dominant heather with abundant: *Hylocomium splendens*; frequent deergrass; and occasional: blaeberry, cowberry, crowberry, common bent, heath rush, *Sphagnum capillifolium*, *Sphagnum tenellum* & tormentil. This assemblage, and the dominance of lichens especially, identifies the M15c *Trichophorum cespitosum*-*Erica tetralix* (deergrass - cross-leafed heath) wet heath, *Cladonia* (lichen) spp. sub-community.
- 3.41 The M15c wet heath community is best-developed over the low summit in the west. Elsewhere, it is scattered through the M15b wet heath on low exposed mounds (with the M15b in less exposed situations). See also Target Notes 2, 7 & 27, in Appendix 1.

E1.6.1 Blanket bog

- 3.42 Blanket bog habitat is distinctive for its accumulations of deep peat (>0.5 m) beneath a variable vegetation composition that includes sub-shrubs, sedges, and most importantly: *Sphagnum*. It is dependent upon a high precipitation : evaporation ratio & topography that favours waterlogged conditions.
- 3.43 Blanket bog is the most extensive habitat at Corriegarth and it becomes almost exclusively dominant to the east, except for linear extents of acid/neutral flush & grassland along

watercourses. Its most distinctive feature is the extent of gullies as a result of erosion. As a result, the blanket bog has a blocky appearance with individual blanket bog/peat units separated by gullies up to 3 m deep, and cutting into the substrate beneath the peat; and up to 5 m wide. In the base of these gullies, there is a variable cover of bare substrate and regenerating acid/neutral flush & blanket bog vegetation. The distribution of ongoing erosion & regeneration is complex, even within individual gullies.

- 3.44 Even though the erosion is indicative of extreme modification and will have led to further impacts (such as dewatering of the isolated peat units) the blanket bog is not mapped as 'modified ... bog' because the *Sphagnum* cover is persistent, albeit potentially reduced. This persistence and the localised, spontaneous regeneration of gullies indicates a moderate degree of resilience.
- 3.45 Drains are also present within the blanket bog. These have been dug in two phases with the most recent being undertaken in the past few years, according to the persistent extent of unvegetated peat (see also Target Note 47, in Appendix 1).
- 3.46 There are three NVC sub-communities associated with the blanket bog, in two NVC communities. M17a & M17b occur in association with each other; and the third, M19a, is associated with a small & distinctive area on the southern boundary.

M17a Trichophorum cespitosum-Eriophorum vaginatum blanket mire, *Drosera rotundifolia-Sphagnum* spp. sub-community

- 3.47 The M17a *Drosera rotundifolia-Sphagnum* spp. (round-leaved sundew - bog-moss) sub-community is the most extensive community within the blanket bog habitat. It is moderately species-rich, even & distinctive. Common bog-cotton, cross-leafed heath, deer grass, hare's-tail bog-cotton and heather are abundant; and there is occasional to rare: blaeberry, bog asphodel, bog-myrtle, crowberry, great sundew & purple moor-grass forming a low (<0.5 m), open sward over a relatively smooth lawn of mosses (lacking distinct hummocks or pools). The moss layer has a moderately species-rich and relatively even assemblage of *Sphagnum* species including *Sphagnum capillifolium*, *Sphagnum papillosum*; and occasional to rare *Sphagnum cuspidatum*, *Sphagnum denticulatum*, *Sphagnum magellanicum*, *Sphagnum subnitens* and *Sphagnum tenellum*. Other bryophytes are frequent and locally dominant. They include: *Aulacomnium palustre*, *Hypnum jutlandicum*, *Hylocomium splendens*, *Pleurozium schreberi*, *Pleurozia purpurea* and *Racomitrium lanuginosum*; and the lichens *Cladonia arbuscula* & *C. uncialis* are locally frequent. See also Target Notes 22 & 24.

M17b Trichophorum cespitosum-Eriophorum vaginatum blanket mire, *Cladonia* spp. sub-comm.

- 3.48 Adjacent to gullies where the peat is dewatered and in exposed situations where surface drying of the vegetation is recurrent, the *Sphagnum* cover is largely replaced by lichens, especially frequent to abundant: *Cladonia portentosa* & *Cladonia uncialis*. Additional associates include abundant: common bog-cotton, deergrass, hare's-tail bog-cotton, heather & *Sphagnum capillifolium*; and frequent to occasional: blaeberry, common bog-cotton, crowberry, heath rush,

Hylocomium splendens, *Hypnum jutlandicum*, *Racomitrium lanuginosum*, *Sphagnum compactum*, *Sphagnum cuspidatum*, *Sphagnum papillosum*, *Sphagnum tenellum* & tormentil.

- 3.49 M17b blanket bog vegetation is intimately associated with the M17a in complex mosaics largely related to the pattern of gullies and their dewatered peat flanks. As a result, it is mapped as a mosaic component with the M17a. See also Target Notes 15 & 54, in Appendix 1.

M19 Calluna vulgaris-Eriophorum vaginatum blanket mire

- 3.50 Two small areas of M19 *Calluna vulgaris-Eriophorum vaginatum* blanket mire are located in the southwest. They are distinct for the association of a sward of hare's-tail bog-cotton with a locally dense canopy of heather. Associates are scarce and limited to hypnaceous mosses (*Hylocomium splendens* & *Hypnum cupressiforme*).
- 3.51 On the southern boundary, the M19a is associated with slumped, blocky peat units, and this gives a stepped appearance to the habitat. The associated dewatering of the peat is reflected in the dense canopy of heather that is assigned to 'H' non-NVC dry heath in a mosaic with the M19a. The other area, in the centre-west, is the dewatered, lower end of a peat-filled, shallow valley.

E1.7 Wet modified bog

- 3.52 Wet modified bog includes vegetation with little or no *Sphagnum*, often with bare peat and patches of deergrass or purple moor-grass. It is usually associated with degraded blanket bogs & raised bogs. It may resemble marshy grassland or wet heath but is distinguished by having a peat depth greater than 0.5 m.

M20 Eriophorum vaginatum blanket and raised mire

- 3.53 Areas of dominance by hare's-tail bog-cotton are associated with wet depressions on the blanket bog where surface water collects on its passage downslope. As a result, conditions are very wet and where there is space between the tussocks of hare's-tail bog-cotton, *Sphagnum fallax* is abundant. This association is not included as a sub-community within the NVC so it is assigned to the M20 *Eriophorum vaginatum* (hare's-tail bog-cotton) blanket and raised mire community.

E2.1 Flush and spring - acid/neutral flush

- 3.54 Acid/neutral, flush/spring habitat is species-poor and supported by surface water or groundwater emerging from non-basic rock or deposits. Vegetation is variable but it is usually dominated by mosses, species-poor & uneven.
- 3.55 Several NVC communities are associated with the flush habitat, including one, M2, that is normally associated with bog pools. The distribution of these communities relates to the qualities of the water sustaining the vegetation. M2 vegetation appears to be sustained by nutrient-poor water emerging from pipes. M32b is also sustained by water emerging from pipes, but in this case, there appears to be some influence from the mineral substrate beneath the peat. The M4 & M6 vegetation is sustained by surface water in dendritic drainage systems focused around the

watercourses. Sub-communities of the latter (M6) form mosaics with each other and U5 acid grassland along watercourses.

M2 *Sphagnum cuspidatum/recurvum* bog pool community

- 3.56 Flushes associated with water discharging from peat pipes are associated with wet lawns of *Sphagnum fallax*. These wet lawns extend over a few square metres and are notable for their extreme species-poverty & unevenness. They are however, distinctive features and the lurid green of the *Sphagnum fallax* is eye-catching. See also Target Notes 12, 22, 25, 51 & 53, in Appendix 1.

M4 *Carex rostrata-Sphagnum fallax* mire

- 3.57 There is a single area of the M4 vegetation community located in the south west of Corriegarth. It is a simple association of bottle sedge, over a wet lawn of *Sphagnum fallax*, with occasional *Sphagnum mucronatum*. It is flushed by water draining from two adjoining areas of the M6 vegetation.

M6 *Carex echinata-Sphagnum fallax/denticulatum* mire

- 3.58 M6 vegetation includes associations of sedge, grass &/or rush and a lawn of *Sphagnum fallax* and related species, including non-*Sphagnum* species (e.g. *Polytrichum commune*) where grazing is intensive. It is frequent across Corriegarth, in lines of surface water flow, including watercourses, but it is not extensive.

M6a *Carex echinata* sub-community

- 3.59 A sward of star sedge rooted in a lawn of *Sphagnum fallax* indicates the M6a *Carex echinata* (star sedge) sub-community. Additional associates are rare to occasional in this species-poor & uneven vegetation and they include: common bog-cotton, common sedge, heath rush, marsh bedstraw sheep's-fescue & tormentil. See also Target Notes 12, 14, 32 & 34.

M6b *Carex nigra-Nardus stricta* sub-community

- 3.60 Pale tufts of mat grass indicate the extent of the M6b *Carex nigra-Nardus stricta* sub-community. It is similar to the other M6 communities with its lawn of moss. In contrast to the similar U5b community, *Sphagnum fallax* is more prominent than *Polytrichum commune* and additional associates are as listed for M6a (see Paragraph 3.59). See also Target Notes 14, 32 & 34.

M6c *Juncus effusus* sub-community

- 3.61 The M6c *Juncus effusus* sub-community is distinct from a distance because of its tall sward of soft rush (e.g. Target Note 31, in Appendix 1). In places, this sward is so dense, and rank with accumulations of rush litter that it excludes other species. Otherwise, there can be a moderately species-rich but uneven assemblage including abundant *Sphagnum fallax*; and frequent to occasional: heath bedstraw, lesser spearwort, marsh cinquefoil, sorrel, star sedge, *Straminergon stramineum* & sweet vernal grass.

M32b-type *Philonotis fontana-Saxifraga stellaris* spring, *Montia fontana-Chrysosplenium oppositifolium* sub-community

- 3.62 Areas of the M32b-type *Philonotis fontana-Saxifraga stellaris* spring (moss-starry saxifrage), *Montia fontana-Chrysosplenium oppositifolium* (blinks-opposite-leaved golden saxifrage) sub-community are very distinctive in a local context. They include springhead vegetation dominated by non-*Sphagnum* mosses with a variable sward of herbs. The water source is presumed to be pipes through the peat that have come into contact with the underlying mineral substrate. This is inferred from the presence of iron-rich water; and the greater degree of productivity than in the M2 vegetation (see Paragraph 3.56) that is associated with peat pipes presumed to flow exclusively within the peat.
- 3.63 Bryophytes dominate the M32b-type vegetation almost exclusively, including variable mixtures of abundant to occasional: *Bryum pseudotriquetrum*, *Calliergonella cuspidata*, *Dichodontium palustre*, *Philonotis fontana*, *Scorpidium revolvens*, *Sphagnum denticulatum* & *Sphagnum fallax*. Herbs include occasional to rare: blinks, bog stitchwort, bulbous rush, common bog-cotton, bog pondweed, cuckooflower, herb bedstraw, lousewort, marsh bedstraw. See also Target Notes 6, 10, 16, 19, 20 & 38, in Appendix 1.

E2.2 Flush and spring - basic flush

- 3.64 Basic flushes typically support a carpet of pleurocarpous 'brown mosses' (e.g. the genera *Drepanocladus*, *Palustriella* or *Scorpidium*), often without *Sphagnum*, overlain by an open, patchy sward of small sedges.

M10a *Carex dioica-Pinguicula vulgaris* mire, *Carex viridula* subsp. *oedocarpa-Juncus bulbosus/kochii* sub-community

- 3.65 There are four indistinct flushes associated with the M10a *Carex dioica-Pinguicula vulgaris* (dioecious sedge-butterwort) mire, *Carex viridula* subsp. *oedocarpa-Juncus bulbosus/kochii* (common yellow-sedge-small rush) sub-community. They are identified from the exposure of mineral substrate (amongst peatland) and the presence of a locally distinctive assemblage including frequent: butterwort, common yellow-sedge, carnation sedge & sheep's-fescue; and occasional: *Blindia acuta* & *Scorpidium scorpioides*.
- 3.66 Surface water & groundwater inputs are variably associated with the M10a flushes. In surface water tracks through the flushes, there is limited vegetation cover, as a result of erosion and cycles of drought & waterlogging. Mosses & the more distinctive vascular plants are therefore associated with the margins or where base-enriched groundwater emerges. The direct access to bases by plants rooted in the mineral substrate therefore results in the presence of base-enrichment indicators whether it is derived from ground or surface water. See also Target Notes 45 & 49, in Appendix 1.

G1.3 Standing water – oligotrophic

- 3.67 Oligotrophic standing water is associated with moderately extensive areas (≈ 0.1 ha) of historical peat erosion that are known as ‘peat pans’. The water cover appears to be very variable across the equally variable topography of the pans. This results in a patchy vegetation cover that includes acid/neutral flush, blanket bog & swamp amongst expanses of bare peat. See Target Notes 22 & 24, in Appendix 1, for examples.

I1.4.1 Other exposure - acid/neutral

- 3.68 Other-exposure – acid/neutral includes the bedrock outcrops associated with the craggy, low summit in the western lobe of Corriegarth. It is associated with crustose lichens and more occasionally, thallose forms; and mosses (including *Andreaea rupestris* & *Racomitrium* spp.).

J5 Other habitat

- 3.69 ‘Other habitat’ includes highly modified ‘habitat’ associated with the current wind farm and a track associated with estate management.

Disturbed ground

- 3.70 Disturbed ground lies alongside most of the wind farm infrastructure but only the larger extents are mapped (>3 m wide). It includes bare peat surfaces being colonised by grass &/or heath rush-dominated swards (e.g. Target Note 13, in Appendix 1).

Tracks & wind farm infrastructure

- 3.71 Non-metalled wind farm & estate tracks cross the centre of the site; and there are additional areas associated with the turbine bases, crane pads, etc. The gravel surfaces are generally unvegetated because of their inhospitable conditions & recent construction, except for the estate tracks that have discontinuous, linear extents of acid grassland.

Notable flora

- 3.72 It should be noted that this report is of a habitat & vegetation survey, not a floristic survey focused upon the detection of notable species. Floristic survey requires different search methods, patterns & timings, potentially over several years; as well as an appropriate expert for each targeted group (e.g. vascular plants, bryophytes, lichens &/or fungi). However, in the course of habitat & vegetation survey, notable species are detected incidentally. These non-comprehensive records are provided & described in this section.
- 3.73 Only one notable species, juniper, was located in one place during the survey: two small (<0.3 m high), heavily grazed shrubs on the south-facing slope of the summit in the western lobe. It is of ‘Least Concern’ in the IUCN Red List and is included on the Scottish Biodiversity List¹⁴. Details on its location are provided in Table 3 & Target Note 23 (in Appendix 1).

Table 3: Notable flora, designations & population size.

Species	Coordinates		Population diameter (m)	Designations	
	X	Y		Red List	Scottish Biodiversity List
Black bog-rush	256702	812033	5	Least Concern	✓

4 Assessment

- 4.1 In this section, the baseline is assessed against legislation & guidance to identify:
- peatland condition
 - valued or sensitive habitats
 - groundwater dependency of Groundwater Dependent Terrestrial Ecosystems.

Peatland Condition Assessment

- 4.2 A series of indicators were employed to assess the peatland condition. The indicators defined in Table 4 were found to relate to Corriegarth. The extent of the condition classes is illustrated in Map 5 & listed in Table 5.

Table 4: Peatland Condition Assessment definitions for Corriegarth.

Condition	Definition
1 Near natural	• Distinctive features present (e.g. shallow bog pools &/or low hummocks). • Moderately species-rich, even & distinctive vegetation. • Distinctive species present & often extensive (e.g. <i>Sphagnum</i> &/or <i>Pleurozia purpurea</i>). • Bare/eroded peat & active erosion absent. • Few or no signs of grazing.
2 Modified	• Distinctive features scarce or absent (e.g. bog pools &/or hummocks). • Moderately species-rich & distinctive vegetation but uneven & dominated by one or two species. • Distinctive species scarce & rarely extensive (e.g. distinctive <i>Sphagnum</i> species are replaced by 'weedy' <i>Sphagnum fallax</i>, or by hypnaceous mosses).
3 Drained	• Drains present & active with an assumed 30 m zone of effect¹². • Other characteristics as '2 Modified'.
4 Erosion	• Gullies & bare peat surfaces; and other features of erosion, such as slumping, present. • Other characteristics as '2 Modified' but lichen are additionally prominent.

- 4.3 Near natural blanket bog was not located. This reflects a history of grazing & erosion and potentially additional factors such as burning. It also reflects the scarcity of basins that can be resistant to drainage and other modifying influences. The peat/peatland is instead, located on gentle to moderate slopes and therefore prone to drainage or erosion. Erosion has been extensive so there are only a few uneroded, 'modified' areas of blanket bog (10.3 ha, 0.9 %). These have been influenced by grazing and the surrounding erosion that has presumably led to

some degree of indirect drainage. Drains are located in 66.1 ha (5.3 %) of uneroded 'Drained' peatland that is comparable to the Modified habitat but for the presence of the drains.

Table 5: Peatland condition areas.

Peatland condition	Area		
	Condition class total (ha)	Absolute (ha)	Relative (%)
2 Modified blanket bog habitat		8.74	0.70
2 Modified blanket bog habitat mosaic	163.6 (13.1 %)	2.57	0.21
2 Modified wet heath		111.56	8.90
2 Modified wet heath mosaic		40.72	3.25
3 Drained blanket bog	66.1 (5.3 %)	66.06	5.27
4 Actively eroding	1,020.0 (81.4 %)	1,020.01	81.37
4 Actively eroding mosaic	3.9 (0.3 %)	3.87	0.31
Totals:		1,253.53	100.00

- 4.4 The extensive erosion has influenced 1,020 ha (81.4 %) of the blanket bog habitat. The pattern of ongoing erosion is complex, with some areas now stabilised and starting to revegetate. This revegetation is most evident in aerial photography where lurid green strips mark the dominance of *Sphagnum fallax* in the base of gullies that are now vegetated with M17a-like blanket bog vegetation. In other places, erosion has continued to cut below the peat and into the underlying substrate (e.g. Target Note 35, in Appendix 1).

Conservation importance

- 4.5 The conservation importance of the habitats and their constituent NVC communities is assessed in Table 7 and illustrated in Map 6.
- 4.6 The extensive peatland habitats (blanket bog, wet modified bog & wet heath) are assessed to be of importance at the Local level. This reflects their low to moderate species richness, evenness & distinctiveness that widely lacks sensitive species and structural features such as pools or hummock-hollow topography. The absence of these features is a consequence of extensive & intensive erosion; and drainage & grazing. However, the peatlands are a highly protected habitat type and important for ecosystem functions as carbon storage within peat accumulations. The peat is especially deep (>0.5 m) beneath the blanket bog. As such, the peatland habitats are valued at the Local level and the blanket bog is additionally valued for its carbon storage.
- 4.7 Other mire features (including the acid/neutral & basic flushes & marshy grassland) and the open water are also assessed to be important at the Local level. All of these habitats are included in

the Highland Biodiversity Action Plan & Scottish Biodiversity List. Furthermore, the acid/neutral flushes are intimately associated with the blanket bog habitat, and the basic flushes are locally distinctive, for their moderate species richness & indicators of base-enrichment. Consequently, they are valued at the Local level despite their small size and low to moderate species-richness, evenness & distinctiveness.

- 4.8 Dry heath habitat is valued at the Local level for the same reasons as the peatland & wetland habitats (i.e. low to moderate species-richness, evenness & distinctiveness; and inclusion in legislation). However, the non-NVC heath 'H' is valued at the Site level for its extremely low species-richness, evenness & lack of distinction.
- 4.9 The remaining habitats including the 'other habitat' & acid grassland are of importance at the Site level. This reflects their low species-richness & distinction; and the latter's modification by pastoral activity. However, many stands of the acid grassland are associated with mire habitats of importance at the Local value. As a result, the intimately associated stands of acid grassland are, in practical terms, of the same Local importance.

Groundwater dependency

- 4.10 British Geological Society hydrogeological mapping¹⁸ identifies that Corriegarth is mostly located on one geological unit: the psammite & semipelite (metamorphosed sedimentary) rock of the Grampian Group. This has the character of a "low productivity aquifer" where "flow is virtually all through fractures and other discontinuities", with "small amounts of groundwater in [the] near surface weathered zone and secondary fractures."¹⁸ There is therefore limited potential across most of the site for the presence of Groundwater Dependent Terrestrial Ecosystems (GWDTE).
- 4.11 Potential GWDTE are assessed in relation to their potential groundwater dependency in Table 8 and their site-specific dependency & distribution is illustrated in Map 7 & Map 8. Four potential GWDTE NVC communities (and seven sub-communities) have been recorded, as listed in Table 8 and bulleted below:
- M15 *Trichophorum cespitosum*-*Erica tetralix* wet heath
 - M15b Typical sub-community
 - M15c *Cladonia* spp. sub-community
 - M6 *Carex echinata*-*Sphagnum fallax/denticulatum* mire
 - M6a *Carex echinata* sub-community
 - M6b *Nardus stricta* sub-community
 - M6c *Juncus effusus* sub-community
 - M10a *Carex dioica*-*Pinguicula vulgaris* mire, *Carex viridula* subsp. *oedocarpa*-*Juncus bulbosus/kochii* sub-community
 - M32b-type spring (*Philonotis fontana*-*Saxifraga stellaris* spring, *Montia fontana*-*Chrysosplenium oppositifolium* sub-community).

¹⁸ British Geological Survey: 1:625 000 hydrogeology map. Available at <https://www.bgs.ac.uk/research/groundwater/datainfo/hydromaps/home.html>. Accessed 28/08/2019.

- 4.12 M15 wet heath includes two sub-communities at Corriegarth: M15b & M15c. These sub-communities are associated with rain-fed locations on moderate slopes too steep for the formation of peat & blanket bog. The more distinctly groundwater-fed M15a sub-community is not present.
- 4.13 Surface water draining from the blanket bog & wet heath collects towards flushed & riparian areas associated with M6 vegetation. The low productivity and species-poor assemblage of the M6 vegetation relates this input of water, and the absence of groundwater influence that would enhance the vegetation's productivity, species richness & distinctiveness (see also Target Notes 12, 14, 32 & 34, in Appendix 1).
- 4.14 Indicators of base-enrichment in the M10a vegetation, and groundwater emerging from obvious springs, relates the groundwater dependency of this GWDTE. However, the influence of surface water is also evident with bases still available from the mineral substrate where flows are not too energetic or variable for the establishment of vegetation, and mosses especially. As a consequence, this GWDTE is assessed to be of high to moderate groundwater dependency, depending upon the degree of influence of ground v. surface water; and the related extent of species-poor but distinctive M10a species (see also Target Notes 45 & 49).
- 4.15 The M32b-type flush vegetation is associated with obvious 'groundwater' discharge. There are no indicators of base enrichment and the water is thought to derive from a pipe within the blanket bog vegetation above. This water appears to have had some contact with the mineral substrate beneath the peat because of the iron-rich discharge and the moderate productivity of the vegetation. See also Target Notes 6, 10, 16, 19 & 20.

Constraints

- 4.16 The key constraints to development identified by the survey & assessment are the following:
- Local importance blanket bog & its related deep peat
 - Moderate to high groundwater dependency M10a & M32b-type flushes.
- 4.17 The distribution of these features is illustrated in Map 9.

Biodiversity Net Gain

- 4.18 Biodiversity Net Gain seeks to improve habitats alongside development. At Corriegarth, the most obvious focus for ecological enhancement is restoration of the extensive, eroded blanket bog. This process has already begun in the west and it poses a significant challenge across 80 % of Corriegarth. Woodland creation is possible on the lowest, riparian areas that are currently associated with acid grassland. These are likely to be capable of supporting a W11/W17-type, birch-oak woodland according to some of the species already present (including woodland relicts).

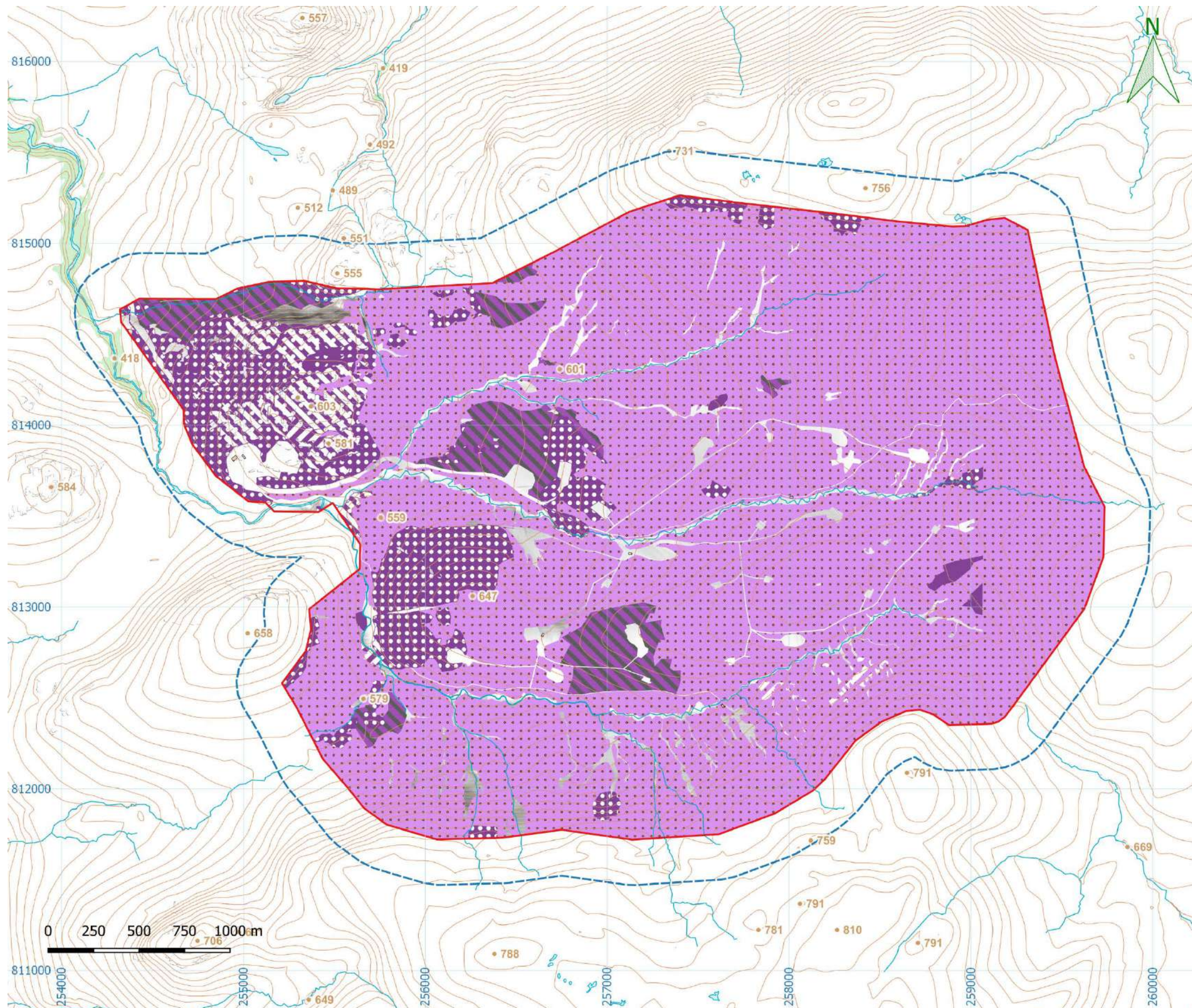
Table 6: Assessment of conservation importance.

Phase 1 habitat code & title	National Vegetation Classification code & title	Notes	Importance
B1.1 Acid grassland - unimproved	U4a <i>Festuca ovina-Agrostis capillaris-Galium saxatile</i> grassland, typical sub-community	Qualities - Scattered areas (< 5 ha in total) of species-poor, moderately even to uneven, indistinctive vegetation. - Secondary habitat derived from dry heath & mire through grazing (U4a & U5a) &/or drainage (U5b). - Included within the Highland Biodiversity Action Plan as a target for biodiversity enhancement. Extent - Extent in Highland not known.	Site
	U5a <i>Nardus stricta-Galium saxatile</i> grassland, species-poor sub-community		
	U5b <i>Nardus stricta-Galium saxatile</i> grassland, <i>Agrostis canina-Polytrichum commune</i> sub-community		
B5 Marsh/marshy grassland	U6a <i>Juncus squarrosus-Festuca ovina</i> grassland, <i>Sphagnum</i> spp. sub-community	Qualities - Small area (3 ha) of low species-richness, evenness & distinctiveness. - Highly modified by grazing. - Included within the Scottish Biodiversity List but not the Highland Biodiversity Action Plan or Habitats Directive. Extent - Extent in Highland or Sutherland not known.	Local
D1.1 Dry dwarf shrub heath - acid	H Non-NVC heath	Qualities - Extremely species-poor, uneven & indistinctive vegetation dominated by a single species. - More species-rich & distinctive forms are included within the Highland Biodiversity Action Plan, Scottish Biodiversity List & Habitats Directive. Extent - Extent in Highland not known.	Site
	H12c <i>Calluna vulgaris-Vaccinium myrtillus</i> heath, <i>Galium saxatile-Festuca ovina</i> sub-community	Qualities - Very small areas (<1 ha) of patchy habitat of low to moderate species-richness & evenness. - Distinctive vegetation in a local context. - Areas of H14 & H16 are so small (<0.1 ha) they are target-noted only (see Target Notes 27 & 43, in Appendix 1). - Included within the Highland Biodiversity Action Plan, Scottish Biodiversity List & Habitats Directive. Extent - Extent in Highland not known.	Local
	H14 <i>Calluna vulgaris-Racomitrium lanuginosum</i> heath community		
	H16 <i>Calluna vulgaris-Arctostaphylos uva-ursi</i> heath		
D2 Wet dwarf shrub heath	M15b <i>Trichophorum cespitosum-Erica tetralix</i> wet heath, typical sub-community	Qualities - Moderately extensive habitat (161 ha including mosaics). - Low to moderate species-richness, evenness & distinctiveness. - Included within the Highland Biodiversity Action Plan, Scottish Biodiversity List & Habitats Directive. Extent - Extent in Highland not known.	Local
	M15c <i>Trichophorum cespitosum-Erica tetralix</i> wet heath, <i>Cladonia</i> spp. sub-community		
E1.6.1 Blanket <i>Sphagnum</i> bog	M17a <i>Trichophorum cespitosum-Eriophorum vaginatum</i> blanket mire, <i>Drosera rotundifolia-Sphagnum</i> spp. sub-c.	Qualities - Extensive habitat (>1,000 ha). - Low to moderate species-richness, evenness & distinctiveness. - Extensively eroded and influenced by grazing & drainage. - Associated with deep peat deposits (>0.5 m). - Included within the Highland Biodiversity Action Plan, Scottish Biodiversity List & Habitats Directive. Extent - Extent of blanket bog in Highland c. 200,000 ha.	Local
	M17b <i>Trichophorum cespitosum-Eriophorum vaginatum</i> blanket mire, <i>Cladonia</i> spp. sub-community		
	M19 <i>Calluna vulgaris-Eriophorum vaginatum</i> blanket mire, <i>Erica tetralix</i> sub-community		
I1.4.1 Other exposure - acid/neutral	n.a.	Qualities - Scattered small areas in an intimate mosaic with blanket bog & wet heath. - Not included within the Highland Biodiversity Action Plan, Scottish Biodiversity List or Habitats Directive. Extent - Extent in Highland not known.	

Phase 1 habitat code & title	National Vegetation Classification code & title	Notes	Importance
E1.7 Wet modified bog	M20 <i>Eriophorum vaginatum</i> blanket and raised mire	Qualities • Very small areas of habitat (<3 ha). • Very low species-richness, evenness & distinctiveness. • Associated with deep peat deposits (>0.5 m). • Included within the Highland Biodiversity Action Plan, Scottish Biodiversity List & Habitats Directive. Extent • Extent of blanket bog in Highland c. 200,000 ha.	Local
E2.1 Flush and spring - acid/neutral flush	M4 <i>Carex rostrata-Sphagnum fallax</i> mire M6 <i>Carex echinata-Sphagnum fallax/denticulatum</i> mire • M6a <i>Carex echinata</i> sub-community • M6b <i>Nardus stricta</i> sub-community • M6c <i>Juncus effusus</i> sub-community	Qualities • Individually small (<0.5 ha) scattered areas totalling 23 ha (including mosaics). • Low to locally moderate species-richness, evenness & distinctiveness. • Included within the Highland Biodiversity Action Plan & Scottish Biodiversity List but not the Habitats Directive. Extent • Extent in Highland not known.	Local
	M32b -type	Qualities • Scattered small areas represented by points (<20 m in the longest dimension). • Moderate species-richness & evenness; and locally distinctive. • Included within the Highland Biodiversity Action Plan & Scottish Biodiversity List but not the Habitats Directive. Extent • Extent in Highland not known.	Local
E2.2 Flush and spring - basic flush	M10a <i>Carex dioica-Pinguicula vulgaris</i> mire, <i>Carex viridula</i> subsp. <i>oedocarpa</i> - <i>Juncus bulbosus/kochii</i> sub-community	Qualities • Small areas represented by points (<20 m in the longest dimension). • Moderate species-richness & evenness; and distinctive locally for the presence of base-enrichment indicators. • Included within the Highland Biodiversity Action Plan & Scottish Biodiversity List but not the Habitats Directive. Extent • Extent in Highland not known.	Local
G1.3 Open water -	n.a.	• Variable habitat including various mire elements (blanket bog, wet heath, acid/neutral flush & swamp) as well as bare peat expanses. • Included within the Highland Biodiversity Action Plan & Scottish Biodiversity List but not the Habitats Directive.	Local
J5 Other habitat	n.a.	• Artificial or highly modified habitat. • Distinctive only for the presence of some common ruderal herbs.	Site

Table 7: Assessment of groundwater dependency by habitat & NVC community, notes and the guidance & site-specific groundwater dependency.

Phase 1 habitat code & title	National Vegetation Classification code & title	Notes	Groundwater dependency	
			Guidance	Site-specific
D2 Wet dwarf shrub heath	M15b <i>Trichophorum cespitosum</i> - <i>Erica tetralix</i> wet heath, typical sub-community	- Extensive areas of habitat located on rain-fed, water-shedding slopes; and often above the likely zone of groundwater emergence. - There are no floristic elements (e.g. yellow-sedges) that suggest base-enrichment derived from groundwater.	Moderate	Low
	M15c <i>Trichophorum cespitosum</i> - <i>Erica tetralix</i> wet heath, <i>Cladonia</i> spp. sub-community			
E2.1 Flush and spring - acid/neutral flush	M6 <i>Carex echinata</i> - <i>Sphagnum fallax/denticulatum</i> mire M6a <i>Carex echinata</i> sub-community M6b <i>Nardus stricta</i> sub-community M6c <i>Juncus effusus</i> sub-community	- One area of M6c is associated with discharge from a spring as well as conducting surface water from the surrounding blanket bog. Other areas have the characteristics listed below: - Located in shallow, waterlogged depressions amongst blanket bog and in riparian settings. - Not associated with obvious, diffuse or point sources of groundwater emergence. - There are no floristic elements (e.g. yellow-sedges) that suggest base-enrichment derived from groundwater.	High	Moderate to Low
	M32b -type spring	- Associated with iron-rich water discharging from peat pipes. Rarely present as scattered mounds in the base of eroded peat gullies. - Moderate productivity presumed to relate to contact of the peat pipe with the underlying, mineral substrate. - There are no floristic elements (e.g. yellow-sedges) that suggest base-enrichment derived from groundwater (cf. M10a).	High	Moderate
E2.2 Flush and spring - basic flush	M10a <i>Carex dioica</i> - <i>Pinguicula vulgaris</i> mire, <i>Carex viridula</i> subsp. <i>oedocarpa</i> - <i>Juncus bulbosus/kochii</i> sub-community	- Obviously associated with groundwater emergence at springs & the influence of this is also apparent in the frequency of floristic indicators of base-enrichment. - Surface water flows across the flushes its passage is marked by a scarcity of vegetation.	High	Moderate to High



Corriegarth

Peatland

Map 5: Peatland Condition Assessment.

Legend

Boundary & buffers

- Site boundary
- GWDTE buffer (250 m)

Peatland Condition Assessment

- 2 Modified blanket bog
- 2 Modified wet heath
- 2 Modified wet heath mosaic
- 2 Modified blanket bog mosaic
- 3 Drained blanket bog
- 4 Actively eroding
- 4 Actively eroding mosaic

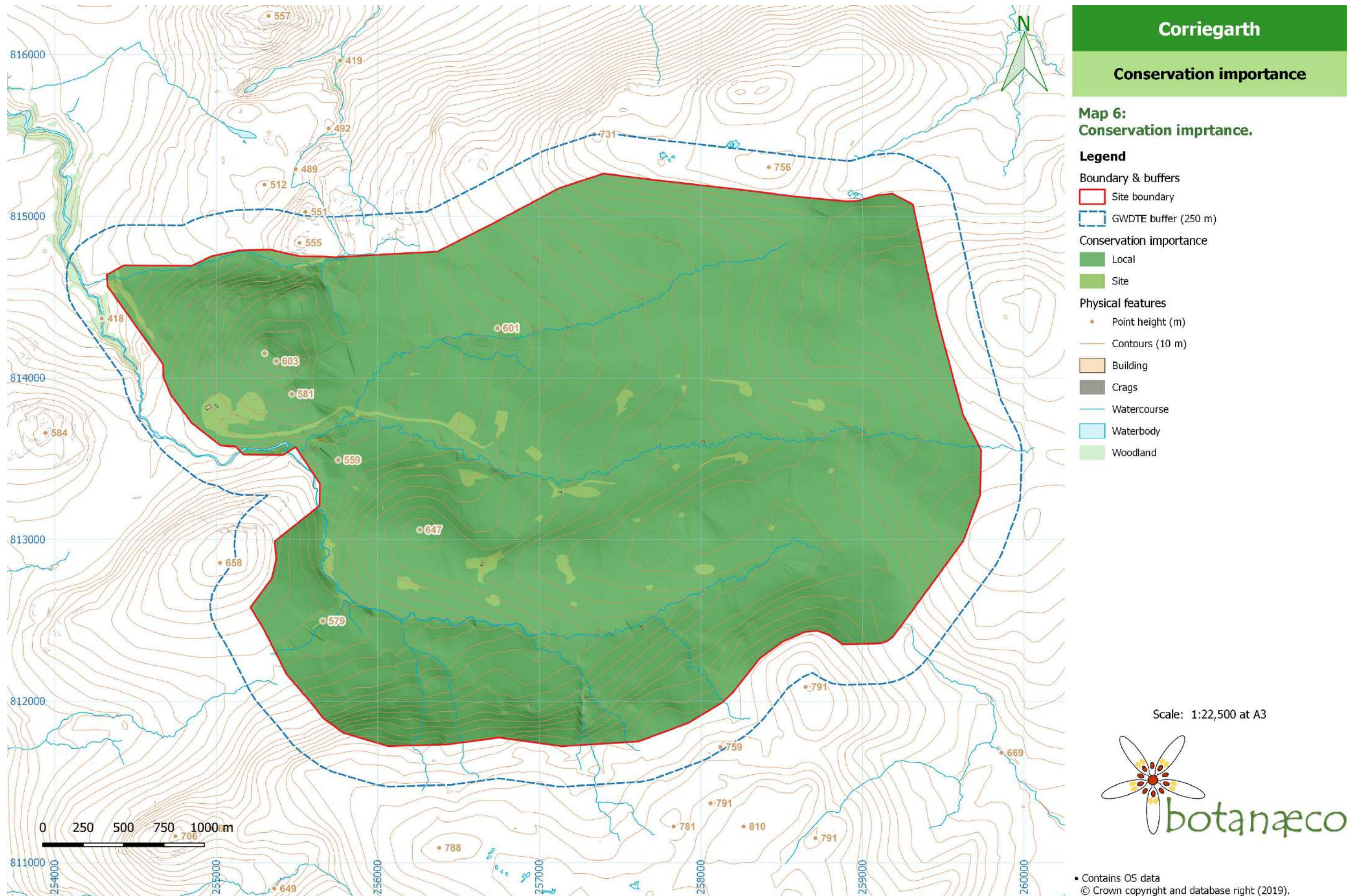
Physical features

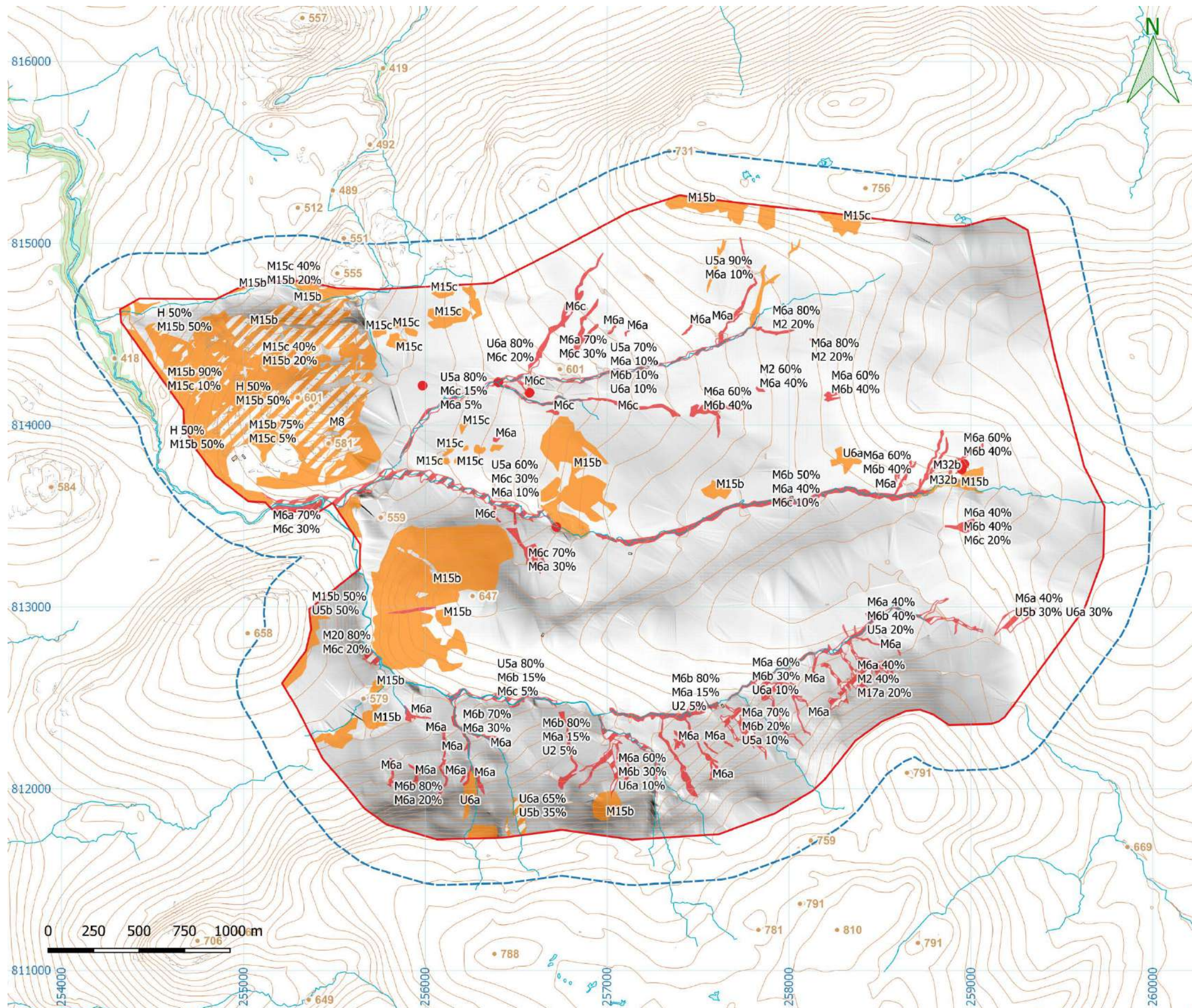
- Point height (m)
- Contours (10 m)
- Building
- Crags
- Watercourse
- Waterbody
- Woodland

Scale: 1:22,500 at A3



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Corriegarth

GWDTE

Map 7:
Guidance groundwater dependency.

Legend

Boundary & buffers

- Site boundary
- GWDTE buffer (250 m)

Guidance groundwater dependency

- High
- High mosaic
- Moderate
- Moderate mosaic
- High (<3 m diam.)

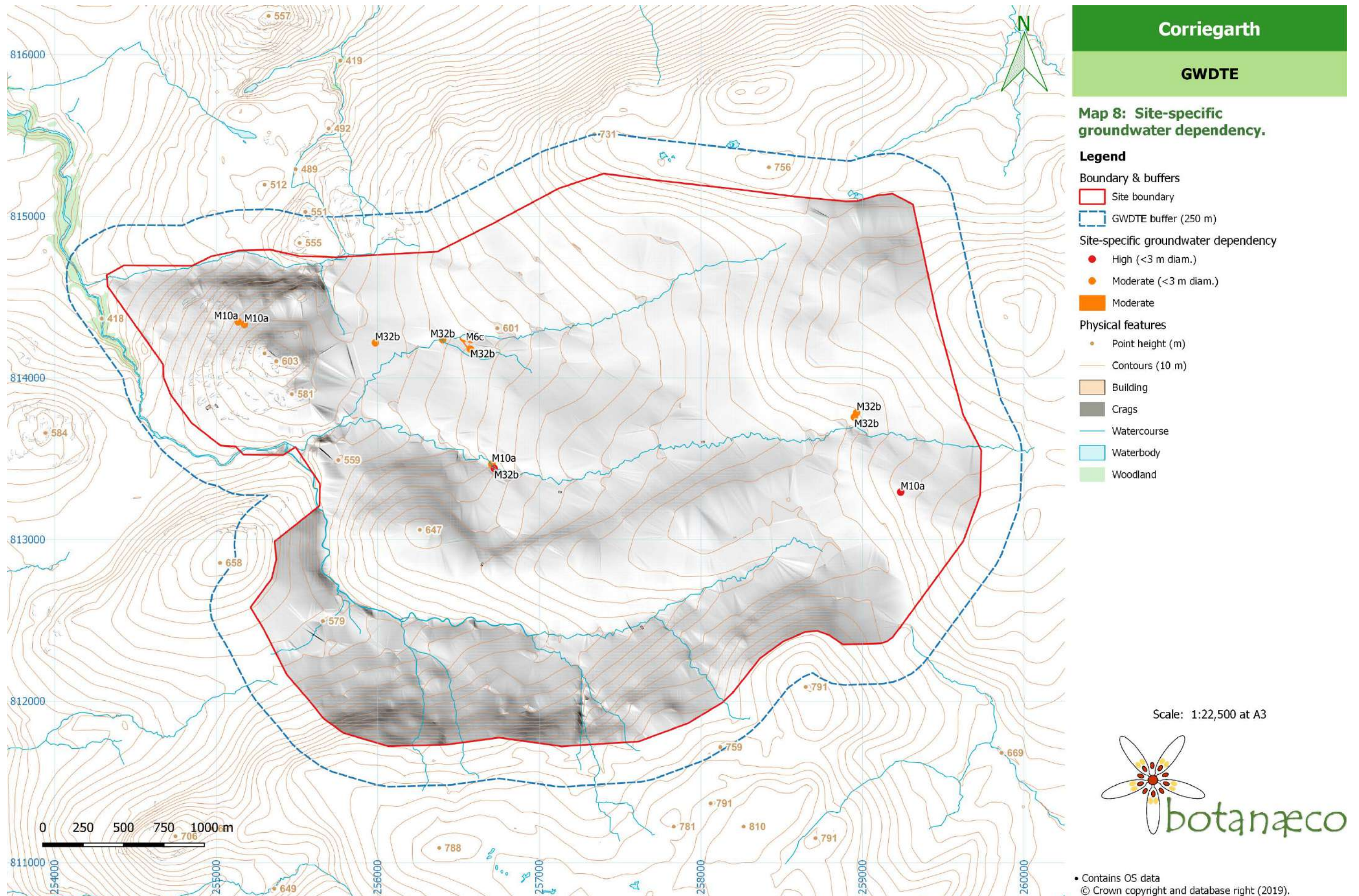
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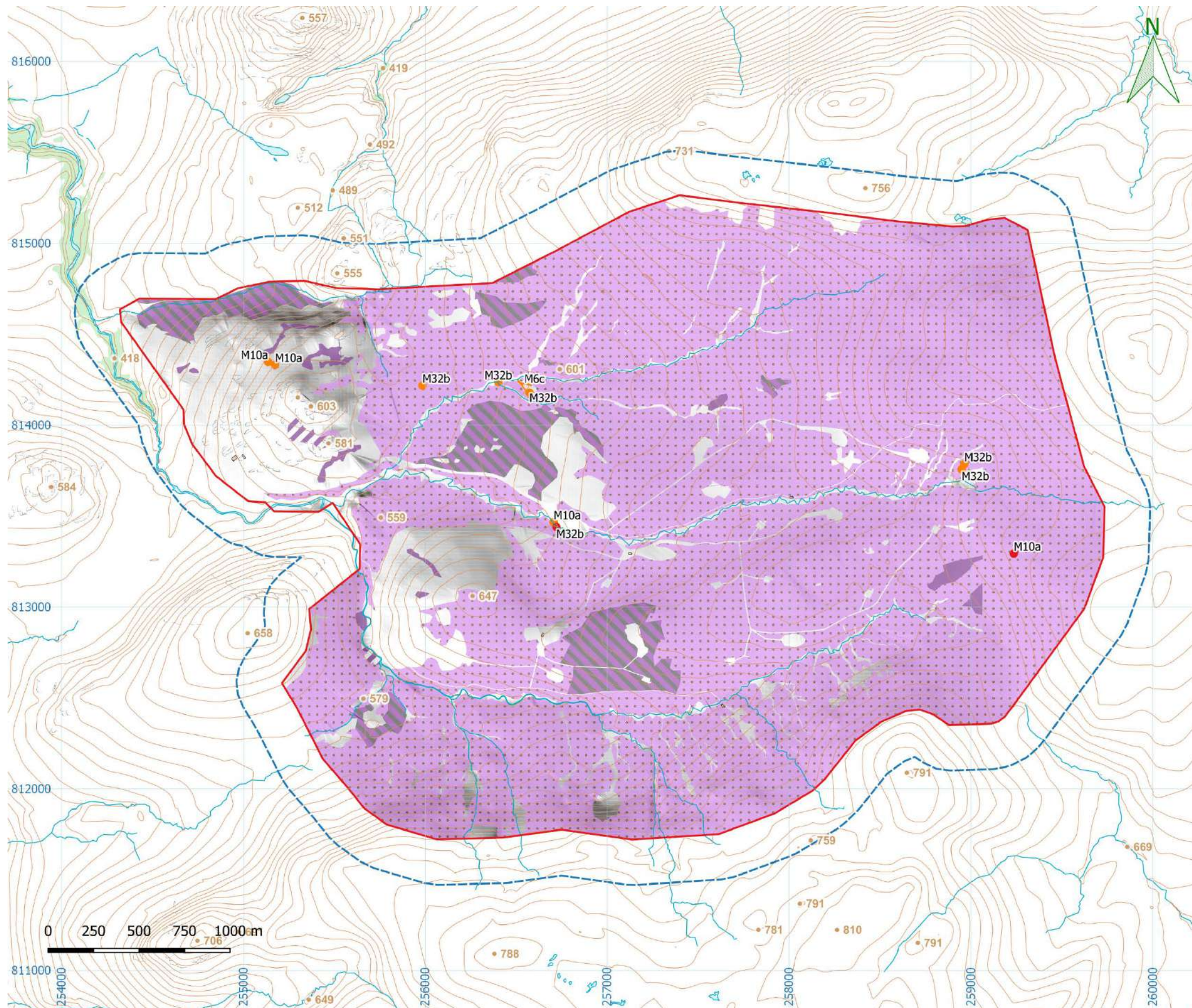
- Point height (m)
- Contours (10 m)
- Building
- Crags
- Watercourse
- Waterbody
- Woodland

Scale: 1:22,500 at A3



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Corriegarth

Constraints

Map 9: Constraints.

Legend

Boundary & buffers

- Site boundary
- GWDTE buffer (250 m)

Constraints

Site-specific groundwater dependency

- Moderate
- High (<3 m diam.)
- Moderate (<3 m)

Peatland Condition Assessment

- 2 Modified blanket bog
- 2 Modified blanket bog mosaic
- 3 Drained blanket bog
- 4 Actively eroding

Physical features

- Point height (m)
- Contours (10 m)
- Building
- Crags
- Watercourse
- Waterbody
- Woodland

Scale: 1:22,500 at A3



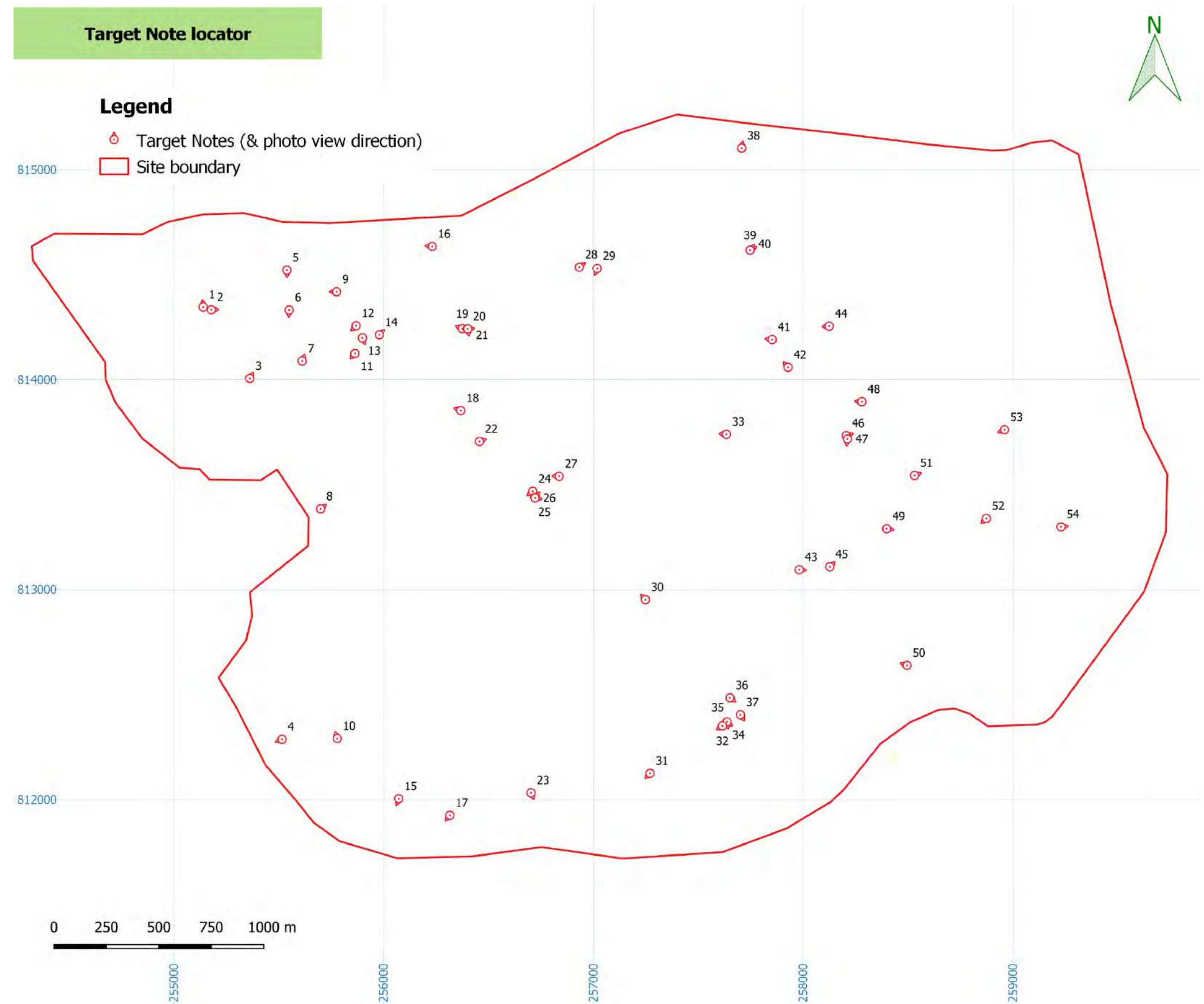
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5 Conclusions

- 5.1 **Corriegarth** encompasses 1,348 ha in the Great Glen, 31 km southwest of Inverness. It is an upland site (>430 m a.s.l.) with extensive peatland habitats. The centre is in operation as a wind farm, and the entire area has been managed for sheep grazing & grouse shooting.
- 5.2 There are **no statutory designations** within 5 km from the Corriegarth boundary.
- 5.3 The **Carbon & Peatland Map** predicts extensive peatland across Corriegarth except for the west-centre; and the north-western & north-eastern margins.
- 5.4 A single area of **ancient woodland** contiguous with several other several units extends along the river valley to the northwest of Corriegarth.
- 5.5 Peatland **habitat** is extensive across 1,206.4 ha (89.4 %) of Corriegarth, including blanket bog (1092.6 ha, 81.0 %); wet heath (111.6 ha, 8.3 %); & wet modified bog (2.2 ha, 0.2 %) and an additional 48.8 ha (3.6 %) of mosaics. The blanket bog is highly eroded. Surface water draining from the peatland is associated with acid/neutral flush (20.1 ha, 1.5 %) or marshy grassland (3.1 ha, 0.2 %) and their mosaic (4.3 ha, 0.3 %). Open water habitat is located in the base of 'peat pans' and it accounts for a seasonally variable 0.3 ha (<0.1 %). Infrastructure associated with the current wind turbine array and a pre-existing track includes hard-surfacing across 16.5 ha (1.2 %) and there is 22.4 ha (1.7 %) of disturbed ground dating from construction of the wind farm.
- 5.6 **Peatland Condition Assessment** identifies that erosion has influenced 1,020 ha (81.4 %) of the blanket bog habitat. The remainder is drained &/or otherwise modified.
- 5.7 The **conservation importance** of the extensive peatland habitats & other mires (acid/neutral & basic flushes, blanket bog, marshy grassland, wet heath & wet modified bog); and most of the dry heath is Local. Some of the dry heath and the 'other habitat' & acid grassland are valued at the Site level.
- 5.8 Groundwater-dependent **GWDTE** are associated with M10a & M32b-type flushes.
- 5.9 The key **constraints** to development are:
 - Local importance blanket bog & its related deep peat
 - Moderate to high groundwater dependency M10a & M32b-type flushes.

Appendix 1

Target Notes



Target No. & coords.	Description	Photograph
1 255139 814347	Blanket bog This area of water-shedding blanket located on a ridge is highly eroded. As a result, the peat is dewatered and an extensive, dense heather canopy is present.	
2 255178 814334	M15c wet heath This area of hummocky moraine is vegetated with M15c with a high cover of lichens.	
3 255361 814007	Blanket bog / bog pools This area of blanket bog in the valley bottom is quite high quality. It has distinctive features such as bog pools and an extensive lawn of <i>Sphagnum</i> species.	
4 255515 812288	Blanket bog: bog pools A bog pool system is present here, in an area ensuring 15 m x 5 m. <i>Sphagnum cuspidatum</i> is dominant and common bog-cotton & <i>Sphagnum denticulatum</i> are frequent.	
5 255538 814523	U6a marshy grassland Heath rush is abundant in this species-poor, even & indistinctive vegetation. <i>Sphagnum fallax</i> & <i>Polytrichum commune</i> are abundant in the field layer; and there is frequent to occasional: <i>Sphagnum fallax</i> , <i>Sphagnum mucronatum</i> & <i>Sphagnum girgensohnii</i> .	

Target No. & coords.	Description	Photograph
6 255549 814333	M32b-type flush Extensive M32b-type flush discharging iron-rich water. A distinctive assemblage of common mosses is present, including: <i>Breutelia chrysocoma</i> , <i>Hylocomium splendens</i> , <i>Rhytidiadelphus triquetrus</i> , <i>Sphagnum fallax</i> & <i>Sphagnum mucronatum</i> .	
7 255611 814090	M15c wet heath Species poor, uneven but distinctive M15c wet heath is present here on exposed slopes. Heather is abundant to dominant in a low, wind-clipped canopy with abundant <i>Hylocomium splendens</i> & <i>Cladonia portentosa</i> . Blaeberry, cowberry, crowberry, common bent, deergrass & heath rush are frequent.	
8 255699 813386	Blanket bog: erosion Lateral movement of the river has undercut the mineral substrate beneath the peat, and led to destabilisation of both (photograph foreground). In the midground of the photograph, it can be seen that such erosion has occurred in the recent past further upstream.	
9 255775 814420	Pipe The peat pipe is located in the base of an eroded gully that retains a depth of peat (>1 m). Its discharge flows away through the blanket bog along a rill that is flanked by indistinctive, M6c acid/neutral flush vegetation.	
10 255778 812292	M32b-type flush This flush vegetation is assumed to be sitting on top of the outlet from a pipe, on a relatively level area of blanket bog. This assumption of a peat pipe is based on the emergence of iron-rich water that would not be associated with surface water. Bryophytes dominate almost exclusively, including abundant <i>Calliergonella cuspidata</i> ; and frequent to occasional: <i>Bryum pseudotriquetrum</i> & <i>Philonotis</i>	

Target No. & coords.	Description	Photograph
	<i>fontana</i> . Herbs include occasional: bog pondweed, cuckooflower & lousewort.	
11 255863 814126	Bog pool Bog pools are scattered in this area, across a radius of c. 15 m.	
12 255868 814258	M1-M2-M6a acid/neutral flush An example of the variability encountered in the base of regenerating gullies. <i>Sphagnum denticulatum</i> (NVC: M1); <i>Sphagnum cuspidatum</i> (NVC: M2); and consolidating rafts of <i>Sphagnum fallax</i> & sedges (M6a) form a mosaic in this location. Such mosaics relate to the main line(s) of water movement and the initial topography with the listed species/communities respectively forming a series from the former to areas of consolidated peat that were formerly upstanding (but are now levelled through the surrounding growth of <i>Sphagnum</i>).	
13 255898 814200	Restored compound/borrow pit Bare peat persists here from the construction phase. A species-poor acid grassland with affinities to the U4a acid grassland is establishing. Common bent & sweet vernal grass are frequent to locally abundant; and heath rush & <i>Polytrichum juniperinum</i> are frequent to occasional.	
14 255979 814215	M6a-M6b acid/neutral flush Located adjacent to watercourses that have cut deeply into the peat. As a result, the peat is somewhat dewatered, eroded & slumped. Surface water flushes across the vegetation from the adjoining bog habitat and this maintains acid/neutral flush vegetation identified as M6a & M6b sub-communities respectively associated with sedges or mat-grass (the whitish tufts in the photograph); and a lawn of <i>Sphagnum</i> is associated with both.	

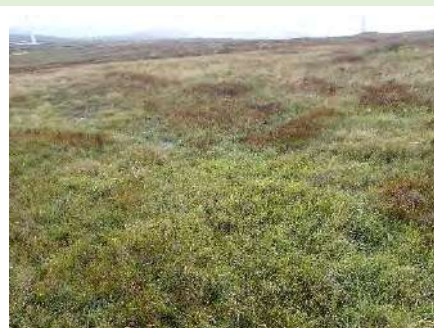
Target No. & coords.	Description	Photograph
15 256071 812005	M17b blanket bog: shallow peat The peat is shallow here (0.4 m to 0.7 m deep) because it is located on an historically eroded area that has now regenerated M17b blanket bog vegetation.	
16 256231 814636	M32b-type flush This area of M32b-type flush vegetation is comparable to that described by Target Note 83. However, this area is much more heavily trampled by deer or sheep. As a result, the vegetation cover is eroded and bare peat is exposed.	
17 256315 811926	Blanket bog: historical erosion Historical erosion & slumping that has regenerated its vegetation cover.	
18 256367 813854	Dubh lochan It is not clear if this dubh lochan is a natural/primary feature or if it has arisen as a result of erosion. It was rather lifeless at the time of survey & unvegetated but assessment was complicated by wind-ruffling of the water surface. A narrow fringe of <i>Sphagnum cuspidatum</i> is present in sheltered margins.	
19 256374 814244	M32b-type spring A spring discharges here to a narrow, steep runnel. Blinks & <i>Philonotis fontana</i> are abundant; with frequent <i>Bryum pseudotriquetrum</i> , <i>Dichodontium palustre</i> & marsh bedstraw.	

Target No. & coords.	Description	Photograph
20 256398 814243	M32b-type spring An M32b-type spring here has the same assemblage as at Target Note 104. However, it is distinct for being heavily poached and heavily iron-stained.	
21 256400 814243	Woodland relicts A small area & number of woodland relicts on low crags by the watercourse. The relicts include: ferns (<i>Dryopteris</i> sp.) & great wood-rush.	
22 256456 813707	Peat pan / open water This is one of a number of peat pans that have been mapped as 'open water' because they have the character of shallow lochans. There is a series of vegetation zones relating the duration &/or depth of water. Their spatial & floristic variability makes it difficult to assign NVC vegetation communities but elements of the following are present: M1, M2, M3, M6, M17 & S9. Variable mixtures of the following species are present. Common bog-cotton & <i>Sphagnum papillosum</i> are abundant; bottle sedge is locally abundant and the following are frequent to occasional: <i>Aulacomnium palustre</i> , bulbous rush, <i>Sphagnum capillifolium</i> , <i>Sphagnum cuspidatum</i> , <i>Sphagnum denticulatum</i> & <i>Sphagnum fallax</i> . Peripherally, M17a vegetation is starting to establish.	
23 256702 812033	Notable species: juniper Two diminutive juniper bushes are located in this vicinity. They are no more than 0.25 m high and grazed to a dense, small crown.	

Target No. & coords.	Description	Photograph
24 256710 813469	Peat pan / open water M17a vegetation is establishing in the base of this peat pan. As a result, bare peat & open water are limited in extent. The bareness of the peat associated with the flooded areas suggests there is recurrent drying & wetting that limits the re-establishment of vegetation.	
25 256721 813440	M2-M6 acid/neutral flush / peat pip A peat pipe emerges from a step created by erosion to flush the lowered/eroded surface with water. Fresh gravel in a small pile suggests that the pipe has recently made contact with the mineral substrate below the peat.	
26 256721 813438	Peat pipes A series of peat pipes discharge along this section of valley side. The associated vegetation is <i>Sphagnum fallax</i> -dominated M2.	
27 256836 813541	M15c wet heath M15c wet heath is associated with exposed locations on top of mounds and south to westerly aspects. In places, <i>Racomitrium lanuginosum</i> is frequent and the vegetation shifts towards H14-type (heather- <i>Racomitrium lanuginosum</i>) heath. The vegetation is species-poor, even & distinctive. <i>Cladonia portentosa</i> , deergrass, heather & <i>Racomitrium lanuginosum</i> are abundant; and the following are frequent to occasional: bell heather, cross-leafed heath, <i>Sphagnum capillifolium</i> & tormentil. Rock protruding through the thin layer of peat associated with the M15b is associated with a cover of <i>Andreaea rupestris</i> , <i>Cladonia podetia</i> , crustose lichens & <i>Racomitrium affine</i> .	

Appendix 1: Target notes

Target No. & coords.	Description	Photograph
28 256932 814537	U5a acid grassland Mat grass is exclusively domain in much of the U5a acid grassland but where alluvium is deposited especially, there can be a species-poor & even assemblage of common bent, common dog-violet, heath bedstraw, sheep's-fescue, sweet vernal grass & wavy hair-grass.	
29 257017 814531	Crags These low crags next to the watercourse are notable for the presence of heather & <i>Racomitrium lanuginosum</i> ; and occasional crowberry.	
30 257247 812953	M15b wet heath The M15b vegetation is variable and this variability is related to the microtopography & aspect. In exposed locations, deergrass is dominant; and heather dominates in sheltered hollows. Associates include frequent to occasional: <i>Cladonia</i> spp. (especially amongst deergrass in exposed places), heath rush, <i>Hylocomium splendens</i> , <i>Racomitrium lanuginosum</i> , <i>Sphagnum capillifolium</i> , <i>Sphagnum cuspidatum</i> , <i>Sphagnum tenellum</i> & tormentil.	
31 257269 812126	Acid/neutral flush A dense, tall sward of soft-rush is present in this area of M6c acid/neutral flush. In spite of this, there is a moderately species-rich assemblage including abundant <i>Sphagnum fallax</i> , and frequent to occasional: heath bedstraw, lesser spearwort, marsh cinquefoil, sorrel, star sedge, <i>Straminergon stramineum</i> & sweet vernal grass.	
32 257614 812352	M6a acid/neutral flush vegetation This stand of M6a acid/neutral flush vegetation is rich in hare's-tail bog-cotton. It may therefore represent an intermediate stage between the presumed, colonising lawn of <i>Sphagnum fallax</i> and the M17a vegetation in the same situation described at Target Note 37.	

Target No. & coords.	Description	Photograph
33 257633 813741	M29 flush Surface water emerging from a well-defined runnel spreads out and slows its flow here, to create wet channels associated with M29 soakway vegetation. Bog pondweed & <i>Sphagnum denticulatum</i> are abundant with frequent: bog asphodel & common bog-cotton; and occasional: common yellow-sedge, deergrass & <i>Sphagnum cuspidatum</i> .	
34 257634 812370	M6a-M6b acid/neutral flush M6a & M6b acid/neutral flush vegetation is located in a shallow, linear depression conducting surface water toward the watercourse.	
35 257636 812371	Severe erosion Severe erosion has cut through the peat and into the underlying mineral substrate. The peat is up to 2 m deep and erosion has cut up to 0.8 m into the underlying mineral substrate.	
36 257650 812486	Stoney flush Peat has eroded from this area. As a result, the underlying mineral substrate is exposed and a small number of distinctive species are rooted within it, including frequent to abundant: common sedge & <i>Sphagnum denticulatum</i> ; and frequent to occasional: bog asphodel, butterwort, common bog-cotton & common yellow-sedge.	
37 257700 812405	Re-vegetation Eroded gully bases, such as this example, appear with a lurid green colour in recent aerial photography. This is presumed to relate to extensive regeneration by <i>Sphagnum fallax</i> especially. However, by the time of the survey, a well-established sward of deergrass & hare's-tail bog-cotton had also established with frequent to occasional: <i>Aulacomnium palustre</i> , blaeberry, crowberry, heath rush, <i>Hylocomium splendens</i> , <i>Sphagnum capillifolium</i> , <i>Sphagnum fallax</i> , <i>Sphagnum papillosum</i> &	

Target No. & coords.	Description	Photograph
	wavy hair-grass. This vegetation is identifiable as the See also Target Note 32.	
38 257706 815104	M32b-type spring Spring located on deep peat c. 1.5 m deep. Presumed to emerging from a peat pipe that has had some contact with the underlying, mineral substrate because of the relatively productivity of the vegetation. A lawn of moss is prominent with abundant <i>Philonotis fontana</i> , <i>Scorpidium revolvens</i> , <i>Sphagnum denticulatum</i> & <i>Sphagnum fallax</i> . Rooted in this is a patchy cover of frequent: bog stitchwort, bulbous rush, common bog-cotton, cuckooflower & marsh-marigold (sub. sp. <i>minor</i>). Grazing maintains the dominance of the mosses to an uncertain extent. Trampling has created numerous pockmarks but the vegetation cover remains intact.	
39 257746 814618	Peatland & bog pools This area appears to have a somewhat domed shape but this is presumed to relate to its presence on a ridge, rather than the formation of 'raised bog' peat deposits. Bog pools on this water-shedding and highly eroded area of bog are not vegetated with <i>Sphagnum</i> . This presumed to relate to extended periods of summer drought	
40 257747 814619	Peatland restoration Cobble dams have been established at regular intervals within the base of eroded gullies. In places, they are supplemented with coir rolls and more rarely with plastic piling. The effectiveness of these actions is variable. Around 50 % of the stone dams are effective. The coir dams are more effective but only a small number have been established. All of the plastic piling is effective.	 Cobble dams  Plastic piling & coir rolls.

Target No. & coords.	Description	Photograph
41 257851 814192	Bog pool Several bog pools dominated by <i>Sphagnum cuspidatum</i> are located across an area of 10 m x 15 m.	
42 257927 814060	Spring This low yield spring is not associated with any distinctive species or vegetation other than a mat of filamentous algae.	
43 257980 813096	H16 dry heath A distinctive area of dry heath with frequent bearberry. This indicates the H16 community. The vegetation is species-poor & uneven with a dense canopy of dominant heather and occasional bell heather, deergrass, heath rush & pill sedge.	
44 258123 814256	Bog pool Despite the proximity & duration next to deep, eroded gullies, the bog pool is persistent. <i>Sphagnum cuspidatum</i> is dominant & <i>Sphagnum denticulatum</i> rare, and this suggests that the pool dries out in summer. Common bog-cotton forms an open sward.	
45 258126 813110	M10 flush Surface water passes over exposed mineral ground here. As a result, M10 flush vegetation is weakly developed. Butterwort, common yellow-sedge, carnation sedge & sheep's-fescue are frequent; and the mosses <i>Blindia acuta</i> & <i>Scorpidium scorpioides</i> are occasional.	

Appendix 1: Target notes

Target No. & coords.	Description	Photograph
46 258204 813734	H12a dry heath H12a dry heath covers the steep, craggy flanks of this minor watercourse. The short, open, heather canopy is a result of the craginess & exposure; and to a lesser extent: grazing. Associates include: blaeberry, <i>Cladonia</i> spp., crowberry, <i>Hylocomium splendens</i> , <i>Pleurozium schreberi</i> , sheep's-fescue & wavy hair-grass. Distinctive species include mountain everlasting & oak fern.	
47 258210 813719	Drainage Drains have recently been ploughed in the blanket bog. They are 0.6 m to 0.8 m wide & 0.6 m deep.	
48 258279 813896	H12a dry heath The heath is quite dense & short (<0.2 m); and this limits the cover & number of associates. Blaeberry is frequent; <i>Hylocomium splendens</i> is abundant; and <i>Cladonia</i> spp. (lichen) & cowberry are occasional.	
49 258397 813291	M10a spring/flush M10a vegetation here is clearly associated with groundwater emerging from a spring. Surface water is also conducted across the flush, from the wet heath habitat above. The vegetation is as described at Target Note 45 but distinctive for the presence of occasional yellow saxifrage.	

Target No. & coords.	Description	Photograph
50 258494 812640	Pipe A large amount of water discharges from this pipe to a distinct but small watercourse that cuts deeply (<0.7 m) into the peat of the surrounding blanket bog.	
51 258530 813545	M2 acid/neutral flush An example of the numerous M2 bog pool-type flushes associated with water emerging from pipes within the peat (as here) and where surface water flows collect (amongst M6 acid/neutral flush communities).	
52 258872 813340	Pipe Water emerges from a pipe here, in the base of a shallow valley.	
53 258959 813763	Pipe Water emerges from a pipe here and is conducted along a runnel flanked with M2 bog pool-type vegetation.	

Appendix 1: Target notes

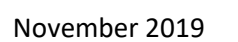
Target No. & coords.	Description	Photograph
54 259228 813300	M17b blanket bog & erosion M17b blanket bog vegetation is associated with the dewatered flanks of eroded gullies through the blanket bog habitat. It is distinct for the abundance of lichen species & heather (in contrast to the M17a vegetation). The M17b vegetation includes frequent to abundant: <i>Cladonia portentosa</i> & <i>Cladonia uncialis</i> (both lichens), common bog-cotton, deergrass, hare’s-tail bog-cotton, heather & <i>Sphagnum capillifolium</i>; and frequent to occasional: blaeberry, common bog-cotton, crowberry, heath rush, <i>Hylocomium splendens</i>, <i>Hypnum jutlandicum</i>, <i>Racomitrium lanuginosum</i>, <i>Sphagnum compactum</i>, <i>Sphagnum cuspidatum</i>, <i>Sphagnum papillosum</i>, <i>Sphagnum tenellum</i> & tormentil.	

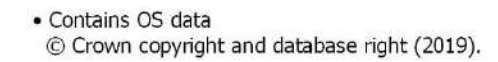
Appendix 2

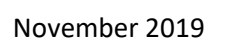
Map 10: Habitats & NVC vegetation communities

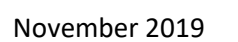
List of NVC community code & title

- H12a** *Calluna vulgaris*-*Vaccinium myrtillus* heath, *Calluna vulgaris* sub-community
- H14** *Calluna vulgaris*-*Racomitrium lanuginosum* heath
- H16** *Calluna vulgaris*-*Arctostaphylos uva-ursi* heath
- M10a** *Carex dioica*-*Pinguicula vulgaris* mire, *Carex viridula* subsp. *oedocarpa*-*Juncus bulbosus/kochii* sub-community
- M15b** *Trichophorum cespitosum*-*Erica tetralix* wet heath, typical sub-community
- M15c** *Trichophorum cespitosum*-*Erica tetralix* wet heath, *Cladonia* spp. sub-community
- M17a** *Trichophorum cespitosum*-*Eriophorum vaginatum* blanket mire, *Drosera rotundifolia*-*Sphagnum* spp. sub-comm.
- M17b** *Trichophorum cespitosum*-*Eriophorum vaginatum* blanket mire, *Cladonia* spp. sub-community
- M19** *Calluna vulgaris*-*Eriophorum vaginatum* blanket mire
- M20** *Eriophorum vaginatum* blanket and raised mire
- M32b** *Philonotis fontana*-*Saxifraga stellaris* spring, *Montia fontana*-*Chrysosplenium oppositifolium* sub-community
- M4** *Carex rostrata*-*Sphagnum fallax* mire
- M6a** *Carex echinata*-*Sphagnum fallax/denticulatum* mire, *Carex echinata* sub-community
- M6b** *Carex echinata*-*Sphagnum fallax/denticulatum* mire, *Carex nigra*-*Nardus stricta* sub community
- M6c** *Carex echinata*-*Sphagnum fallax/denticulatum* mire, *Juncus effusus* sub-community
- U4a** *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland, typical sub-community
- U5a** *Nardus stricta*-*Galium saxatile* grassland, species-poor sub-community
- U5b** *Nardus stricta*-*Galium saxatile* grassland, *Agrostis canina*-*Polytrichum commune* sub-community
- U6a** *Juncus squarrosus*-*Festuca ovina* grassland, *Sphagnum* spp. sub-community











CORRIEGARTH 2 WIND FARM
APPENDIX 7.2: PROTECTED SPECIES

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1 INTRODUCTION

Arcus Consultancy Services Ltd ('Arcus') was commissioned by Corriegarth 2 Windfarm Ltd (the 'Client') to undertake protected species surveys to inform the Ecological Impact Assessment (EclA) for Corriegarth Wind Farm, hereafter referred to as the 'Development'.

This Technical Appendix (TA) will present the methods and results of Protected Species Surveys undertaken in 2019. This TA will support Chapter 7: Ecology of the Environmental Impact Assessment (EIA) in addition to:

- A7.1: Habitats¹;
- A7.3: Bats²; and,
- A7.4: Fisheries Habitat & Fish Fauna³.

The following terminology will be used throughout this TA:

- The Development: the whole physical process involved in the development of the land at Corriegarth 2 Wind Farm, including the wind farm construction and operation (not a piece of land);
- The Site: all land with the potential to support the Development (as shown in Figure 1, Appendix A);
- Ecology Survey Area (ESA): the land within which the Protected Species Surveys were undertaken (shown as the red-line boundary in Figure 2, Appendix A) including all land within the Site boundary and a 250 metre (m) buffer, where accessible.

The aim of the Protected Species Surveys was to obtain detailed information regarding the occurrence and distribution of Protected Species within the ESA (Figure 2, Appendix A), to provide an accurate and robust baseline on which to base an EclA.

1.1 Site Background

The Site, centred on National Grid Reference 256250, 814340, located approximately 5km from Whitebridge in the west and 18km northeast of Fort Augustus, Inverness. The Site can be accessed via an unclassified road and access tracks running from the B862 to the northwest of the Site.

The landscape largely consists of rural upland farmland used for grazing and moorland.

The topography of the Site comprises rolling hills (ranging in height from 600-800 m AOD) and plateau bisected by a number of watercourses, including River E and its tributaries Allt Bad Fionnaich and Allt a' Ghille Charaich within the River Foyers and Findhorn watersheds. Land cover is mainly undulating open moorland, with topography creating an upland 'bowl' contained by the landform including Carn na Saobhaidhe (811 m AOD) to the northeast, Carn a' Coire Sheilich (791 m AOD) to the southeast, and Carn na Saobhaidhe (602 m AOD) to the west.

An area of ancient woodland is located near the entrance to the Site, next to the River E, with deciduous species such as Alder and Silver birch.

1.2 Desk Study Methods

1.2.1 Protected Species

To provide local context to the EclA, recent records (1999 - 2019) of protected and/or notable species (excluding bats² and fish³) were sought up to and within a 5 kilometre (km) buffer of the Site (Figure 1, Appendix A). In addition, the desk study aimed to identify

¹ Arcus (2019) Appendix 7.1: Habitats. Corriegarth Wind Farm. Corriegarth 2 Windfarm Ltd

² Arcus (2019) Appendix 7.3: Bats. Corriegarth Wind Farm. Corriegarth 2 Windfarm Ltd

³ Arcus (2019) Appendix 7.4: Fisheries Habitat & Fish Fauna Corriegarth Wind Farm. Corriegarth 2 Windfarm Ltd

recent records of invasive species located up to and within a 2 km buffer of the Site. This information was obtained via the publicly available National Biodiversity Network (NBN) database⁴.

1.2.2 Designated Sites

The desk study aimed to identify non-statutory and statutory designated sites of ecological conservation interest within 2 km and 10 km, respectively (Table). Information relating to designated sites was obtained from NatureScot Sitelink⁵ and ArcGIS information system.

Table 7.2.1: Search Criteria for Designation Sites of Nature Conservation Interest

Level of Protection	Designation	Search Radius from Site
Non-Statutory	Site of Interest for Nature Conservation (SINC)	2 km
	Scottish Wildlife Trust (SWT) Reserve	
Statutory	Local Nature Reserve (LNR)	10 km
	National Nature Reserve (NNR)	
	Ramsar	
	Site of Species Scientific Interest (SSSI)	
	Special Area of Conservation (SAC)	

Sites designated for their bat, fish, floral or ornithological interest are considered in their respective TAs and are therefore not discussed within this TA.

1.3 Field Survey Methods

Protected Species Surveys were undertaken by Matt Rea associate member of the Chartered Institute for Ecology and Environmental Management (ACIEM) and Sallie Turnbull (BSc (Hons)), between September 2019 and January 2020. Error! Reference source not found. 7.2.2 provides information relating to the key species surveyed, recommended search areas and indicators of their presence.

A watching brief of protected and/or notable species was maintained throughout all ecology surveys^{1,2,3}. Where evidence was recorded, this is reported within this TA.

The protected species surveys included surveys for the following:

- Amphibians;
- Badger (*Meles meles*);
- Otter (*Lutra lutra*);
- Pine marten (*Martes martes*);
- Reptiles;
- Red squirrel (*Sciurus vulgaris*);
- Wildcat (*Felis silvestris*); and
- Water vole (*Arvicola amphibious*).

The Protected Species Surveys were undertaken within the ESA (Figure 2, Annex A). The ESA encompassed all land within the Site, plus an additional buffer if up to 250 metres (m),

⁴ National Biodiversity Network Atlas Scotland. Available online at: <https://scotland.nbnatlas.org/> [Accessed September 2020]

⁵ Naturescot. *Naturescot Sitelink*. Available at: <https://gateway.nature.scot.gov.uk/sitelink/>. [Accessed September 2020]

informed by a review of NatureScot guidance. Although all Protected Species Surveys (including watching briefs) were undertaken within the ESA, species specific surveys were undertaken to varying extents depending on survey guidelines and best practice, as outlined below:

- Badger: Suitable habitats within the Site and up to 100 m buffer outwith⁶;
- Otter: Suitable riparian habitats within the Site and up to 200 m up and downstream of watercourses potentially impacted by the Development⁷;
- Pine marten: Suitable habitats within the Site and up to 250 m buffer outwith⁸;
- Red squirrel: Suitable habitats within the Site and up to 50 m buffer outwith⁹;
- Scottish wildcat: suitable habitats such as woodland and felled forestry within the Site and up to 200 m outwith¹⁰; and,
- Water vole: Suitable riparian habitats within the Site and up to 50 m up and downstream of watercourses potentially impacted by the Development¹¹.

The location of field signs, habitats and notable features identified during the protected species surveys were recorded with a handheld Global Positioning System (GPS) or using the Esri Collector for ArcGIS mobile application. Where appropriate, photographs were taken to visually document evidence and habitat features to assist interpretation of results, and inform reporting and assessment (Appendix B: Photographs).

Various guidance texts were consulted to ensure accuracy of the identification of field signs and appropriate application of guidance. The key utilised texts, and indicators of presence are summarised in Table 7.2.2 (overleaf). In addition to the targeted Protected Species Surveys, a watching brief was maintained by Arcus personnel whilst undertaking work within the ESA and incidental records of protected species were maintained.

⁶ NatureScot (2001). Scotland's Wildlife: Badgers & Development. ISBN 1 85397

⁷ NatureScot (2016a), Protected Species Advice for Developers: Otter. Available at: <http://www.nature.scot.gov.uk/docs/A1959316.pdf> [Accessed September 2020]

⁸ NatureScot (2016b), Protected Species Advice for Developers: Pine Marten. Available at: <http://www.nature.scotgov.uk/docs/A1959323.pdf> [Accessed September 2020]

⁹ NatureScot (2016c), Protected Species Advice for Developers: Red Squirrel. Available at: <http://www.nature.scot.gov.uk/docs/A1959329.pdf> [Accessed September 2020]

¹⁰ NatureScot (2016d), Protected Species Advice for Developers: Scottish Wildcat. Available at: <http://www.nature.scot.gov.uk/docs/A1959342.pdf> [Accessed September 2020]

¹¹ NatureScot (2016e), Protected Species Advice for Developers: Water Vole. Available at: <http://www.nature.scot.gov.uk/docs/A1959339.pdf> [Accessed September 2020]

Table 7.2.2: Summary of Protected Species Indicators and Key Guidance Utilised.

Species	Indicators of presence	Key guidance documents utilised
Amphibians	Sightings, suitable habitats, spawn	Common Standards Monitoring Guidance for Reptiles and Amphibians ¹² Evaluating the suitability of habitat for the Great Crested Newt ¹³
Badger	Setts (groups of burrows), paths, snuffle holes, feeding remains, scratching posts, latrines (dung pits used as territorial markers), prints, hairs and suitable habitats	Surveying Badgers ¹⁴ How to Find and Identify Mammals ¹⁵ Animal Tracks and Signs ¹⁶ Mammals of the British Isles: Handbook, 4 th Edition ¹⁷
Otter	Sprainting sites, prints, resting sites, paths, slides, feeding remains and suitable habitat	Animal Tracks and Signs ¹¹ How to Find and Identify Mammals ¹⁰ Mammals of the British Isles: Handbook, 4 th Edition ¹²
Pine marten	Dens, scats, prints and suitable habitats	UK BAP (Biodiversity Action Plan) Mammals Interim Guidance for Survey Methodologies, Impact Assessment and Mitigations ¹⁸ Animal Tracks and Signs ¹¹ How to Find and Identify Mammals ¹⁰ Mammals of the British Isles: Handbook, 4 th Edition ¹²
Red squirrel	Watching brief maintained for sightings, feeding remains and dreys	Practical Techniques for Surveying and Monitoring Squirrels ¹⁹ Animal Tracks and Signs ¹¹ How to Find and Identify Mammals ¹⁰ Mammals of the British Isles: Handbook, 4 th Edition ¹²
Reptiles	Sightings, suitable hibernacula	National Amphibian and Reptile Recording Scheme Reptile Habitat Guide ²⁰ Common Standards and Monitoring Guidance for Reptiles and Amphibians ⁷

¹² Joint Nature Conservation Committee (2014) *Common Standards Monitoring Guidance for Reptiles and Amphibians*, Version February 2004. JNCC, Peterborough.

¹³ Oldham R.S., Keeble J., Swan M.J.S. & Jeffcote M. (2000). *Evaluating the suitability of habitat for the Great Crested Newt (Triturus cristatus)*. Herpetological Journal 10 (4), 143-155.

¹⁴ Harris, S., Cresswell, P. and Jefferies, D. (1991) *Surveying Badgers*, The Mammal Society, London

¹⁵ Sargent, G. and Morris, P. (1997) *How to Find and Identify Mammals*, The Mammal Society, London

¹⁶ Bang, P. and Dahlström, P. (2001). *Animal Tracks and Signs*. Oxford University Press, Oxford.

¹⁷ Harris et al. (2001) *Mammals of the British Isles: Handbook*, 4th Edition, The Mammal Society, London

¹⁸ Cresswell, W.J., Birks, J.D.S., Dean, M., Pacheco, M., Trehwella, W.J., Wells, D. and Wray, S. (2012). *UK BAP Mammals Interim Guidance for Survey Methodologies, Impact Assessment and Mitigations*. The Mammal Society, Southampton

¹⁹ Gurnell, J. Lurz, P. and Pepper, H. (2009). *Practical Techniques for Surveying and Monitoring Squirrels*. Forestry Commission, Surrey.

²⁰ The Herpetological Conservation Trust (2007). *National Amphibian and Reptile Recording Scheme, Habitat Recording Guide*

Species	Indicators of presence	Key guidance documents utilised
Wildcat	Recordings on camera traps, prints, scats and dens	Scottish Wildcats: Naturally Scottish ²¹ How to find and Identify Mammals ¹⁰ Animal Tracks and Signs ¹¹ UK BAP Mammals Interim Guidance for Survey Methodologies, Impact Assessment and Mitigations ²² Mammals of the British Isles: Handbook, 4 th Edition ¹²
Water vole	Droppings, prints, burrows, feeding stations, runs, 'nests', lawns of short vegetation around burrow entrances and suitable habitat.	The Water Vole Mitigation Handbook ²³ How to find and Identify Mammals ¹¹ Animal Tracks and Signs ¹⁰ Mammals of the British Isles: Handbook, 4 th Edition ¹³

1.4 Survey Constraints and Limitations

1.4.1 Otter and Water Vole Survey Limitations

Due to the nature of the terrain and the watercourses present, it was not possible to survey the full extent of all watercourses and wetland areas within the ESA in detail, for health and safety reasons.

The dense nature of much of the plantation forestry significantly limited access to some areas of woodland, reducing the ability to survey in detail. Access to some areas, including areas of wind-blown trees and areas inundated with water, was not possible for health and safety reasons.

This affected the survey for those protected species more likely to be associated with woodland habitat such as badger, wildcat, red squirrel and pine marten. However, it is worth noting that dense and waterlogged stands of coniferous woodland generally provide less favourable resources to these species.

2 RESULTS

2.1 Summary

Evidence of badger, otter and water vole was recorded within the ESA (Figure 2, Appendix A). Otter was the most frequently recorded species, with many signs present on rivers and lochs. There was also possible evidence found for water vole within the ESA.

2.2 Desk Study Results

2.2.1 Statutory Designated Sites

Two Sites of Special Scientific Interest (SSSI) were recorded within 5 km of the Site; summarised in Table 7.2.3 below.

²¹ Kilshaw et al. (2011) *Scottish Wildcats: Naturally Scottish*. Scottish Natural Heritage, Perth.

²² Cresswell et al. (2012) *UK BAP Mammals: Interim Guidance for Survey Methodologies, Impact Assessment and Mitigation*. The Mammal Society, London.

²³ Dean, M., Strachan, R., Gow, D., and Andrew, R. (2016) *The Water Vole Mitigation Handbook* (The Mammal Society Mitigation Guidance Series). The Mammal Society, London.

Table 7.2.3: Statutory Designated Sites within 5 km of the Site

Name	Designation	Relevant Designated Features
Easter Ness Forest	SSSI	- Upland mixed ash woodland - Upland oak woodland
Loch Bran	SSSI	Dragonfly assemblage

2.2.2 Recent Ecological Records

Any protected, notable or invasive species noted during the desk study in the NBN database are detailed below in Table 7.2.4.

Table 7.2.4: Protected and Notable Species Desk Study Results

Species	Conservation Status	Distance and Direction from ESA	Year of Record(s)
European Water Vole (<i>Arvicola amphibious</i>)	WCA ²⁴ , SBL ²⁵ , LBAP ²⁶	3 km southeast	2014 (5 records)
Pine marten (<i>Martes martes</i>)	HR ²⁷ , SBL, LBAP	4 km northwest	2007 (1 record)
Eurasian Badger (<i>Meles meles</i>)	PBA ²⁸ , LBAP	1 km north	2014 (1 record)
Red Squirrel (<i>Sciurus vulgaris</i>)	WCA, SBL, LBAP	5 km northwest	2000 - 2018 (13 records)
Wildcat (<i>Felis silvestris</i>)	HR, SBL, LBAP	3 km south	2013 (1 record)
West European Hedgehog (<i>Erinaceus europaeus</i>)	SBL	4 km northwest	2005 and 2006 (2 records)
Brown hare (<i>Lepus europaeus</i>)	SBL, LBAP	4.5 km west	2005 – 2017 (7 records)
Mountain hare (<i>Lepus timidus</i>)	SBL, LBAP	Within the Site	2000 – 2006 (8 records)

2.3 Field Survey Results

Results of the Protected Species Surveys are provided below with reference to figures provided in Appendix A and photographs provided in Appendix B

2.3.1 Otter

Evidence of otter was frequently observed in the ESA, including numerous spraints (8+) and two potential shelters.

Allt a' Ghille Charaich, which runs east from the River E, had one spraint at the beginning of the watercourse (see Photograph 1) and four spraints with a possibly active couch in an undercut bank (Photograph 3) towards the end, in the east of the ESA. The river is generally

²⁴ Wildlife and Countryside Act (1981). Available online at <http://www.legislation.gov.uk/ukpga/1981/69> [Accessed September 2020]

²⁵ Scottish Biodiversity List. Available online at <http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL>. [Accessed on September 2020]

²⁶ The Inverness and Nairn Biodiversity Action Plan (2004). Available online at http://www.highlandbiodiversity.com/userfiles/file/acion-plans/inverness_nairn.pdf. [Accessed September 2020]

²⁷ The Habitats Regulations (1994). Available online at <http://www.legislation.gov.uk/uksi/1994/2716/contents/made> [Accessed September 2020]

²⁸ Protection of Badgers Act (1992). Available online at <https://www.legislation.gov.uk/ukpga/1992/51/contents> [Accessed September 2020]

very suitable for otter (Photograph 5), with wide banks, a fast flow and rocky substrate with the possibility to support fish in some areas.

Allt Bad Fionnaich is another tributary of River E which had signs of otter. Three spraints (Photograph 2) and an inactive couch (Photograph 4) were observed along the watercourse. The river varies in suitability with some areas slow and narrow, suitable for commuting (Photograph 6), and other areas steep and fast, suitable for foraging (Photograph 7).

Several upland burns near Beinn Bhurach and Carn na Saobhaidhe (Photographs 10 and 11) were generally suboptimal for otter as they were very narrow and slow flowing. A similar river to the east of the ESA (Photograph 12) was also identified as being possibly suitable for otter, but with more areas to shelter or lay-up on the peaty banks.

The start of the River E, at the entrance to the ESA, provided suitable habitat for otter, with ancient woodland surrounding the banks (Photograph 13). The river was wide and fast with multiple caves and tree crevices for sheltering in (Photograph 15), and the opportunity for foraging with many large pools. Some sections of the river were quite steep however, with some large valley gorges, limiting accessibility for commuting up (Photograph 14).

2.3.2 *Water Vole*

Several possible signs of water vole were found in the south of the ESA, on a tributary of Allt a' Ghille Charaich (Photograph 9).

A burrow (Photograph 16) and latrine with some vole-like droppings (Photograph 19) were identified. However, they couldn't be confirmed as water vole, as other characteristic signs were not observed alongside the burrow, such as distinctively chewed vegetation or prints.

The watercourses within the ESA varied in their suitability for water vole. Several rivers were identified as having potential to support water vole populations, although signs were only observed on one. Allt Bad Fionnaich was suitable in some areas that were slow and grassy (Photograph 8) and other narrower rivers throughout the ESA, such as an upland burn in the north of the ESA (Photograph 11) and in the east (Photograph 12). Along these watercourses grass and rushes dominated the bankside cover, flow rate of the water was slow and the substrate and banksides were of a peaty nature. These qualities provided an environment in which water voles may establish burrows²⁹.

2.3.3 *Badger*

During the Wildcat Winter Walkover Survey, a single, outlier sett with two entrance holes (Photograph 17) was identified within coniferous woodland south of the access track in the west of the ESA (Figure 1, Appendix A). The discovery of a badger hair (Photograph 18) inside the entrance of the sett confirmed that it was active. Despite a search of the surrounding area, no further setts were found. However, heavy snow on the day of the survey (conducted in January 2020), which lay on the ground a couple of inches thick, could have concealed evidence (such as paths/prints) of the species. Woodland within the west of the ESA was deemed to have the greatest potential to support badger, with dry areas of deciduous woodland possible for sett construction. However, this habitat was relatively sparse within the landscape and isolated from larger woodland blocks within the wider area. Lowland, grassland areas and riparian habitat adjacent to the River E provide suitable foraging for badger. Although, within the east of the ESA, where turbines will be constructed, the landscape was dominated by upland bog and moorland and considered unsuitable for badger.

²⁹ Dean, M., Strachan, R., Gow, D., and Andrews, R. (2016) *The Water Vole Mitigation Handbook (3rd edition) (The Mammal Society Mitigation Guidance Series)*. The Mammal Society, London.

2.3.4 Red Squirrel

No squirrel evidence was recorded within the ESA; however, multiple records were identified during the Desk Study and therefore the presence of red squirrel cannot be ruled out.

The majority of the ESA was unsuitable for squirrel, with only one area of woodland located within.. The trees within the ESA were quite sparse in some areas, with limited connectivity to similar, suitable habitat and were therefore deemed suboptimal for squirrel populations, as they can become isolated from each other and their food sources. There may also be a higher risk of predation where animals are forced to cross open ground³⁰.

2.3.5 Pine Marten

No signs of pine marten were observed within the ESA.

Habitats within the ESA varied in their suitability to support pine marten. No pine marten dens were identified during the protected species surveys; however, the small area of ancient woodland within the ESA may provide potential denning habitat for pine marten. Wind-blown trees, particularly their root plates, can provide features (for example cavities) which pine marten may use for dens or refuge³¹, as well as large rocky outcrops.

2.3.6 Wildcat

The Wildcat Winter Walkover Survey recorded no confirmed or potential evidence of wildcat within the ESA. Habitats within the east ESA and wider local environment were considered to be of very low value to wildcat for foraging, commuting and denning due to the dominance of wet bog and moorland landscape and absence of any woodland. The west of the ESA, along the existing access track, is more suitable for the species with the presence of scattered, broadleaved trees and riparian habitat adjacent the River E, as well as coniferous plantation. However, the relatively small size and isolated nature of this woodland within the extensively open habitat present in the wider area makes it sub-optimal.

However, the ESA lies within the known range of the species³² and historical records of wildcat, identified during the desk study, suggest that the species may be present in the wider environment, potentially occurring where more extensive areas of suitable habitat exist. Therefore, the presence of wildcat within the ESA cannot be ruled out.

2.3.7 Other Species

No evidence of amphibians (including sightings) were recorded during the surveys. Habitats within the ESA were considered suitable for amphibians generally being of a wet nature with vegetation (such as soft-rush, sharp-flowered rush and bog-mosses) indicative of this. In addition, waterbodies recorded within the ESA may provide suitable breeding opportunities for amphibians. Common lizard was recorded in the southeast of the ESA. Felled woodland, recorded within the ESA, may provide suitable foraging, refuge and hibernacula opportunities for reptiles. No suitable ponds for breeding great crested newt (*Triturus cristatus*) were present within the Ecology Survey Area.

A large population of mountain hares (20+) were also found in the ESA, especially near the substation.

³⁰ NatureScot (2019) *Red squirrel*. Available online at <https://www.nature.scot/plants-animals-and-fungi/mammals/land-mammals/red-squirrel> [Accessed September 2020]

³¹ Hanniffy, R. (2016). *A native enigma: the pine marten*. Vincent Wildlife Trust

³² Mathews F., Kubasiewicz L. M., Gurnell J., Harrower C. A., McDonald R. A. & Shore R. F. 2018. A review of the population and conservation status of British mammals: Technical Summary. A report by the Mammal Society under contract to Natural England, Natural Resources Wales and Scottish Natural Heritage. Natural England, Peterborough.

3 CONCLUSION

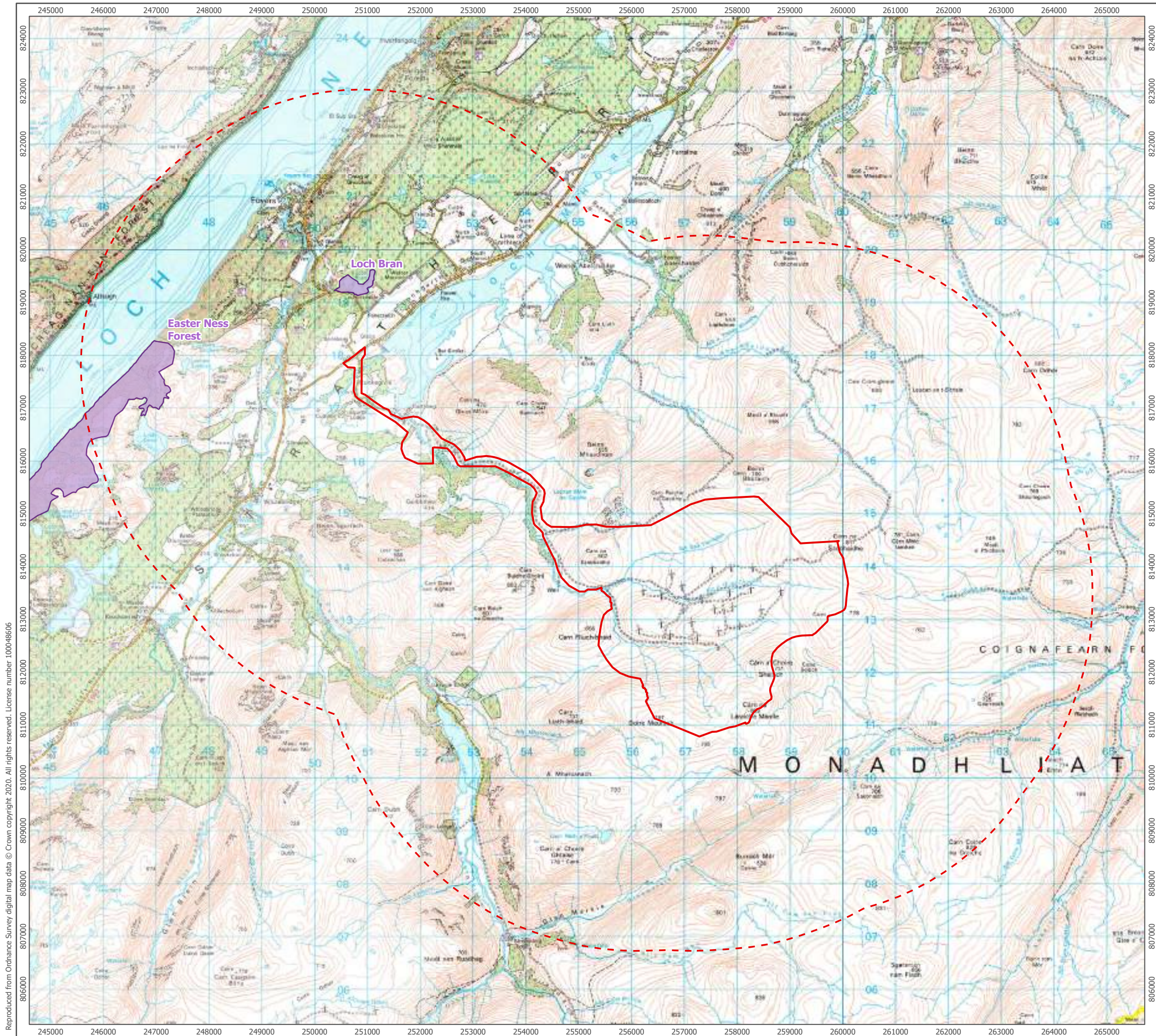
During the course of the 2019 surveys signs of protected species were recorded within the ESA. Otter and badger were confirmed to be within the ESA, with possible water vole signs observed. Habitats varied in their suitability for the species, with the ancient woodland providing possible refuge for red squirrel, pine marten and badger, and the many rivers and lochs within the ESA able to support otter and water vole.

No evidence of red squirrel or pine marten could be established, although suitable habitat for both species exists within the ESA and so their presence cannot be discounted.

APPENDIX A: FIGURES

Figure 1 - Statutory Designated Sites within 5 km of the Site

Figure 2 - Site Boundary and Protects Species Survey Results



-  Site Boundary
-  Statutory Designated Sites Search Buffer (5 km)
-  Sites of Special Scientific Interest

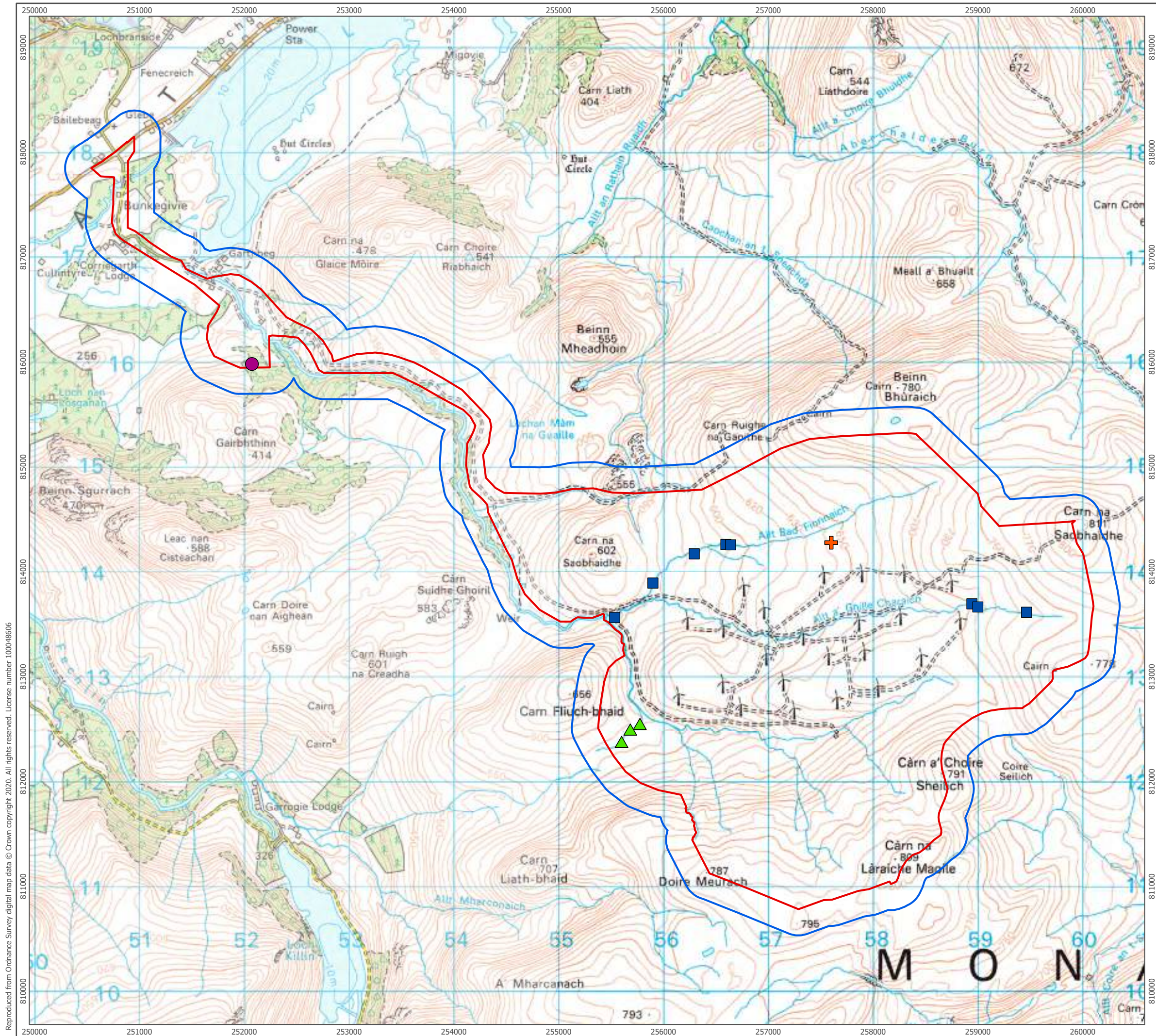
1:69,466 Scale @ A3



Produced By: ST	Ref: 3369-REP-020
Checked By: SC	Date: 15/09/2020

Statutory Designated Sites within 5 km
Figure 1

**Corriegarth Wind Farm
Technical Appendix 7.2
Protected Species**



- Site Boundary
- Ecology Survey Area
- Badger
- Water Vole
- Otter
- Reptile



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Site Boundary and Protected Species
Figure 2

Corriegarth Wind Farm
Technical Appendix 7.2:
Protected Species

APPENDIX B: PHOTOLOG

	
Photograph 1: Otter spraint found on Allt a' Ghille Charaich.	Photograph 2: Otter spraint found on rock near Allt Bad Fionnaich
	
Photograph 3: Possible active couch with spraint inside – lay-up site in undercut bank, Allt a' Ghille Charaich.	Photograph 4: Inactive couch with old spraint found inside – on Allt Bad Fionnaich.
	
Photograph 5: Beginning of Allt a' Ghille Charaich, fast flow, boulder substrate, suitable for otter	Photograph 6: Allt Bad Fionnaich, slow and grassy, suitable for otter and water vole

	
Photograph 7: Allt Bad Fionnaich, steep and fast in some areas, suitable for otter	Photograph 8: Some sections of Allt Bad Fionnaich suitable for water vole
	
Photograph 9: Tributary of Allt a' Ghille Charaich, suitable for water vole, signs found.	Photograph 10: River in north of site, near Beinn Bhurach, suboptimal for otter and water vole
	
Photograph 11: Northern river near Carn na Saobhaidhe, suitable for water vole	Photograph 12: Burn in far east of site, suitable for water vole and otter.



Photograph 13: Beginning of River E, suitable for otter, wide and rocky.



Photograph 14: Beginning of River E, starting to become unsuitable for otter – steep river gorge



Photograph 15: Possible areas for otter shelter on River E, in rock caves and crevices.



Photograph 16: Burrow found in tributary of Allt a' Ghille Charaich, possible water vole but no confirmed signs present



Photograph 17: Outlier badger sett, located in the west of the ESA and classified as active with two entrance holes.



Photograph 18: Badger hair found within the entrance to the sett.



Photograph 19: Latrine found with possible vole droppings.

Corriegarth 2 Wind Farm

Bat Survey Report

Technical Appendix A7.3

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Figure A7.3.2 Overall Risk Assessment 2019 (June, July, September and October) Common Pipistrelle

Figure A7.3.3 Overall Risk Assessment 2019 (June, July, September and October) Soprano Pipistrelle

EXECUTIVE SUMMARY

MacArthur Green was commissioned by the Applicant to carry out bat surveys for the Corriegarth 2 Wind Farm (referred to as the 'Development').

These surveys were undertaken to aid and inform the ecological assessment for the Corriegarth 2 Wind Farm Environmental Impact Assessment Report (EIA Report, Chapter 7).

This report presents the results of the bat survey work undertaken between May and October 2019.

In total two bat species and one genus classification were recorded for the Site: soprano pipistrelle (*Pipistrellus pygmaeus*), common pipistrelle (*Pipistrellus pipistrellus*) and *Myotis* spp.

No trees or structures with bat roost potential were recorded within 300 m of a Wind Turbine during surveys.

Soprano pipistrelle and common pipistrelle are high collision risk species for which the risk assessment was undertaken. The risk assessment concluded a 'Low' risk for soprano and common pipistrelle bats within the Site.

1 INTRODUCTION

MacArthur Green was commissioned by the Applicant to undertake bat surveys for the Corriegarth 2 Wind Farm (hereafter referred to as ‘the Development’). The Development lies approximately 18 km to the north-west of Fort Augustus in the Scottish Highlands.

Bat surveys were undertaken to aid and inform the ecological impact assessment for the Corriegarth 2 Wind Farm Environmental Impact Assessment Report (EIA Report, Chapter 7).

The surveys in 2019 included:

- Desk study;
- Bat roost suitability surveys; and
- Automated activity surveys.

The aim of the surveys was to quantify Site usage and variation of activity levels within the Site.

2 THE SITE AND SURVEY AREA

The Site consists of undulating open moorland hills, lying between approximately 560 m and 710 m above Ordnance Datum (AOD). The connectivity of the Site to surrounding habitats is supported by two watercourses. The access track for the Development follows the existing Operational Corriegarth Wind Farm track.

The Survey Area within which the bat surveys were conducted was defined by the Development layout at the time of survey, as detailed in Figure A7.3.1.

3 BATS AND WIND FARMS

3.1 Policy and Guidance

All bat species are protected under the following legislation:

- The Habitats Directive 92/43/EEC (as amended);
- The Wildlife and Countryside Act 1981 (as amended); and
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

Details pertaining to the legal status of bats are included within Annex A and in Table A-1.

In the UK and Europe, guidelines have been produced with regards to assessing the ecological impact upon bats from Wind Farm developments. These guidelines help to inform survey and mitigation strategies.

The following guidance documents have been used in the preparation of this report:

- Hundt, L. (2012). *Bat Surveys: Good Practice Guidelines*. 2nd Edition, Bat Conservation Trust;
- Collins, J. (ed) (2016). *Bat Surveys for Professional Ecologists: Good Practice Guidelines* (3rd edn). The Bat Conservation Trust, London; and

- Scottish Natural Heritage, Natural England, Natural Resources Wales, Renewable UK, Scottish Power Renewables, Ecotricity Ltd, the University of Exeter & Bat Conservation Trust (BCT). (2019). *Bats and Onshore Wind Turbines: Survey Assessment and Mitigation*.

4 METHODS

4.1 Desk-Based Study

A desk-based study was undertaken in order to inform the surveys and this report with regards to the presence of designated sites for bats and records of bats within the Site and its environs.

A search of designated sites which have bats as qualifying feature was carried out within 5 km of the Site Boundary using Scottish Natural Heritage (SNH) SiteLink¹.

A National Biodiversity Network (NBN)² search was completed for records within 10 km of the Site Boundary.

4.2 Field Survey Methods

4.2.1 Preliminary Bat Roost Assessment

The preliminary bat roost assessment followed the assessment methodology as set out in Collins³ whereby a potential roost feature (PRF) is assigned a value of low, moderate or high suitability which indicates the likelihood of bats being present and the need for further survey work such as a climbing inspection and/or dusk and dawn surveys.

The preliminary bat roost assessment was carried out within a 300 m buffer from the Wind Turbines which was defined by the Development layout at the time of survey, as shown in Figure A7.3.1.

4.2.2 Automated Activity Surveys

The Site was assessed as a low risk due to its elevation and lack of foraging and commuting habitats for bats.

SNH guidance⁴ recommends a minimum of ten consecutive nights of sampling in spring, summer and autumn. Therefore, automated activity surveys for the Development have gone beyond this minimum requirement by sampling for c.a. 14 nights once per season between May and October 2019.

SNH guidance⁴ also recommends that, “Where developments have more than ten turbines, detectors should be placed within the developable area at ten potential turbine locations plus a third of additional potential turbine sites up to a maximum of 40 detectors for the largest developments.”

¹ <https://sitelink.nature.scot/home>

² NBN Atlas Scotland. Available at: <https://nbnatlas.org>.

³ Collins, J. (ed.) (2016). *Bat Surveys for Professional Ecologists: Good Practice Guidelines* (3rd edn.) The Bat Conservation Trust, London. ISBN-13 978-1-872745-96-1.

⁴ Scottish Natural Heritage, Natural England, Natural Resources Wales, Renewable UK, Scottish Power Renewables, Ecotricity Ltd, the University of Exeter & Bat Conservation Trust (BCT). (2019). *Bats and Onshore Wind Turbines: Survey Assessment and Mitigation*.

In accordance with SNH *et al.* (2019)⁴ guidance, the number of static detectors based on the Development layout was to deploy 13 detectors. A total of 14⁵ detectors were deployed at 13 Wind Turbine locations with deployment locations spread throughout the Survey Area. The detectors were deployed in locations which allowed for good survey coverage across the Site to be achieved, as shown in Figure A7.3.1. The detector locations remained consistent throughout the survey period.

Each detector was placed at a height of 2 m and was set to record bats from dusk to dawn with detectors starting 30 minutes before dusk and finishing 30 minutes after dawn. Table B-1 of Annex B provides an overview of the recording dates and detector operational times and Table B-2 of Annex B lists the grid references of the detector locations as well as the microphone direction (compass bearings). All detectors were placed in open moorland habitat.

Data was analysed using Kaleidoscope 4 Auto ID classifier which assigns a species label to a sound file. To ensure that all non-*Pipistrellus* calls (excluding *Nathusius*' pipistrelle calls) were identified correctly by the software, they were manually reviewed by an experienced bat Ecologist using Kaleidoscope Viewer and AnalookW software. This method of analysis is in line with current guidelines (Collins, 2016) for data analysis which recommends the manual checking of all non-*Pipistrellus* calls when using automated methods. Sound files labelled as noise were not reviewed.

4.3 Methods for Analysing Bat Activity Levels and Risks

SNH *et al.* 2019⁴ details an updated methodology for analysing bat activity levels. This method is summarised below and involves the following steps:

1. Estimating bat activity levels;
2. Categorising collision risk of the relevant species;
3. Identifying population relevant abundance (size of the populations);
4. Categorising the potential vulnerability of bat populations by combining collision risk with population abundance;
5. Categorising the Site risk level;
6. Completing the overall risk assessment; and
7. An assessment of significance and mitigation.

4.3.1 Step 1: Bat Activity Levels

A measure of relative bat activity was obtained using the secure online tool *Ecobat*⁶. SNH guidance⁴ explains that, “The tool compares data entered by the user with bat survey information collected from similar areas at the same time of year and in comparable weather conditions.... *Ecobat* generates a percentile rank for each night of activity and provides a numerical way of interpreting the

⁵ The deployment of two detectors at location 6 and 6R provided data to compare different file format recording types (full spectrum (.wav) and zero crossing (.zc)).

⁶ The Mammal Society. (2017). *Ecobat*. Available at: <http://www.mammal.org.uk/science-research/ecostat/>

levels of bat activity recorded at a site across regions in Britain”. Table 4-1 below, taken from SNH guidance⁴ shows the five percentile categories for ease of reference.

The reference range data set were stratified to include:

- Only records from within 30 days of the survey date;
- Only records from within 100 km² of the survey location; and
- Records using any make/model of bat detector.

Table 4-1: Percentile Score and Categorised Level of Bat Activity⁷.

Percentile Score	Bat Activity
81 to 100	High
61 to 80	Moderate to High
41 to 60	Moderate
21 to 40	Low to Moderate
0 to 20	Low

4.3.2 Step 2: Vulnerability to collision

SNH guidance⁴ presents a generic assessment of vulnerability to collision for UK species, based on species behaviour, flight characteristics and casualties in the UK and the rest of Europe. Table 4-2 below provides a summary of this information by showing the bat species vulnerable to collision.

Habitat characteristics at the location of Wind Turbines can have an important influence on vulnerability of bat species to collision. For example, proximity to key feeding sites such as water features and woodland edge habitats is known to increase likelihood of bat collision.

Table 4-2: Vulnerability of Bat Species to Turbine Impact in the UK⁷.

Risk of Turbine Impact (Collision Risk)		
Low	Medium	High
Myotis spp.	Serotine	Common pipistrelle
Long eared bats	Barbastelle	Soprano pipistrelle
Horseshoe bats		Noctule
		Leisler's bat
		Nathusius' pipistrelle

⁷ Sourced from: Scottish Natural Heritage, Natural England, Natural Resources Wales, Renewable UK, Scottish Power Renewables, Ecotricity Ltd, the University of Exeter & Bat Conservation Trust (BCT). (2019). *Bats and Onshore Wind Turbines: Survey Assessment and Mitigation*.

4.3.3 Step 3: Population Relative Abundance

SNH guidance⁴ details the sensitivity of a bat species to impact based on their population's relative abundance in Scotland as detailed in Table 4-3. Species with the rarest relative abundance are more susceptible to significant effects.

Table 4-3: Population Relative Abundance of Bats in Scotland⁷.

Relative Abundance	Species
Common	Common pipistrelle
	Soprano pipistrelle
Rarer	Brown long eared bat
	Daubenton's bat
	Natterer's bat
Rarest	Whiskered bat
	Brandt's bat
	Nathusius' pipistrelle
	Noctule bat
	Leisler's bat

4.3.4 Step 4: Potential Vulnerability of Bat Populations

Table 4-4 below, sourced from SNH guidance⁴, uses the measure of collision risk, in combination with relative population abundance, to indicate the potential vulnerability of populations of British bat species. The overall potential vulnerability of bat populations is identified as: low (yellow), medium (orange), high (red).

Table 4-4: Level of Potential Vulnerability of Populations of British Bat Species⁷.

		Collision Risk		
Relative Abundance	Scotland	Low collision risk	Medium collision risk	High collision risk
	Common species			Common pipistrelle Soprano pipistrelle
	Rarer species	Brown long eared bat Daubenton's bat Natterer's bat		
	Rarest species	Whiskered bat Brandt's bat		Nathusius' pipistrelle Noctule bat Leisler's bat

4.3.5 Step 5: Categorise the Site Risk Level

The Site risk level is categorised through a combination of habitat risk and project size which is then entered into the table matrix as shown below in Table 4-5 to calculate the overall Site risk level. The full matrix table provided within the SNH guidance⁴, including descriptions on how to determine the habitat risk and project size for the Site, is provided in Annex C.

Table 4-5: Initial Site Risk Assessment⁷.

Site Risk Level (1-5) *		Project Size		
Habitat Risk		Small	Medium	Large
	Low	1	2	3
	Moderate	2	3	4
	High	3	4	5

Key: Green (1-2) – low/lowest site risk; Amber (3) – medium site risk; Red (4-5) – high/highest site risk

* Some sites could conceivably be assessed as being of no (0) risk to bats. This assessment is only likely to be valid in more extreme environments, such as above the known altitudinal range of bats, or outside the known geographical distribution of any resident British species.

4.3.6 Step 6: Risk Assessment

The risk assessment is undertaken for high collision risk species identified on Site and involves combining Site risk level (Section 4.3.5 Table 4-5) with the Ecobat activity level (Section 4.3.1, Table 4-1). This risk assessment matrix is shown in Table 4-6 below where Low Site risk level (green) is 0-4, Medium Site risk level (amber) is 5-12, and High Site risk level (red) is 15-25.

Table 4-6: Overall Risk Assessment⁷.

Ecobat activity category (or equivalent justified categorisation)						
Site Risk Level	Nil (0)	Low (1)	Low-moderate (2)	Moderate (3)	Moderate-high (4)	High (5)
Lowest (1)	0	1	2	3	4	5
Low (2)	0	2	4	6	8	10
Med (3)	0	3	6	9	12	15
High (4)	0	4	8	12	15	18
Highest (5)	0	5	10	15	20	25

4.3.7 Step 7: Assessment of Significance and Mitigation

The outputs of the risk assessment detailed in step 6 above are then used to assess the significance of effect within the Ecological Impact Assessment. At this stage other site-specific factors should be considered such as habitat characteristics (and how they may change), behaviour of species at the Site, and location of the Site regarding the natural range of the species and how this could affect favourable conservation status.

Mitigation measures as detailed within SNH guidance⁴ are then considered, as appropriate.

5 BAT SURVEY LIMITATIONS

Some temporal calls were assigned an unknown value (NoID), due to a very faint call or incomplete call that could not be identified to species level on the spectrogram. These were not considered further in the Ecobat analysis.

Furthermore, during the survey seasons, some bat detectors failed to record data. These are listed in B-1 of Annex B, as having zero complete nights of recording and are marked on Figures A7.3.2 and A7.3.3 as “No Data” locations. As the majority of locations recorded for more than ten nights and, in some cases, recorded for longer than 14 nights, the small loss of data is not seen to have altered the overall assessment of risk. The survey timings can be seen in Annex B, Tables B-1 and B-2.

For the *Myotis* spp. calls it was only possible to identify the call to genus level. It is possible that for *Myotis* spp. these recordings could represent species not identified in the analysis of the recorded data. All *Myotis* spp. calls are categorised as low collision risk species, as per above.

The Ecobat analysis automatically analyses data per month and not per season. The results are presented based on this analysis per month. Detectors for the first deployment period were deployed on the 29th May. As there were only a small amount of recording nights in May with no bats detected during this month, this month was not displayed in Figure A7.3.2 and Figure A7.3.3.

The seasonal deployment period for spring in the UK is from April to May⁴. The surveys for this Site only surveyed for a few nights in May (May 29/05/2019 – June 13/06/2019), so did not record the full 10 nights of data for spring. As the Site is located in the Highlands at a northern latitude and as it is located at a high altitude, not surveying for the full 10 nights in May is unlikely to have impacted the assessment, due to bats being less active in May than in June, especially for this Site which is unlikely to experience the optimal survey conditions for bats in May (8° in Scotland, maximum ground level wind speed of 5m/s4 and no rain or light rain).

Kaleidoscope Auto ID classifier can rarely mislabel bat calls as noise files. From data analysis at other sites it was found that 1 % of noise files contained bat calls that could be identified to species level. As noise files were not manually checked, it can be assumed that there was a small (but negligible) loss of bat data.

SNH guidance⁴ states that ‘full spectrum automatic detectors should be deployed, as a minimum’. SNH was consulted on the 21st March 2019 regarding the requirement for full spectrum detectors, following the publication of the new guidance. SNH advised that the use of zero crossing detectors would be permitted with a transition over time towards full spectrum detectors. They also suggested deploying a few full-spectrum detectors alongside the zero crossing detectors at a subset of locations, so that detectability can be calibrated; this was incorporated into the survey method for the Site. At location six, an Anabat Express detector recording zero crossing files was deployed alongside an Anabat Swift detector set to full spectrum. The Anabat Express detector recorded 24 registrations while the Anabat Swift full spectrum detector recorded 21 registrations. The Anabat Express detector recorded an additional species with a soprano pipistrelle registration recorded. The registration difference in detectors at the same location highlights the suite of

variables affecting how well bats are recorded including, whether the microphone gets wet, how close the bat passes the microphone, the detector type, and if a recording is filtered out as noise.

6 SURVEY RESULTS & ANALYSIS

6.1 Desk-Based Study

Bat species records obtained within a 10 km data search area from the NBN Atlas are as follows:

- Daubenton's bat (*Myotis daubentonii*);
- Brown long-eared bat (*Plecotus auritus*);
- Common pipistrelle;
- Soprano pipistrelle; and
- *Pipistrellus* spp.

There are no statutory designations with bats as qualifying ecological features within 5 km of the Site.

The potential for bat roosts within 10 km of the Site is low. Some potential roost features may exist within an area of broadleaved woodland along a river to the north-west of the Site and woodland next to Loch Killin to the west. Other woodland areas within the surrounding area consist of plantation forest with low roost suitability.

6.2 Preliminary Bat Roost Assessment

No potential bat roost features were found during the preliminary bat roost assessment within a 300 m buffer from the proposed Wind Turbine locations. The preliminary bat roost assessment survey area is shown in Figure A7.3.1.

6.3 Automated Activity Surveys

MacArthur Green deployed 14⁸ static detectors at 13 locations during three visits to the Site in spring (May to June), summer (July) and autumn (September to October) in 2019 (see Table B-1 and B-2 of Annex B and Figure A7.3.1).

The survey results were processed using the Ecobat tool to gain a measure of relative bat activity at the Site. The results are presented in Steps 1 – 6 below.

Between May and October 2019, bats were detected on just 16 of the 561 complete recording nights, using 13 static bat detectors with a total of two bat species and one genus classification recorded for the Site. The total number of passes recorded for each species across all of the detectors within the Site is shown below;

- Common pipistrelle: 208 passes and 87% of passes;

⁸ The deployment of two detectors (at location 6 and 6R) provided data to compare different file format recording types (full spectrum (.wav files) and zero crossing (.zc)).

- Soprano pipistrelle: 24 passes and 10.1% of passes; and
- Myotis bats: 5 passes and 2.1% of passes.

Step 1: Bat Activity Levels

Average Annual Site Activity Levels

Table 6-1 and Chart 6-1 details the average annual Site activity levels calculated using the Ecobat tool.

Table 6-1: Average Annual Site Activity Levels taken from Ecobat Analysis⁹

Species/Species Group	Median Percentile	95% CIs	Max Percentile	Nights Recorded	Reference Range
<i>Myotis</i> spp.	0	0 - 0	0	5	401
<i>Pipistrellus pipistrellus</i>	18	35 - 35	79	59	1119
<i>Pipistrellus pygmaeus</i>	0	0 - 0	63	8	1010

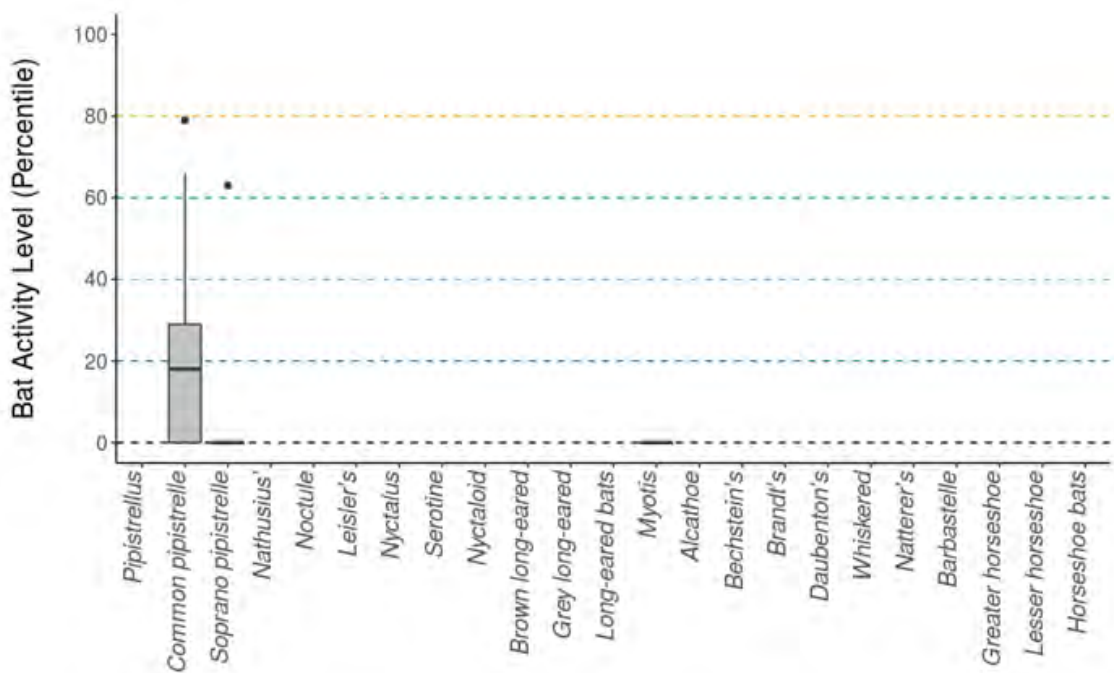


Chart 6-1: Average Annual Site Activity Levels - Box Plots⁹

⁹ Ecobat analysis report created on the 28/10/2019 from automated activity data of the Site.

Monthly Location Specific Activity Levels

Data on monthly location specific activity levels for 2019 is provided in Table D-1 of Annex D.

Step 2, 3 and 4: Collision Risk, Population Relative Abundance and Potential Vulnerability

Table 6-2 details the collision risk population relative abundance and potential vulnerability of the bat species recorded on Site.

Table 6-2: Collision Risk, Population Relative Abundance and Potential Vulnerability.

Bat Species	Collision Risk	Population Relative Abundance	Potential Vulnerability
Common pipistrelle	High	Common	Medium
Soprano pipistrelle	High	Common	Medium
Myotis spp.	Low	Rarer	Low

Step 5: Categorising Site Risk Level

The Site risk level is determined by project size and habitat risk (Table 4-5). The Development falls within the upper category of 'Medium' project size, as shown in Table 4-5 and in Table C-1 of Annex C.

In terms of habitat quality for bats, no features were found to have roost potential. There are two watercourses, providing good habitat connectivity throughout the different areas of the Site and the surrounding landscape. The habitat is at an elevation of 560 m to 710 m AOD and consists of open moorland. Other than watercourses there are few features for foraging and commuting habitats present. Considering these factors, the Site falls within the 'Low' Site risk level as shown in Table 4-5 and in Table C-1 of Annex C.

According to Table 4-5 and Table C-1 of Annex C, the 'Medium' (greater than ten turbines) project size combined with a 'Low' Site risk level results in an overall Site Risk Level of 'Low' (2).

Step 6: Risk Assessment – High Collision Risk Species Only

Figures A7.3.2 and A7.3.3 present the results of the monthly risk assessment scores of high collision risk bat species at the various sample locations, with this data also presented in Table D-1 of Annex D. Table 6-3 below summarises this data for the Site with an overall risk assessment score based on medium and maximum percentiles. The overall Site risk score for high collision risk bat species (common and soprano pipistrelle species) is 'Low' (2) to 'Medium' (8) based on median percentile and maximum percentiles, respectively.

To provide an indication of how activity varies across the survey period by species, Table 6-4 shows the percentage of sample locations where a 'High' risk assessment score was recorded for the sampling periods. Using this method, all high collision risk bat species recorded a 'Low' risk assessment score per month with no 'High' risk assessment scores recorded during the survey period. 'Medium' risk assessment scores were recorded for high risk species at location 11 and

location 12 in July for common and soprano pipistrelle species, respectively, as shown in Table D-1 of Annex D.

Table 6-3: Risk Assessment Scores Based on Median and Maximum Percentiles

Species	Risk Assessment Score based on Median Percentile	Risk Assessment Score based on Max. Percentile
Common pipistrelle	Low (2)	Medium (8)
Soprano pipistrelle	Low (0)	Medium (8)

Table 6-4: Monthly High Risk Assessment Scores

Species	May	June	July	Sept	Oct
Common pipistrelle	0%	0%	0%	0%	0%
Soprano pipistrelle	0%	0%	0%	0%	0%
Average %	0%	0%	0%	0%	0%

Green – 0%, Yellow - 1-33%, Amber 34-66%, Red - 67-100%

6.4 Proximity of Roost Sites Based on Activity Data

The Ecobat output includes an analysis of bat activity data at sample locations, referenced against the known roost emergence times for each high collision risk bat species¹⁰. This indicates whether a roost site could be present in proximity to the sample location.

The Ecobat output did not locate any bat registrations across the Site within the maternity roost emergence times.

¹⁰ Russ, Jon (2012). British Bat Calls a Guide to species Identification. Pelagic Publishing.

ANNEX A. PROTECTED SPECIES LEGAL STATUS

All bat species receive protection under the Conservation Regulations (1994) (as amended).

The information contained in this Annex is a summarised version of the legislation and should be read in conjunction with the appropriate legislation.

It is an offence to:

- Deliberately or recklessly to capture, injure or kill a wild animal of a European protected species;
- Deliberately or recklessly:
 - Harass a wild animal or group of wild animals of a European protected species;
 - Disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
 - Disturb such an animal while it is rearing or otherwise caring for its young;
 - To obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place (i.e. roost sites);
 - To disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs; or
 - To disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young;
- To damage or destroy a breeding site or resting place of such an animal.

Table A-1 Legal and Conservation Status of all UK Bats¹¹

Species	Legislation / Convention													
	Bern Convention Appendix II	Bonn Convention Appendix II	WCA	Habitats Directive Annex IV	Habitats Directive Annex II	Habs Regs 1994 (as amended) Scotland	Conservation of Habs & Species Regs 2010	Conservation Regs (N Ireland) 1995	CROW Act 2000	NERC Act 2006	Wild Mammals Protection Act	UK BAP Priority species	IUCN Red List*	EUROBATS Agreement
Greater horseshoe bat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	✓
Lesser horseshoe bat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	✓
Daubenton's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Natterer's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Whiskered bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Brandt's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Bechstein's bat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NT	✓
Alcathoe bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		DD	✓
Noctule	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	LC	✓
Leisler's bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Serotine	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Common pipistrelle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Soprano pipistrelle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	LC	✓
Nathusius' pipistrelle	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Brown long-eared bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	LC	✓
Grey long-eared bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓
Barbastelle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NT	✓
Greater mouse-eared bat	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		LC	✓

*IUCN categories: LC is Least Concern, NT is Near Threatened, DD is Data deficient; see www.iucnredlist.org for more details.

¹¹ Source: Bat Conservation Trust http://www.bats.org.uk/pages/bats_and_the_law.html

ANNEX B. SURVEY TIMINGS & ANABAT LOCATIONS

Table B-1 Summary of Temporal Survey Effort

Survey Date	Locations	Total Number of Complete Nights
May 29/05/2019 – June 13/06/2019	1	0
	2	14
	3	14
	4	14
	5	14
	6	14
	6R	14
	7	14
	8	15
	9	15
	10	15
	11	15
	12	15
	13	15
July 03/07/2019 – July 17/07/2019	1	14
	2	14
	3	14
	4	14
	5	14
	6	13
	6R	13
	7	13
	8	13
	9	13
	10	14
	11	14
	12	14
	13	14
September 19/09/2019 – October 07/10/2019	1	11
	2	10
	3	14
	4	14

Survey Date	Locations	Total Number of Complete Nights
	5	14
	6	14
	6R	18
	7	13
	8	13
	9	14
	10	14
	11	1
	12	18
	13	14
Total	-	561

Table B-2 Description of Anabat Locations

Location	Easting	Northing	Bearing	Survey period 2019
1	258156	814356	0	July to October
2	257699	814360	280	May to October
3	257208	814070	260	May to October
4	256445	813933	350	May to October
5	255991	813937	20	May to October
6	255772	813429	280	May to October
6R	255772	813429	280	May to October
7	255923	813036	330	May to October
8	255502	812635	80	May to October
9	2555776	812344	160	May to October
10	256613	812200	70	May to October
11	257519	812228	230	May to October
12	258480	812691	100	May to October
13	258927	813081	100	May to October

ANNEX C. INITIAL SITE RISK ASSESSMENT

Table C-1 Initial Site Risk Assessment⁷.

Site Risk Level (1-5) ¹²		Project Size		
Habitat Risk		Small	Medium	Large
	Low	1	2	3
	Moderate	2	3	4
	High	3	4	5
Key: Green (1-2) – low/lowest site risk; Amber (3) – medium site risk; Red (4-5) – high/highest site risk				
Habitat Risk	Description			
Low	Small number of potential roost features, of low quality. Low quality foraging habitats that could be used by small numbers of foraging bats. Isolated site not connected to the wider landscape by prominent linear features.			
Moderate	Buildings, trees or other structures with moderate-high potential as roost sites on or near the site. Habitat could be used extensively by foraging bats. Site is connected to the wider landscape by linear features such as scrub, tree lines and streams.			
High	Numerous suitable buildings, trees (particularly mature ancient woodland) or other structures with moderate-high potential as roost sites on or near the site, and/or confirmed roosts present close to or on the site. Extensive and diverse habitat mosaic of high quality for foraging bats. Site is connected to the wider landscape by a network of strong linear features such as rivers, blocks of woodland and mature hedgerows. At/near edge of range and or an important flyway. Close to key roost and /or swarming.			
Project Size	Description			
Small	Small scale development (<10 turbines). No other wind energy developments within 10km. Comprising turbines <50m in height.			
Medium	Larger developments (between 10 and 40). May have some other wind development within 5km. Comprising turbines 50 – 100m in height.			
Large	Largest developments (>40 turbines) with other wind energy developments within 5km. Comprising turbines >100m in height.			

¹² Some sites could conceivably be assessed as being of no (0) risk to bats. This assessment is only likely to be valid in more extreme environments, such as above the known altitudinal range of bats, or outside the known geographical distribution of any resident British species.

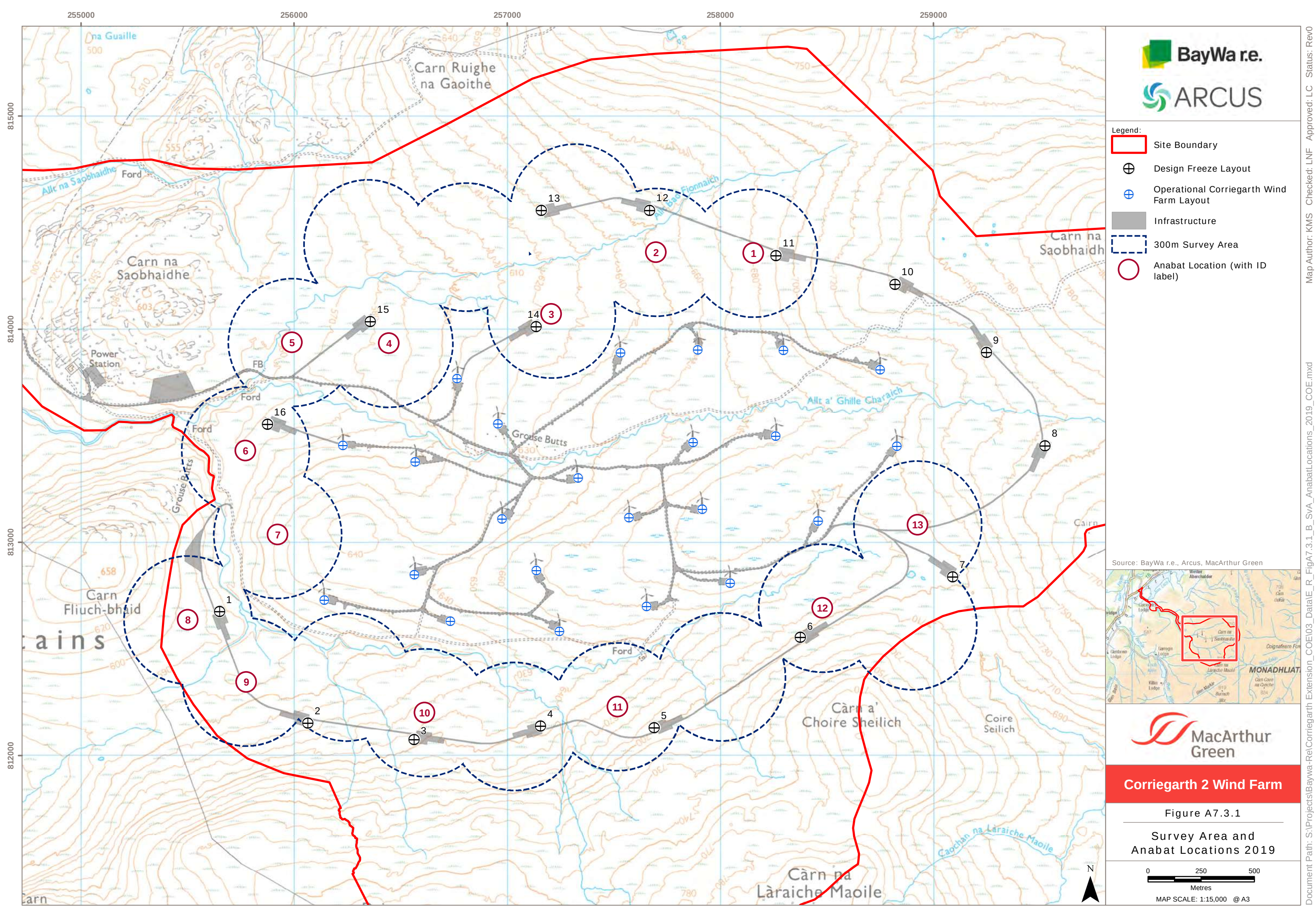
ANNEX D. MONTHLY LOCATION SPECIFIC DATA

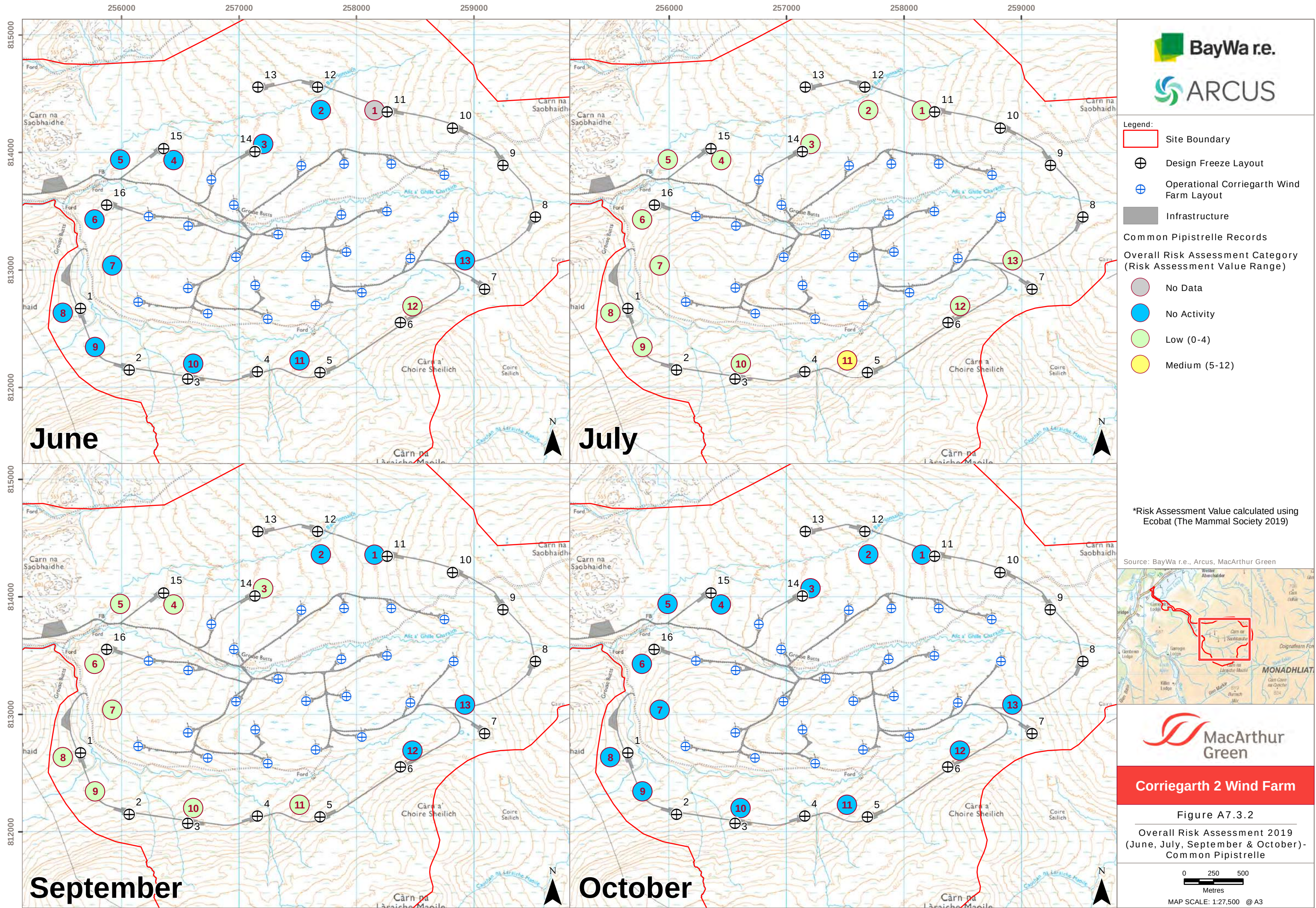
Table D-1 Monthly Location Specific Data for High Collision Risk Species

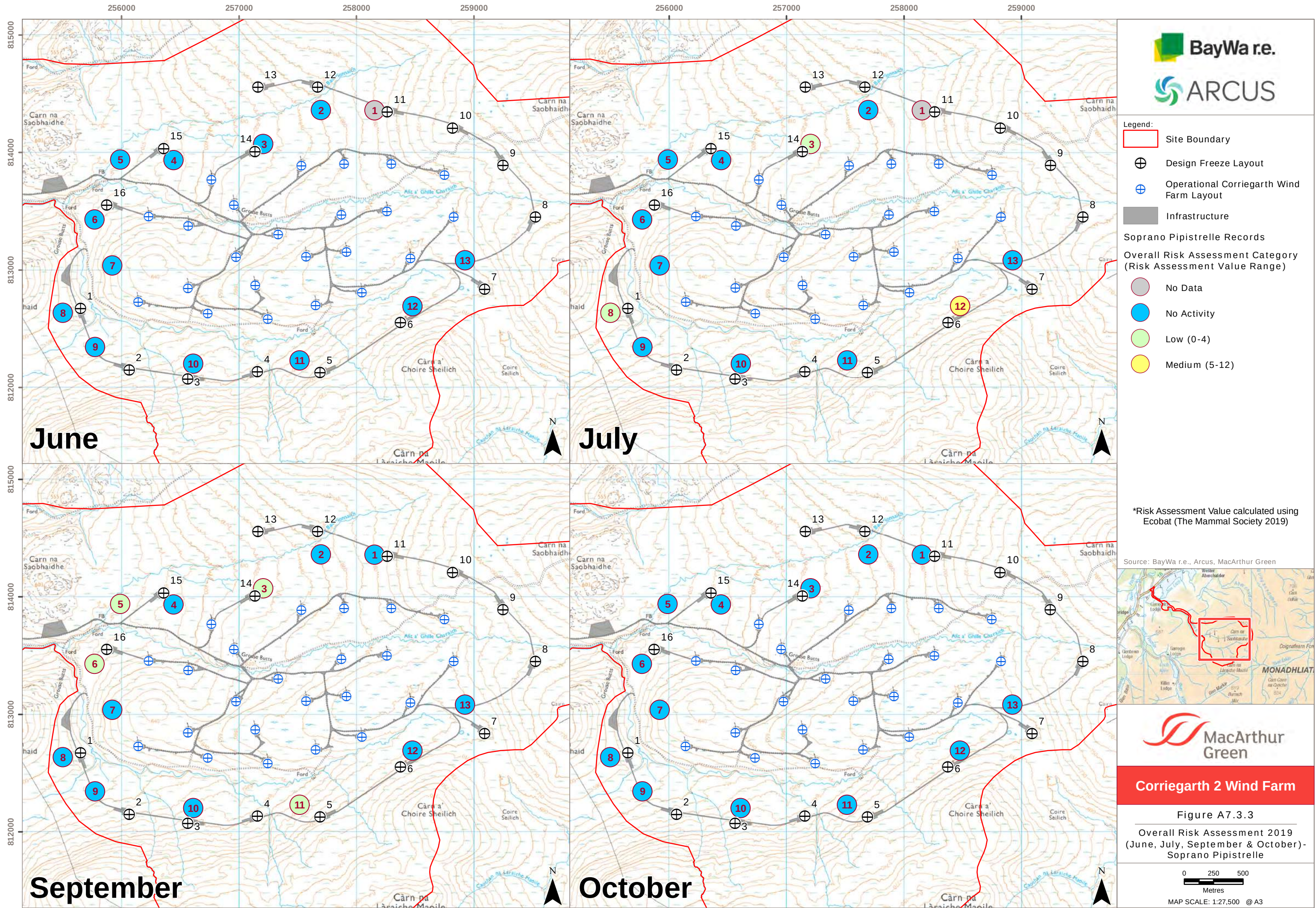
Detector ID	Species	Month	Median Percentile	Percentile Range	Activity Category	Level of Bat Activity (Taken from Table 4-1)	Site Risk (Taken from Table 4-5)	Overall Risk (Taken from Table 4-6)	Overall Category
1	<i>Pipistrellus pipistrellus</i>	Jul	18	0 - 20	Low	1	2	2	Low
10	<i>Pipistrellus pipistrellus</i>	Jul	34	>20 - 40	Low-Moderate	2	2	4	Low
10	<i>Pipistrellus pipistrellus</i>	Sep	0	0 - 20	Low	1	2	2	Low
11	<i>Pipistrellus pipistrellus</i>	Jul	42	>40 - 60	Moderate	3	2	6	Medium
11	<i>Pipistrellus pipistrellus</i>	Sep	0	0 - 20	Low	1	2	2	Low
11	<i>Pipistrellus pygmaeus</i>	Sep	0	0 - 20	Low	1	2	2	Low
12	<i>Pipistrellus pipistrellus</i>	Jun	0	0 - 20	Low	1	2	2	Low
12	<i>Pipistrellus pipistrellus</i>	Jul	9	0 - 20	Low	1	2	2	Low
12	<i>Pipistrellus pygmaeus</i>	Jul	63	>60 - 80	Moderate-High	4	2	8	Medium
13	<i>Pipistrellus pipistrellus</i>	Jul	0	0 - 20	Low	1	2	2	Low

Detector ID	Species	Month	Median Percentile	Percentile Range	Activity Category	Level of Bat Activity (Taken from Table 4-1)	Site Risk (Taken from Table 4-5)	Overall Risk (Taken from Table 4-6)	Overall Category
2	<i>Pipistrellus pipistrellus</i>	Jul	0	0 - 20	Low	1	2	2	Low
3	<i>Pipistrellus pipistrellus</i>	Jul	26	>20 - 40	Low-Moderate	2	2	4	Low
3	<i>Pipistrellus pipistrellus</i>	Sep	0	0 - 20	Low	1	2	2	Low
3	<i>Pipistrellus pygmaeus</i>	Jul	0	0 - 20	Low	1	2	2	Low
3	<i>Pipistrellus pygmaeus</i>	Sep	0	0 - 20	Low	1	2	2	Low
4	<i>Pipistrellus pipistrellus</i>	Jul	0	0 - 20	Low	1	2	2	Low
4	<i>Pipistrellus pipistrellus</i>	Sep	32	>20 - 40	Low-Moderate	2	2	4	Low
5	<i>Pipistrellus pipistrellus</i>	Jul	18	0 - 20	Low	1	2	2	Low
5	<i>Pipistrellus pipistrellus</i>	Sep	19	0 - 20	Low	1	2	2	Low
5	<i>Pipistrellus pygmaeus</i>	Sep	0	0 - 20	Low	1	2	2	Low
6	<i>Pipistrellus pipistrellus</i>	Jul	0	0 - 20	Low	1	2	2	Low
6	<i>Pipistrellus pipistrellus</i>	Sep	26	>20 - 40	Low-Moderate	2	2	4	Low

Detector ID	Species	Month	Median Percentile	Percentile Range	Activity Category	Level of Bat Activity (Taken from Table 4-1)	Site Risk (Taken from Table 4-5)	Overall Risk (Taken from Table 4-6)	Overall Category
6	<i>Pipistrellus pygmaeus</i>	Sep	0	0 - 20	Low	1	2	2	Low
7	<i>Pipistrellus pipistrellus</i>	Jul	0	0 - 20	Low	1	2	2	Low
7	<i>Pipistrellus pipistrellus</i>	Sep	0	0 - 20	Low	1	2	2	Low
8	<i>Pipistrellus pipistrellus</i>	Jul	0	0 - 20	Low	1	2	2	Low
8	<i>Pipistrellus pipistrellus</i>	Sep	19	0 - 20	Low	1	2	2	Low
8	<i>Pipistrellus pygmaeus</i>	Jul	0	0 - 20	Low	1	2	2	Low
9	<i>Pipistrellus pipistrellus</i>	Jul	26	>20 - 40	Low-Moderate	2	2	4	Low
9	<i>Pipistrellus pipistrellus</i>	Sep	26	>20 - 40	Low-Moderate	2	2	4	Low









CORRIEGARTH WIND FARM EXTENSION

FISHERIES HABITAT SURVEY

SEPTEMBER 2020



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1 INTRODUCTION

1.1 Background

This Technical Appendix (TA) presents the methods and results of Fish Habitat Surveys (hereby referred to as 'the Survey') undertaken to provide baseline ecological information for the proposed Corriegarth Wind Farm Extension, hereafter referred to as the 'Development'.

The Survey was undertaken by Mhor Environmental Ltd, who were commissioned by Arcus Consultancy Services on behalf of BayWa r.e. (the 'Client').

The following terminology is used throughout this TA:

- The Development: the whole physical process involved in the development of land at Corriegarth Wind Farm Extension, including wind farm construction, operation and decommissioning (not a piece of land or an area);
- The Site: the proposed area of land, provided by the client, within which all development works for the wind farm will take place (shown as the red-line boundary in Appendix A, Figure 1).

1.2 Site Description

The Site lies within the Monadhliath mountains, 15km north-east of Fort Augustus and near the village of Whitebridge. There are three main watercourses within the Site. The largest of the three is the River E which flows north-west along the edge of the southern site boundary into Loch Mhor. The other two watercourses are tributaries of the River E:

- Allt a Ghille Charaich which flows through the centre of the turbine envelope towards the north west; and
- Allt Bad Fionnaich which flows towards south east where it joins with the Allt a Ghille Charaich at a ford.

Both of these watercourses flow through and in close proximity to the site boundary. In addition to these main watercourses, there are numerous smaller burns and drains which cross the proposed development area and flow into the River E along its lower reaches. The Allt na Loin further downstream of the Site was also included in the survey.

The development area is dominated by moorland, areas of deep peat, ancient woodland to the south-west and the existing Corriegarth Wind Farm. There are also extensive access tracks within the Site associated with the wind farm.

1.3 Objectives

The aim of the Surveys was to provide a detailed assessment of watercourse bankside and habitat quality along River E, Allt a Ghille Charaich, Allt Bad Fionnaich and various tributaries of the main watercourses, to obtain detailed information regarding the suitability of watercourses for fish species within and in close proximity to the Site.

Detailed information obtained from the fish habitat surveys will provide an accurate and robust baseline on which to base the Environmental Impact Assessment (EIA).

The purpose of the fisheries habitat survey was to:

- Provide a baseline fisheries habitat report to assess fish utilisation potential and habitat quality of watercourses within the Site, including an assessment and searches for lamprey and freshwater pearl mussel habitat;
- To determine the requirement for further surveys (including targeted electrofishing surveys); and

- Use the baseline information for future comparison studies, potentially required during the Development construction and post-construction phases.

Fisheries Habitat Survey used a 'combined' survey methodology incorporating several a widely used survey and assessment methods to characterise in-stream habitats for potentially sensitive species, including Scottish Fisheries Co-ordination Centre (SFCC) (2007) walkover protocols¹, and method developed by Hendry and Cragg-Hine² to determine the Fish Utilisation Potential (FUP) and Fish Habitat Quality (FHQ) of watercourse that may be impacts by the Development.

To determine FUP, various habitat criteria detailed within the above methodologies were considered, including, but not limited to, cover provided by habitat, barriers to fish migration, channel modifications, and point & diffuse pollution.

To determined FHQ, flow and substrate types were considered to determine the value of each instream habitat for fish species of consideration concern, considering the habitat requirement for various life stages.

1.4 Sampling Locations

A total of eighteen sampling locations were assessed for fisheries habitat potential. The sampling locations are presented in Table 1 (below).

Table 1: Fisheries Habitat Survey Sampling Locations

Site Code	Watercourse	Downstream Location	Upstream Location
CG1	Allt na Loin	NH 50745 17678	NH 50769 17674
CG2	River E	NH 51791 16752	NH 51818 16729
CG3	Unnamed Tributary – River E	NH 52559 16175	NH 52600 16159
CG4	Allt Doirean na Smeoraich	NH 53736 15790	NH 53781 15794
CG5	Allt na Saobhaidhe	NH 54320 14613	NH 54358 14623
CG6	River E	NH 54533 13763	NH 54559 13752
CG7	River E	NH 55296 13556	NH 55320 13564
CG8	Allt a Ghille Charaich	NH 55473 13576	NH 55513 13564
CG9	Unnamed Tributary – River E	NH 56146 12473	NH 56163 12435
CG10	River E	NH 56100 12520	NH 56132 12504
CG11	Allt Bad Fionnaich	NH 55799 13753	NH 55831 13776
CG12	Allt a Ghille Charaich	NH 55824 13729	NH 55852 13714
CG13	Allt Bad Fionnaich	NH 57461 14394	NH 57511 14416
CG14	Allt a Ghille Charaich	NH 58408 13619	NH 58472 13635
CG15	River E	NH 56798 12471	NH 56827 12472

¹ SFCC (2007) Habitat Surveys Training Course Manual. Revised August 2007

² Hendry K & Cragg-Hine D (1997). Restoration of riverine salmon habitats. Fisheries Technical Manual 4 Environment Agency, Bristol.

Site Code	Watercourse	Downstream Location	Upstream Location
CG16	Allt Dearg	NH 56957 12396	NH 56971 12346
CG17	River E	NH 58367 12838	NH 58421 12890
CG18	Allt na Saobhaidhe	NH 55571 14706	NH 55644 14713

See Figure 1 (Appendix A) for a map showing the sampling locations and Appendix B for photographs.

1.5 Consultation

Consultation with the relevant Fisheries Board / Trust was undertaken via email dated 31st January 2020. At the time of writing this report no official reply was received from Ness District Salmon Fishery Board (NDSFB)/ The Ness & Beaully Fisheries Trust (NBFT).

1.6 Survey Limitations

Deep snowdrifts limited access to the upstream sections of the Site. Where snow restricted the ability to undertake the survey, the locations were relocated downstream as per SFCC guidelines. Survey location CG1 (Allt na Loin) could not be surveyed due to high water levels caused by maintenance works on the Loch Mhor dam.

2 METHODS

2.1 Desktop Study

A detailed desktop study was undertaken to identify any statutory, non-statutory or designated/classified sites, relevant to the aquatic environment, within 2km of the Site. The following web-based sources were utilised for this:

- Scottish Natural Heritage (SNH) website³ - information provided covered the location of any designated sites, statutorily protected species or habitats;
- Scottish Environment Protection Agency (SEPA) website⁴ - information provided covered classified and designated waterbodies under the Water Framework Directive (WFD) and Freshwater Fish Directive (FFD);
- Marine Scotland MAPS NMPi website⁵ – information provided on Atlantic salmon (*Salmo salar*) and brown/sea trout (salmon salar) records. Information/ location of barriers to migratory species.
- National Biodiversity Network (NBN)⁶ – information provided covered localised species records, and focused on legally protected and ecologically significant species; and
- Google earth⁷ – satellite imagery provided detailed maps used during fieldwork.

2.2 Dates and Survey Conditions

The Surveys were conducted between the 21st – 22nd March 2020. Survey weather conditions were overcast, with moderate water levels, and good water clarity. Higher ground was covered with snow, very deep snowdrifts were recorded along the north east side of the Site.

³ www.gateway.snh.gov.uk (accessed online 21/12/2019)

⁴ www.sepa.org.uk (accessed online 21/12/2019)

⁵ www.marinescotland.atkinsgeospatial.com/nmpi/ (accessed online 21/12/2019)

⁶ www.searchnbn.net (accessed online 22/12/2019)

⁷ <http://earth.google.co.uk> (accessed online 20/12/2019)

2.3 Fisheries Habitat Survey Methods

The Survey was carried out by Leigh Kelly BA MRes MIFM of Mhor Environmental Ltd (Scottish Fisheries Co-ordination Centre (SFCC) Qualified Electrofishing Team Lead and Salmonid Habitat Surveyor). During the March 2020 field survey a combination of methods developed by Hendry and Cragg-Hine⁸ and those developed for the river/fisheries habitat surveying^{9,10} were adopted.

Fisheries Habitat Survey used a 'combined' survey methodology incorporating several a widely used survey and assessment methods to characterise in-stream habitats for potentially sensitive species, including SFCC walkover protocols¹¹, and method developed by Hendry and Cragg-Hine¹² to determine the Fish Utilisation Potential (FUP) and Fish Habitat Quality (FHQ) of watercourse that may be impacts by the Development.

To determine FUP, various habitat criteria detailed within the above methodologies were considered, including, but not limited to, cover provided by habitat, barriers to fish migration, channel modifications, and point & diffuse pollution.

To determined FHQ, flow and substrate types were considered to determine the value of each instream habitat for fish species of consideration concern, considering the habitat requirement for various life stages.

See Figure 1 (Appendix A) for a map showing the sampling locations and Appendix B for photographs.

During the field survey the watercourse and the surrounding habitats were characterised and assessed according to the following criteria:

- Predominant channel substrate and flow-types;
- Habitat features;
- Modifications to the channel and banks;
- Channel vegetation types;
- Vegetation structure of the banks and bank-top; and
- Land-use.

The habitat was then defined as described in Table 2 (below).

Table 2: Fisheries Habitat Classification

Habitat Type	Classification
Spawning habitat	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt. Substrate size with a diameter of 1.3 to 10.2 cm.
Salmon Fry (0+) habitat	Shallow (<20 cm) and fast flowing water indicative of riffles and runs with a substrate dominated by gravel and cobbles.
Salmon Parr (1+) habitat	Riffle-run habitat that is generally faster and deeper than fry habitat (20-40 cm). Substrate consists of boulder, cobbles and gravels.
Trout Fry (0+) habitat	Slow to medium flowing shallow water with a substrate dominated by pebbles and smaller cobbles, often concentrated at stream margins.
Trout Parr (1+) habitat	Variety of substrate sizes; undercut banks, tree roots, big rocks; deeper, slower water.

⁸ Hendry K, Cragg-Hine D (1997) - A Guidance Manual. APEM Ltd, Fisheries Technical Manual 4, R & D Technical Report W44, Version 1.0/07-97. R & D Project 603.

⁹ Environment Agency (2003) - River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual: Environment Agency, Bristol.

¹⁰ SFCC (2007) - Fisheries Management SVQ – Habitat Surveys Training Course Manual.

¹¹ SFCC (2007) Habitat Surveys Training Course Manual. Revised August 2007

¹² Hendry K & Cragg-Hine D (1997). Restoration of riverine salmon habitats. Fisheries Technical Manual 4 Environment Agency, Bristol.

Lamprey spawning habitat ¹³	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt (but may contain some sand). Substrate size varies from gravels to pebbles.
Juvenile lamprey habitat ¹³ ,	Optimal: Stable fine sediment or sand ≥ 15 cm deep with low water velocity and the presence of organic detritus/plant material. Sub-optimal: Shallow sediment (<15 cm deep), often patchy and interspersed among coarser substrate.
Freshwater Pearl Mussel ¹⁴	Small sand patches stabilised amongst large stones or boulders in fast-flowing streams and rivers.
Eel Habitat	Variety of habitats including streams, rivers, and muddy or silt-bottomed lakes during their freshwater stage.
Glides	Smooth laminar flow with little surface turbulence and generally greater than 30 cm deep.
Pool	No perceptible flow. Shallow pool ≤ 0.3 m – Deep pool > 0.3 m
Flow constrictions	Physical features providing a narrowing of the channel resulting in increased velocity and depth.
Obstructions to migration	Impassable falls, weirs, bridge sills etc. shallow braided river sections preventing upstream migration during low flows.

When determining habitat type, if significant amounts of different habitat types were found to co-exist in the same section, these habitat classifications were adequately described. For example, in the case of salmonids, fry and parr habitat is classified as juvenile habitat. Where parr habitat is mentioned, this refers to habitat that has principally been identified as habitat more suited to parr than fry, however habitually contains a lower quantity of fry habitat and habitat which is suited to both fry and parr.

2.3.1 Sampling Locations

A total of eighteen sampling locations were selected to assess for fisheries habitat potential. The sampling locations are presented in Table 1 (below).

Table 1: Fisheries Habitat Survey Sampling Locations

Site ID	Watercourse	Downstream Location	Upstream Location
CG1	Allt na Loin	NH 50745 17678	NH 50769 17674
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CG7	River E	NH 55296 13556	NH 55320 13564
CG8	Allt a Ghille Charaich	NH 55473 13576	NH 55513 13564

¹³ Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough

¹⁴ Skinner, A, Young M & Hastie L (2003). Ecology of the Freshwater Pearl Mussel. Conserving Natura 2000 Rivers Ecology Series No. 2 English Nature, Peterborough.

Site ID	Watercourse	Downstream Location	Upstream Location
CG9	Unnamed Tributary – River E	NH 56146 12473	NH 56163 12435
CG10	River E	NH 56100 12520	NH 56132 12504
CG11	Allt Bad Fionnaich	NH 55799 13753	NH 55831 13776
CG12	Allt a Ghille Charaich	NH 55824 13729	NH 55852 13714
CG13	Allt Bad Fionnaich	NH 57461 14394	NH 57511 14416
CG14	Allt a Ghille Charaich	NH 58408 13619	NH 58472 13635
CG15	River E	NH 56798 12471	NH 56827 12472
CG16	Allt Dearg	NH 56957 12396	NH 56971 12346
CG17	River E	NH 58367 12838	NH 58421 12890
CG18	Allt na Saobhaidhe	NH 55571 14706	NH 55644 14713

See Figure 1 (Appendix A) for a map showing the sampling locations and Appendix B for photographs.

2.4 Consultation

Consultation with the relevant Fisheries Board / Trust was undertaken via email dated 31st January 2020. At the time of writing this report no official reply was received from Ness District Salmon Fishery Board (NDSFB)/ The Ness & Beaully Fisheries Trust (NBFT).

2.5 Survey Limitations

Deep snowdrifts limited access to the upstream sections of the Site. Where snow restricted the ability to undertake the survey, the locations were relocated downstream as per SFCC guidelines. Survey location CG1 (Allt na Loin) could not be surveyed due to high water levels caused by maintenance works on the Loch Mhor dam.

3 RESULTS

3.1 Desktop Study Results

3.1.1 SNH SiteLink website¹⁵

No statutory designated sites, Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) or Special Protection Area (SPA), are present within the Site. No statutory or non-statutory sites are present within a 2km radius of the Development.

3.1.2 SEPA Water Classification Hub website¹⁶

Two watercourses are classified and designated under the Water Framework, the River E and Allt na Loin. The latest available information is detailed below and presented in Table 3:

¹⁵ <https://sitelink.nature.scot/map>

¹⁶ <https://www.sepa.org.uk/environment/water/aquatic-classification/>

- River E is a river (ID: 20274), in the River Ness catchment of the Scotland river basin district. The main stem is approximately 11.4 kilometres in length. The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on water storage for hydroelectricity generation.
- Allt an Loin is a river (ID: 20272), in the River Ness catchment of the Scotland river basin district. The main stem is approximately 3.3 kilometres in length. The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on water storage for hydroelectricity generation.

Table 3: Water Classification Data

Parameters	2018 Data	
	River E	Allt na Loin
Overall status	Medium ecological potential	Good ecological potential
Pre-HMWB status	Medium	Medium
Overall ecology	Medium	Medium
Biological elements	High	High
Fish	High	High
Fish barrier	High	High
Hydromorphology	Medium	Medium
Morphology	High	High
Overall hydrology	Medium	Medium
Modelling hydrology	Bad	Medium
Hydrology (medium/ high flows)	Bad	Medium
Hydrology (low flows)	High	High

3.1.3 Marine Scotland MAPS NMPI website¹⁷

3.1.3.1 Salmon and Sea Trout – Scottish Salmon Rivers data

No records are available for Atlantic salmon or Sea trout within the watercourses surveyed during this survey. The closest record to site was downstream of the Falls of Foyers.

3.1.3.2 Barriers to Fish Migration

Two records detailing barriers to fish migration are available, both barriers are considered highly likely to significantly impact upstream migration through the watercourses detailed in this report. The Falls of Foyers (grid reference NH 49778 20323) and the Loch Mhor dam (grid reference NH 51327 18069) are considered impassable to migratory fish species.

3.2 Fisheries Habitat Survey Results

Table 4 presents a summary of the prominent habitat characteristics recorded during the fish habitat survey (August 2019).

¹⁷ <https://marinescotland.atkinsgeospatial.com/nmpi/>

Table 4: Fisheries Habitat Survey Results

Site Code	FUP	FHQ	Site Characteristics
CG1	N/A	N/A	Watercourse flows into the River Foyers from Loch Mhor. Unable to survey this watercourse due to high water levels caused by maintenance works on Loch Mhor dam.
CG2	High	Good	Watercourse flows into Loch Mhor. Adult and Juvenile habitat. Flow type predominantly run/riffle sequences. Average wet width 7.3m. Depth ranging from <10-30 cm. Cobble/boulder substrate – instream dredging/ improvement works upstream. Good instream cover. Land use is grazing. Erosion recorded along left bank. Large spanned bridge at watercourse crossing point upstream.
CG3	Low	Poor	Watercourse flows into the River E. Poor habitat. Flow type predominantly run with cascade and step pool throughout. 1.4m falls recorded in survey section considered impassable in low flow due to depth of pool and slope. Average wet width 1.6m. Depth ranging from <10-20 cm. Cobble/gravel substrate with various sand deposits. Sections of bedrock recorded. Poor instream cover. Land use is grazing/ moorland with sparse woodland along watercourse. Large spanned bridge at watercourse crossing point upstream.
CG4	Moderate	Moderate	Watercourse flows into the River E. Juvenile habitat. Flow type predominantly glide/run with step pools. Average wet width 1.7m. Depth ranging from <10-30 cm. Cobble/pebble substrate with limited boulder and small sections of bedrock. Moderate instream cover. Land use is grazing/ moorland with sparse woodland along watercourse. Steep embankment both banks.
CG5	Moderate	Moderate	Watercourse flows into the River E. Juvenile habitat. Flow type predominantly glide/run sequences with riffle upstream section. Average wet width 1.4m. Depth ranging from <10-30 cm. Cobble, pebble/gravel substrate with limited boulder. Moderate instream cover. Land use is grazing/ moorland with sparse woodland along watercourse. Large spanned bridge at watercourse crossing point upstream.
CG6	Moderate	Moderate	Parr habitat. Flow type predominantly glide with a large pool below impassable barrier (3m+ falls). Average wet width 6.1m. Depth ranging from <10-50 cm - 1.6m at pool. Bedrock, boulder/cobble substrate with limited pebble/gravel deposits. Good instream cover. Land use is moorland. Impassable weir upstream of falls.
CG7	High	Good	Adult and Juvenile habitat. Flow type predominantly glide/run sequences with riffle upstream section. Average wet width 7.3m. Depth ranging from <10-50 cm. Cobble/boulder with limited pebble/gravel substrate. Good instream cover. Land use is moorland. Brown trout observed during survey.
CG8	High	Good	Adult and juvenile habitat. Potential spawning habitat recorded within section. Flow type predominantly run/riffle/glide sequences with pool/cascade upstream. Average wet width 6 m. Depth ranging from <10-30 cm. Cobble/boulder with patches of gravel/pebble. Good instream cover. Land use is moorland.
CG9	Moderate	Moderate	Watercourse flows into the River E. Juvenile habitat. Flow type predominantly run/riffle sequences with step pool upstream. Average wet width 1.5 m. Depth ranging from <10-20 cm. Cobble with patches of gravel/pebble. Moderate

Site Code	FUP	FHQ	Site Characteristics
			instream cover. Land use is moorland however survey effort limited due to snow drift.
CG10	High/ Moderate	Good/ Moderate	Juvenile habitat. Flow type predominantly run/riffle/glide sequences with pool/cascade. Average wet width 3.7 m. Depth ranging from <10-40cm. Cobble/boulder with patches of gravel/pebble. Bedrock recorded upstream. Moderate instream cover. Land use is moorland.
CG11	High	Good	Watercourse flows into the Allt a Ghille Charaich. Juvenile habitat. Flow type predominantly run with step pool small cascade throughout. Average wet width 4 m. Depth ranging from <10-50 cm. Cobble/boulder with patches of gravel/pebble. Good instream cover. Land use is moorland. Left bank is considered unstable due to erosion. Large spanned bridge at watercourse crossing point upstream.
CG12	High/ Moderate	Good/ Moderate	Watercourse flows into the River E. Adult and juvenile habitat. Potential spawning habitat recorded within section. Flow type predominantly run/riffle sequences with glide. Average wet width 4.2 m. Depth ranging from <10-25 cm. Cobble/pebble with patches of gravel and limited boulder. Moderate instream cover. Land use is moorland.
CG13	Low/ Moderate	Poor/ Moderate	Watercourse flows into the Allt a Ghille Charaich. Parr habitat. Flow type predominantly run/riffle sequences with step pool upstream. Average wet width 1.5 m. Depth ranging from <10-20 cm. Cobble with patches of gravel/pebble. Moderate instream cover. Land use is moorland. Survey effort limited due to snow drift.
CG14	Moderate	Moderate	Parr habitat. Flow type predominantly run/riffle/glide sequences. Average wet width 2.6 m. Depth ranging from <10-20 cm. Cobble/pebble with limited boulder. Moderate/poor instream cover. Land use is moorland. Survey effort limited due to snow drift.
CG15	High/ Moderate	Good	Juvenile habitat. Flow type predominantly run/riffle sequences with step pool upstream. Average wet width 3.5 m. Depth ranging from <10-45cm. Predominantly cobble substrate with boulder and patches of pebble/ gravel. Good instream cover. Land use is moorland.
CG16	Low/ Moderate	Poor/ Moderate	Watercourse flows into the River E. Flow type predominantly riffle. Average wet width 3 m. Depth ranging from <10-30 cm. Bedrock throughout downstream section with patches of cobble/gravel/pebble. Poor instream cover. Land use is moorland however survey effort limited due to snow drift.
CG17	Low/ Moderate	Poor/ Moderate	Flow type predominantly run/riffle sequences with cascade and small falls. Average wet width 3.4 m. Depth ranging from <10-35cm. Bedrock outcrops with cobble/boulder substrate. Good instream cover. Land use is moorland.
CG18	Moderate	Moderate	Watercourse flows into the River E. Parr habitat. Flow type predominantly run/glide sequences with step pools. Average wet width 1.1m. Depth ranging from 10-35 cm. Cobble/boulder substrate with patches of pebble/gravel. Moderate instream cover. Land use is grazing/ moorland. Large double culvert at watercourse crossing point downstream.

4 EVALUATION OF RESULTS

4.1 Fisheries Habitat Survey

The habitat quality of the Sampling Locations was coherent in terms of supporting salmonid populations. However, the connectivity between the watercourses throughout the catchment is significantly affected by various barriers to fish migration. The most significant barrier, Falls of Foyers, was recorded 3.5km downstream of the Site. The Falls of Foyers is a 165ft waterfall which prevents all upstream migration. Habitat connectivity is integral to survival of migratory salmonids, successful migration upstream and downstream is required to support populations of migratory fish species¹⁸¹⁹. Therefore, it is considered that all watercourses within the survey area, where moderate/ good habitat was recorded (CG2, CG4, CG5, CG6, CG7, CG8, CG9, CG10, CG11, CG12, CG14, CG15 and CG18), are likely to contain only resident brown trout, if salmonids are present.

All eighteen survey sites were located in the River E catchment. Thirteen had suitable combinations of flow types, depths and variable substrates providing moderate/ good habitat for juvenile salmonids, namely brown trout. Three sites (CG13, CG16 and CG17) had poor/ moderate habitat for juvenile salmonids however these watercourses are considered likely to support low populations of brown trout.

One site (CG3) was poorer in quality and considered to be low in terms of fish utilisation potential and poor fisheries habitat quality. This site was small in size and the substrate characteristics were considered inadequate to support populations of brown trout. One site, Allt na Loin (CG1), was not surveyed and therefore should be included in future surveys.

4.2 Potential Impacts

The main processes, associated with wind farm construction activities, can impact fish populations due a variety of different issues²⁰. Deterioration in water quality, can have an effect on spawning success, hatching of eggs, production of juveniles and angling success. Poor water quality can be the result of various construction activities including the release of sediment when excavating turbine and control building/substation foundations, installation of access, cable tracks and borrow pits. Spillages, including fuel and concrete. The use of non-metal based flocculants (for sediment control) and tree felling which forms part of the enabling works. Another main issue is associated with poorly designed watercourse crossings such as culverts/bridges/fords, which can prevent fish migration.

5 RECOMMENDATIONS

To ensure compliance with relevant environmental legislation and implementation of good working practices, the following recommendations are provided.

5.1 Avoidance

Avoidance measures should include (all sites):

- Fish rescue – removal of fish from the temporary working areas (culvert installation); and
- Work must not be carried out when fish are likely to be spawning in the affected surface water, or in the period between spawning and the subsequent emergence of juvenile fish.

¹⁸ Hendry K & Cragg-Hine D (2003). Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Ecology Series No.7. English Nature, Peterborough.

¹⁹ Willem B. Buddendorf, et al (2019). Integration of juvenile habitat quality and river connectivity models to understand and prioritise the management of barriers for Atlantic salmon populations across spatial scales. STOTEN 655, 557-566.

²⁰ Bridcut, E.E. (20015). Impacts on Salmon and Trout Populations Associated with Onshore Wind Farm Developments in Scotland

5.2 Pollution Prevention & Culvert installation

It is recommended that a pollution prevention plan is provided and that Guidance for Pollution Prevention (GPPs)²¹ are adhered to at all times during works. Particular attention should be paid to GPP 5: Works and maintenance in or near water, GPP 21: Pollution incident response planning and GPP 22: Dealing with spills.

Watercourse crossing should be kept to a minimum and culvert design should be in-line with best practice and authorised under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)²².

5.3 Construction and Post-Construction Monitoring of Aquatic Ecology

As part of an ongoing assessment of potential impacts which may occur as a result of the Development, it is recommended that a construction and post-construction fish fauna and aquatic invertebrate monitoring plan is produced (utilising baseline sampling sites plus one control site).

The suggested monitoring schedule would include the following:

- Baseline Fish Fauna - in areas of Moderate to High Fish Utilisation Potential (FUP) or Fish Habitat Quality (FHQ) – watercourses CG2, CG3, CG4, CG5, CG6, CG7, CG8, CG9, CG10, CG11, CG12, CG13, CG14, CG15, CG16, CG17 and CG18. It is also recommended that CG1 is included in the baseline fish fauna survey;
- Fish fauna – annually during construction (summer) and post-construction Year 1 (summer) and Year 2 (summer); and
- Aquatic invertebrates – annually during construction (spring/autumn) and post-construction during Year 1 (spring/autumn) and Year 2 (spring/autumn).

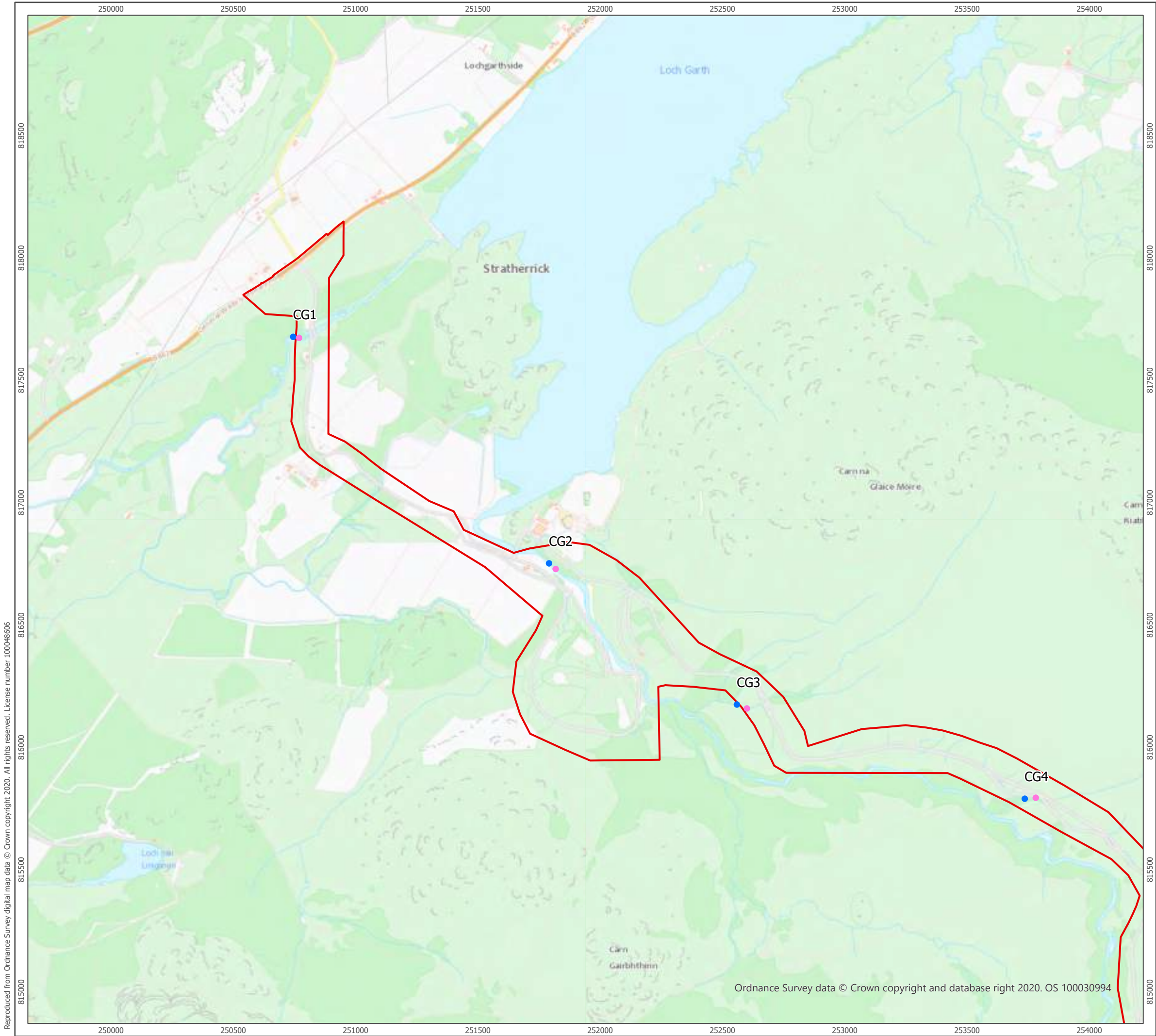
It is also recommended that an Environmental Clerk of Works (ECoW) with knowledge of the water environment should be appointed during major works. The ECoW should undertake water quality monitoring as part of their role.

²¹ NetRegs - Environmental guidance for your business in Northern Ireland & Scotland. Available online at :<https://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-pgps-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/> (accessed online 24/08/2020)

²² https://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf (accessed online 24/02/2020)

APPENDIX A: FIGURES

Figure 1: Sampling Locations



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 Planning Boundary

Sampling Location

 Downstream

 Upstream

1:15,000 Scale @ A3



0 0.25 0.5 km

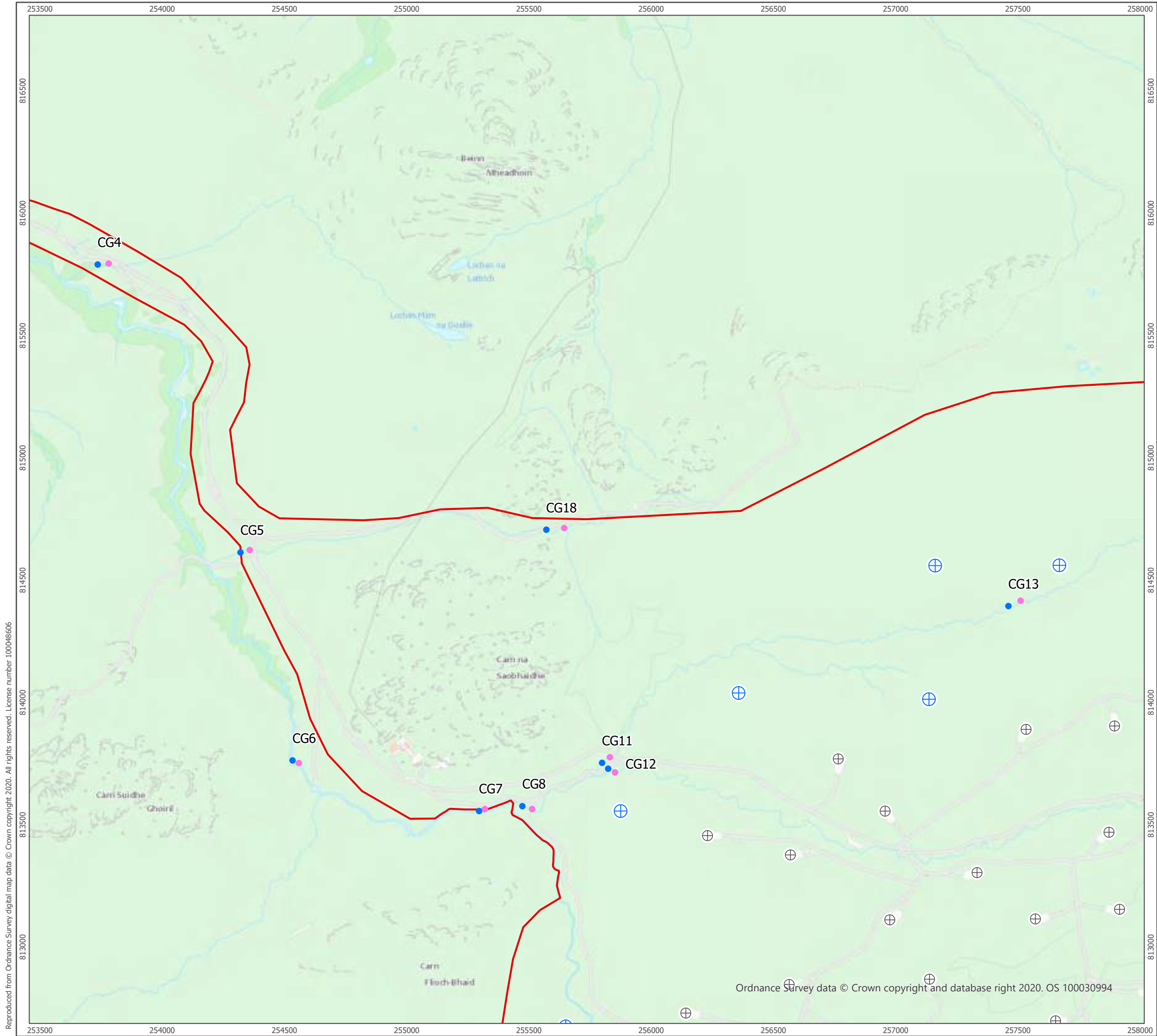
NORTH

Produced By: FC	Ref: 3369-REP-081
Checked By: NW	Date: 11/09/2020

Survey Locations
Figure 1a

Corriegarth 2 Wind Farm
Technical Appendix A7.4:
Fisheries Habitat Survey

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Planning Boundary

Proposed Wind Turbine

Operational Corriegarth Wind Turbine

Sampling Location

Downstream

Upstream

1:15,000 Scale @ A3

0 0.25 0.5 km

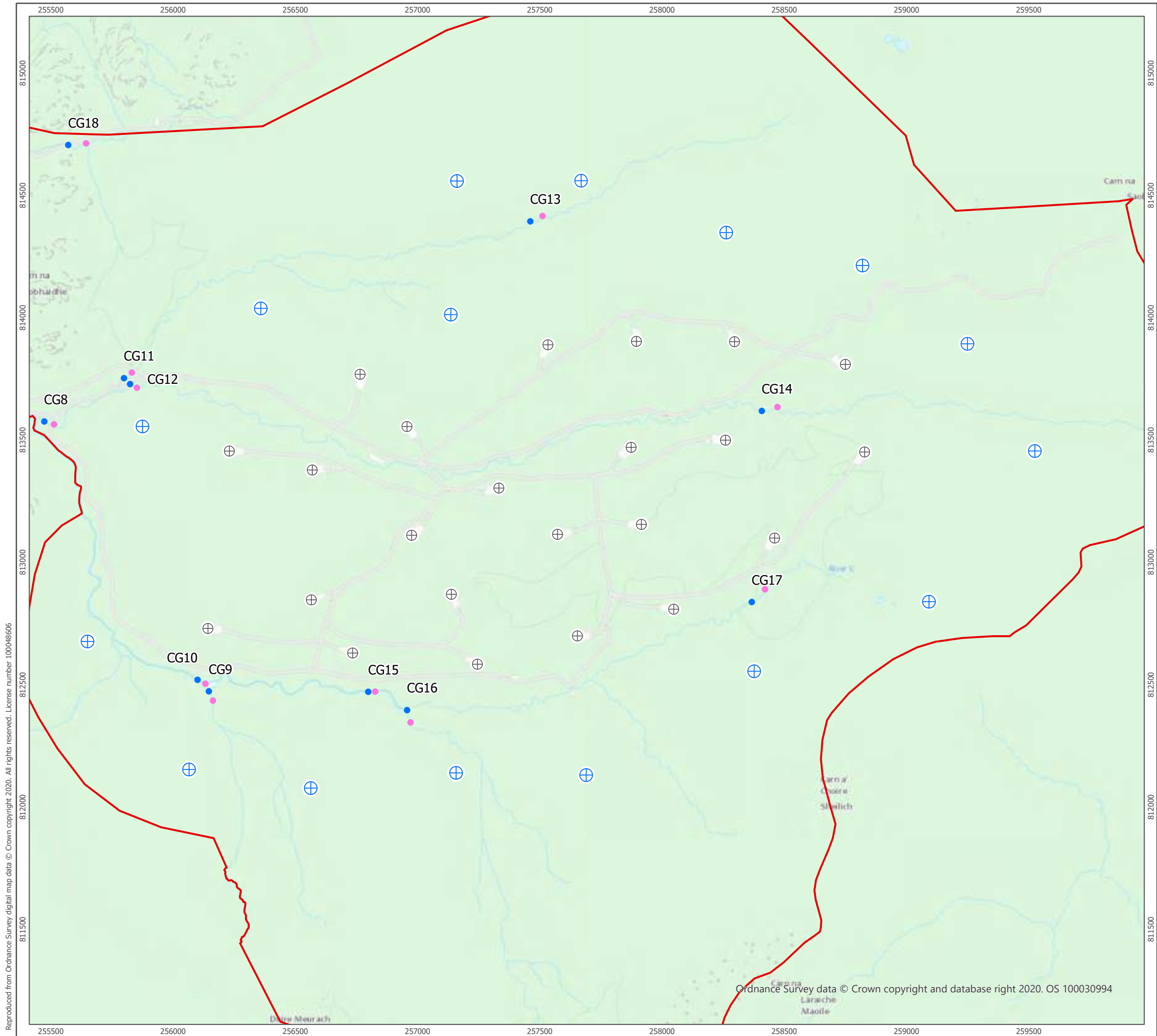
NORTH

Produced By: FC	Ref: 3369-REP-081
Checked By: NW	Date: 11/09/2020

Survey Locations
Figure 1b

**Corriegarth 2 Wind Farm
Technical Appendix A7.4:
Fisheries Habitat Survey**

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 Planning Boundary

 Proposed Wind Turbine

 Operational Corriegarth Wind Turbine

Sampling Location

 Downstream

 Upstream

1:15,000 Scale @ A3



0 0.25 0.5 km

 NORTH

Produced By: FC	Ref: 3369-REP-081
Checked By: NW	Date: 11/09/2020

Survey Locations
Figure 1c

**Corriegarth 2 Wind Farm
Technical Appendix A7.4:
Fisheries Habitat Survey**

APPENDIX B: PHOTOGRAPHS

	
Plate 1 – CG1 (facing upstream)	Plate 2 – CG2 (facing upstream)
	
Plate 3 – CG3 (facing upstream)	Plate 4 – CG4 (facing upstream)
	
Plate 5 – CG5 (facing upstream)	Plate 6 – CG6 (impassable barrier)



Plate 7 – CG7 (facing downstream)



Plate 8 – CG8 (facing upstream)



Plate 9 – CG9 (facing upstream / snow drift)



Plate 10 – CG10 (facing upstream)



Plate 11 – CG11 (facing upstream)



Plate 12 – CG12 (facing upstream)



Plate 13 – CG13 (facing upstream / snow drift)



Plate 14 – CG8 (facing upstream / snow drift)



Plate 15 – CG15 (facing downstream)



Plate 16 – CG16 (facing upstream / snow drift)



Plate 17 – CG17 (facing upstream)



Plate 18 – CG18 (facing upstream)



Plate 19 – upstream of CG6 (weir)



Plate 20 – snow drift upstream of CG14

CORRIEGARTH 2

TECHNICAL APPENDIX 8.1: BREEDING BIRD REPORT 2019

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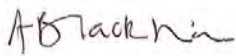
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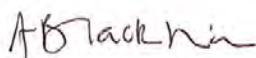
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Executive Summary

Contents	Summary
Site Location	15 km north-east of Fort Augustus and south-east of Loch Mhor off the B862 (central Ordnance Survey grid reference NH 57530 13480)
Proposals	Construction of Corriegarth 2 Wind Farm ('the Development')
Survey Scope	The following surveys were undertaken in 2019, specifically to gather data for the Development: ✔ Flight activity (vantage point) surveys – with viewsheds extending 500 m beyond the outermost proposed wind turbine locations; ✔ Moorland breeding bird surveys – survey area to 500 m beyond proposed wind turbine locations; ✔ Breeding raptor surveys – survey area to 2 km beyond proposed wind turbine locations; and ✔ Golden eagle surveys – survey area to 6 km beyond proposed wind turbine locations.
Results	Flight Activity Survey Species recorded comprised eight target species and three secondary species. Target species were: dunlin (2 flight lines), golden eagle (6 flight lines), golden plover (3 flight lines), merlin (1 flight line), peregrine (1 flight line), red kite (17 flight lines), teal (2 flight lines) and white-tailed eagle (2 flight lines). Red kites appear to use the site frequently for scavenging/hunting and were most often recorded flying within the 'at risk height band.' Golden eagle activity was greatest earlier in the season, with sightings consisting mainly of a young bird hunting throughout the site. Moorland Breeding Bird Survey ✔ Golden plover: Five probable territories and two possible territories recorded. ✔ Dunlin: Two confirmed territories, two probable territories and four possible territories recorded. ✔ Common sandpiper: Two confirmed territories, two probable territories and a further four possible territories recorded. ✔ Red grouse: Three confirmed and five probable territories recorded. ✔ Other target species: One possible teal territory and one possible wigeon (BoCC Amber List) territory were recorded. Raptor Survey A total of seven species of raptors were recorded within the survey area, four of which were considered to be non-breeders. Results of the 2019 raptor surveys are presented in Confidential Annex A8.5 and on Confidential Figure 8.2.3. ✔ Buzzard: Recorded during the surveys but no firm evidence of breeding within the survey area. ✔ Peregrine: One probable territory recorded to the north-west of the site. ✔ Golden eagle: Numerous records of flight lines associated with hunting in the western part of the survey area. Six roost sites recorded.

	✔ Red kite: Flights and ground-based registrations of foraging birds in most parts of the survey area. Most frequently recorded raptor species. ✔ Osprey: One commuting flight by a single bird. ✔ Kestrel: Two records of foraging birds, but no evidence of breeding. ✔ White-tailed eagle: Four records of flights/hunting within the survey area. Breeding Eagle Survey Information on known breeding sites for golden eagle and white-tailed eagle in 2019 and 2018 are presented in Confidential Appendix A8.5 and in Confidential Figure 8.2.1.
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1 Introduction

1.1 Background

Nevis Environmental Ltd. (Nevis) was commissioned by BayWa r.e. in April 2019 to undertake ornithological surveys to inform an application for Corriegarth 2 Wind Farm ('the Development'), located adjacent to the Operational Corriegarth Wind Farm on high ground between Loch Ness to the west and the Monadhliath mountains to the east.

The Operational Corriegarth Wind Farm site is located 15 km north-east of Fort Augustus and south-east of Loch Mhor off the B862. The original planning application was submitted in July 2007. Consent for a wind farm with 20 wind turbines with a tip height of 120 m and a maximum output of 49 MW was issued in May 2013 (planning ref: 07/00673/FULIN), together with approval for a variation to part of the access route (planning ref: 11/04358/FULIN).

A proposal for an extension of the Operational Corriegarth Wind Farm was submitted in 2013 to extend the maximum capacity of the consented scheme to up to 61 MW by increasing the capacity of each of the existing wind turbines to up to 3.04 MW. In addition, consent was sought for the erection of three further wind turbines to increase the total number of wind turbines to 23 and the total capacity to 70 MW.

Construction started in 2014 with the enabling works, followed by the main site construction in 2015. Wind turbine erection started in 2015 and was completed in 2016, consisting of 23 turbines with a generating capacity of 70 MW.

Ornithological survey work took place during the 2019 breeding season (April to August inclusive), comprising several different methodologies to cover different bird orders and species. Post-construction ornithological monitoring surveys of the Operational Corriegarth Wind Farm commenced in September 2015, and took place in the years 2015-2016, 2016-2017 and 2017-2018. The data gathered during these surveys will be used to inform assessment of impacts within the Environmental Impact Assessment (EIA) Report. This approach was agreed with Scottish Natural Heritage (SNH) on 6th June 2019. Ornithological baseline survey data were gathered to inform the planning application for the Operational Corriegarth Wind Farm that was submitted in 2007, with pre-construction bird surveys also undertaken in 2013. Data from these surveys have been used to inform the desk study and feed into the assessment within the EIA Report but are not included within this report.

1.2 Site Location and Context

The site is located 15 km north-east of Fort Augustus and south-east of Loch Mhor off the B862 (central Ordnance Survey grid reference NH 57530 13480). The survey area(s) discussed within this report comprises the footprint of the proposed construction works, including the Operational Corriegarth Wind Farm, together with buffers appropriate to different ornithological receptors.

The site comprises an area of high undulating moorland (over 600 m above sea level). It comprises the Operational Corriegarth Wind Farm and immediately surrounding land, which is managed for grouse shooting. Several watercourses are present within the study area, including Allt Bad Fionnaich to the north and Allt a Ghille Charaich

at the centre. Higher ground is present within the vicinity of the site rising to 811 m to the east. The valley of the River E, which is lined with broadleaved woodland, is located to the south of the existing Operational Corriegarth Wind Farm access track.

To the south and east the landscape is similar to that within the site, comprising undulating moorland with waterbodies and watercourses, with the higher ground of the Monadhliath mountains present further to the south-east. Several small settlements are present to the west of the site on lower-lying ground, close to Loch Ness. The site is accessed from B862, which lies to the west, via the existing Operational Corriegarth Wind Farm access track.

1.3 Survey and Reporting Objectives

It is acknowledged that SNH normally requires two years of survey work to support a planning application for a new wind farm site. However, a significant amount of ornithological study has taken place on and around the site during the last 15 years. It was therefore agreed with SNH in June 2019 to utilise a combination of existing ornithological data survey work during the 2019 breeding season to support a planning application, provided no additional ornithological issues arise which would require winter work.

This report details the methodology and findings of surveys undertaken in 2019 and is intended to provide supporting information for the assessment of effects on important ornithological features within the EIA Report. Although the results of previous surveys undertaken are not detailed within this report, these have been used to inform the assessment and recommendations as appropriate.

2 Methods

2.1 Desk Study

2.1.1 Previous Reports

The following ornithology reports are available for the Operational Corriegarth Wind Farm:

- ✔ Corriegarth Windfarm Environmental Statement (SLR 2007) – containing baseline information on bird populations assessed in the EIA Report for the Operational Corriegarth Wind Farm;
- ✔ Corriegarth Windfarm Pre-Construction Avian Surveys (SKM Enviros 2013) – containing results of pre-construction surveys for the Operational Corriegarth Wind Farm;
- ✔ Corriegarth Wind Farm Operational Monitoring and HMP Implementation Annual Report 2016 (Nevis Environmental 2017) – containing results of Year 1 of flight activity (Vantage Point) surveys of the Operational Corriegarth Wind Farm;
- ✔ Corriegarth Wind Farm Operational Monitoring and HMP Implementation Annual Report 2017 (Nevis Environmental 2018) – containing results of Year 2 of Vantage Point surveys of the Operational Corriegarth Wind Farm; and
- ✔ Corriegarth Wind Farm HMP Implementation Annual Report 2018 (Nevis Environmental 2019) – containing results of Year 3 of Vantage Point surveys of the Operational Corriegarth Wind Farm.

Additionally, data collected by Nevis Environmental during supervision of construction of the Operational Corriegarth Wind Farm in 2014 and 2015 were reviewed. All of the above documents were reviewed for additional context in relation to the data collected in 2019. The results of the above surveys are however discussed in more detail in the EIA Report.

2.1.2 Online Resources

The following web-based databases were also accessed:

- ✔ Scottish Natural Heritage (SNH) SiteLink, for information on statutory designated sites.
- ✔ Department for Environment Food and Rural Affairs (DEFRA) MAGIC, for information on statutory designated sites

The search radius for Natura 2000 sites (i.e. SPAs/SACs) and those designated under The Ramsar Convention on Wetlands of International Importance (Ramsar sites) was 20 km and the search area for SSSIs was 5 km.

2.1.3 Raptor Study Group

Supplementary data regarding the locations of breeding raptors was provided by the local Raptor Study Group (RSG) throughout the project.

2.2 Field Survey

Survey effort in 2019 was designed to ensure that an appropriate level of data was collected for all target and secondary species (i.e. important ornithological features), with reference to SNH (2017). The following surveys were undertaken in 2019, specifically to gather data for the Development:

- ✔ Flight activity (vantage point) surveys – with viewsheds extending 500 m beyond the outermost proposed wind turbine locations;
- ✔ Moorland breeding bird surveys – survey area to 500 m beyond proposed wind turbine locations;
- ✔ Breeding raptor surveys – survey area to 2 km beyond proposed wind turbine locations; and
- ✔ Golden eagle surveys – survey area to 6 km beyond proposed wind turbine locations.

Dates and weather conditions for the vantage point, moorland breeding bird and raptor surveys are presented in Appendix 1. Survey visit dates for the eagle survey are included in Appendix 2.

2.3 Flight Activity Surveys

The purpose of flight activity (vantage point) surveys was to record flight lines of species potentially sensitive to collision with moving infrastructure in order to allow the risk of collision to be calculated. Survey methodology followed that outlined within SNH (2017), with the direction of movement, height and activity of all target and secondary species recorded, in addition to details on age, gender and behaviour of individual birds. Birds on the ground within the survey area were also recorded. With specific reference to vantage point surveys, target species were considered to comprise the following:

- ✔ Qualifying species of all sites of international importance for nature conservation designated for their ornithological interest within 20 km (see section 4.1).
- ✔ Raptor species listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife and Countryside Act 1981 (as amended);
- ✔ Wader species listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife and Countryside Act 1981 (as amended);
- ✔ All diver and grebe species; and
- ✔ All ducks, geese and swans.

In addition, activity by the following secondary species considered to be potentially relevant to the proposals (i.e. particularly vulnerable to collision or effects of habitat loss/disturbance) was recorded during the surveys:

- ✔ All other wader species (e.g. snipe);
- ✔ All other raptor species (e.g. buzzard *Buteo buteo*, kestrel *Falco tinnunculus* and sparrowhawk *Accipiter nisus*); and
- ✔ Raven *Corvus corax*.

Three vantage point locations were utilised (Figure 8.4) to allow all proposed wind turbine locations to be covered with these being broadly similar to those utilised during the monitoring surveys at the Operational Corriegarth Wind Farm during 2015-2018 (Figure 8.3) but adapted to cover the Development and appropriate buffer zone.

Six hours of survey were undertaken from each vantage point location per month, to cover the period March to August 2019 (inclusive), as agreed with SNH. Due to late commissioning, the surveys commenced in April with two sets of VP watches undertaken during the first month to make up for the lack of survey effort in March. In summary, twelve hours of survey per VP were undertaken in April, with six hours of survey per VP in the months May to August. Individual watches lasted for three hours and were varied to start and finish at different times of day, including to cover crepuscular and daytime periods. Where surveys ran consecutively at a given vantage point location, a break of at least 30 minutes was taken by the surveyor.

2.4 Moorland Breeding Bird Survey

The Brown and Shepherd (1993) method was used to survey for moorland breeding bird (upland wader species) territories, with the survey covering the proposed wind turbine locations plus a 500 m buffer. Four visits were made between April and July 2019 (inclusive), in accordance with Calladine et al (2009). The surveyor walked parallel transects 200 m apart, spending 20-25 minutes within each 500 m² quadrat. This methodology ensured that every part of the survey area was visited to within 100 m. The survey route was varied between visits to reduce bias.

During the transect surveys regular stops were made to scan and listen for birds. Surveys were carried out between 08:00 and 18:00 and in favourable weather conditions as far as possible, and all wader species were recorded. Additional species were also noted as appropriate, such as red grouse *Lagopus lagopus scotica*, raptors, breeding wildfowl such as teal *Anas crecca* and mallard *Anas platyrhynchos*, gulls and notable passerines. Birds were recorded on electronic maps for accuracy, using standard BTO codes for species and activity as per Gilbert et al (1998).

2.5 Breeding Raptor Survey

The survey was undertaken to record the presence of breeding raptor species (other than eagles) within a 2 km buffer of proposed turbine locations. In particular, species listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) were sought, together with other species such as Red and Amber List birds of conservation concern. Four visits were made between April and August 2019. The initial visits comprised visiting all areas considered suitable for breeding raptors such as crags and rocky outcrops and areas of deep heather or other dense vegetation suitable for ground-nesting species such as merlin. Tree cover was very limited and therefore the site was considered unsuitable for tree-nesting species such as red kite. Data was collected digitally using background maps to ensure accuracy of location, particularly where nest sites were noted.

Where confirmed or potential breeding activity was noted, during both raptor walkover survey and any other surveys, specific methodologies for the relevant species were employed on subsequent visits, as per Hardey *et al* (2013) and nest sites were monitored via vantage point watches from a suitable distance to determine their success. Signs of raptor presence, such as feeding remains, feathers and old nests were also recorded as appropriate.

2.6 Breeding Eagle Survey

It was understood that the local RSG were monitoring all golden eagle territories within 6 km of the site. In order to avoid unnecessary disturbance to birds at potential nest sites by repeat visits it was agreed with SNH that the relevant data to inform the impact assessment would be obtained from the RSG. Data for the eagle survey in 2018 were also requested to provide further background data.

2.7 Taxa scoped out of surveys

Initial moorland bird and raptor walkover survey results confirmed a lack of waterbodies suitable for breeding divers within 1 km of the site and therefore breeding diver surveys were not considered necessary.

Habitats within 1.5 km of the site were not considered to provide potential lekking/breeding habitat for black grouse. No black grouse were recorded during species-specific surveys carried out along the access track or during any of the other surveys in 2013. The Environmental Statement baseline survey recorded no black grouse during 2006 although they had been recorded incidentally in 2005. Surveys for black grouse were therefore considered unnecessary.

2.8 Limitations

Due to late commissioning, the surveys commenced in late April 2019. To make up for the lack of survey effort in March, 12 hours of Vantage Point watches were undertaken during April. This is not considered to be a major limitation to the study because of the ongoing monitoring of the operational wind farm where flight line data have been collected in March in 2016, 2017 and 2018.

Due to the April start, raptor surveys therefore commenced later than the period recommended by Hardey et al. (2013) for checking for occupied home ranges of the target raptor species. However, the recommended total number of survey visits were carried out and consistency of results between the visits shows that the later than recommended start was not a major limitation of the study.

Part of the raptor survey area lying within the Garrogie Estate could not be visited until 15th May due access restrictions. Although this meant that the final walkover of Visit 1 was not completed until 15 days after the initial visits on 25th and 29th April, this is not considered to be a significant limitation of the study as the recommended four visits were carried out to this part of the survey area during the breeding season.

Although every effort was made to ensure that surveys were undertaken during the most optimal weather conditions, on occasion surveys were undertaken during rain showers and/or times of reduced visibility in order to ensure that they were completed within the correct survey periods. Where weather deteriorated significantly during a visit, surveys ceased and were rescheduled in order to ensure the welfare of birds and the collection of robust data. As a result, periods of inclement weather were not considered to have had a significant impact on the results.

Third party survey data has been used to inform assessment of the potential effects of the Development, Nevis is not responsible for the accuracy of this data.

3 Results

3.1 Designated Sites

The site is located within 20 km of six statutory sites of international importance (Figure 8.1). The closest designated site is Monadhliath SSSI, which is 6.8 km to the south-east. There are no statutory sites that are designated for their ornithological interest within 5km.

Details of all the nature conservation sites are provided in Table 1 and their locations in relation to the site shown on Figure 8.1.

Table 1 Summary of Nature Conservation Sites Designated for their Ornithological Features within 20km of the site

Site Name	Designation	Site Area	Location in Relation to Site	Qualifying Features
Monadhliath	SSSI	10671.11	6.0 km South-east	Dotterel <i>Charadrius morinellus</i> , breeding population of national importance. Moorland breeding bird assemblage including raptors, golden plover <i>Pluvialis apricaria</i> , dunlin <i>Calidris alpina</i> , ring ouzel <i>Turdus torquatus</i> , wheatear <i>Oenanthe oenanthe</i> , stonechat <i>Saxicola rupicola</i> , red grouse <i>Lagopus lagopus scoticus</i> , meadow pipit <i>Anthus pratensis</i> and dipper <i>Cinclus cinclus</i> .
Loch Knockie and nearby Lochs	SPA SSSI (Glendoe Lochans SSSI & Knockie Lochs SSSI)	396.4ha	9km to west	Qualifies under Article 4.1 by regularly supporting a population of European importance of the Annex 1 species: Slavonian grebe (1992 to 1995, up to 6 pairs, up to 10% of the GB population).
Loch Ruthven	SPA Ramsar Site SSSI	200.84ha	12.5km to north	Qualifies under Article 4.1 by regularly supporting a population of European Importance of the Annex 1 species: Slavonian grebe (1988 to 1992, 14 pairs, 18.9% of the GB population).
North Inverness Lochs	SPA SSSI (Dubh Lochs SSSI & Balnagrantach SSSI)	123.18ha	18.3km to north-west	Qualifies under Article 4.1 by regularly supporting a population of European Importance of the Annex 1 species: Slavonian grebe (1991 to 1995, 7 pairs, 12% of the GB population).
River Spey – Insh Marshes	SPA Ramsar Site SSSI	1157.26ha	18.8km to south-west	Qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species: osprey <i>Pandion haliaetus</i> forage throughout the SPA (2008 to 2012, five year average of up to 10 territories within feeding range, 5% of the GB population and 1991 to 1995 a five year average of 4 pairs breeding within the site, 4% of the GB population); spotted crane <i>Porzana porzana</i> (1991 to 1995, a 5 year average of 3 calling males, 19% of the GB population); wood sandpiper <i>Tringa glareola</i> (1991 to 1995, a five year

				average of 2 pairs, 33% of the GB population). Over the period 1990/91 to 1994/95, average winter peak counts of: whooper swan <i>Cygnus cygnus</i> (190 individuals, 3% of the GB population) and hen harrier <i>Circus cyaneus</i> (11 individuals, 1% of the GB population). Further qualifies under Article 4.2 by regularly supporting a population of European importance of the migratory species: wigeon <i>Anas penelope</i> (2006 to 2010, average of 17 pairs).
Loch Ashie	SPA SSSI	162.55ha	19.1km to north-east	Qualifies under Article 4.1 by regularly supporting a population of European importance of the Annex 1 species: Slavonian grebe - an autumn gathering of (up to 60 individuals, up to 15% of the GB population). This is the most important known moult site in Scotland.
Creag Meagaidh	SPA SSSI	2872.6ha	19.8km to south	The site is of special nature conservation and scientific importance within the European Community because it supports a nationally important population of breeding dotterel <i>Charadrius morinellus</i>. Britain holds one of the most important populations of dotterel in the EC and, because of its rarity, this species is listed as requiring special conservation measures under Article 4.1 of The Wild Birds Directive. From 1987 to 1994, an average of 23 pairs of dotterel bred within the Creag Meagaidh SPA, representing 3% of the British breeding population. Dotterel on Creag Meagaidh breed at around five times the average density of dotterel on montane areas of Great Britain. The British breeding population of 860 pairs of dotterel breed mainly in Scotland with only a few pairs found in England. Creag Meagaidh is an important spring staging area for dotterel that breed in Scotland and in Scandinavia.

3.2 Flight Activity Surveys

All flight lines recorded during the flight activity surveys are presented Figures 8.5 to 8.12, and full survey results are provided in Appendix 2 of this report.

A total of 11 species were recorded during the vantage point watches undertaken between April and August 2019 (inclusive). Both flight lines and ground-based registrations were made. Species recorded comprised eight target species and three secondary species. The target species recorded are presented in Table 2.

Table 2 Flight Lines by Target Species Recorded During Vantage Point Surveys in 2019

Species	Legal/Conservation Status	No. Flight lines
Dunlin <i>Calidris alpina schinzii</i>	Annex I, SBL	2
Golden eagle	Annex I, Schedule 1, SBL, LBAP	6
Golden plover	Annex I, SBL, LBAP	3
Merlin	Annex 1, Sched 1, SBL, LBAP, BoCC Red List	1
Peregrine	Annex 1, Sched 1, SBL, LBAP	1
Red kite	Annex 1, Sched 1, SBL, LBAP	17
Teal	BoCC Amber List	2
White-tailed eagle	Annex 1, Sched 1, SBL, BoCC Red List	2

The three secondary species were raven (8 flight lines), buzzard (4 flight lines) and kestrel (1 flight line).

A total of 47 flight lines were recorded during the vantage point surveys, 34 of which were made by target species. The most frequently recorded species was red kite, with 17 flight lines, over a third of the total number of flight lines recorded. Red kites appear to use the site frequently for scavenging/hunting and were most often recorded flying within the 'at risk height band.' Raven was the second most frequently recorded species with eight flight lines and golden eagle was the third most frequent with six flight lines. Golden eagle activity was greatest earlier in the season, with sightings consisting mainly of a young bird hunting throughout the site. All other species made between one and four flight lines during the survey period.

Flight activity was greatest in the earlier spring months (April and May), with flight line numbers decreasing throughout the season. Activity across all species dropped off significantly in July and August with only a handful of flight lines recorded. Flight lines were quite evenly distributed throughout the site, though slightly more flight lines were recorded from VP 7 in western part of the survey area. In addition to the flight lines, twelve instances of either audible 'heard, not seen' or ground observations of birds were also recorded.

3.3 Moorland Breeding Bird Survey

Full survey moorland breeding bird survey results are available in Appendix 2 and displayed on Figure 8.13.

Three upland wader species and one game bird species were recorded holding territories during the moorland breeding bird surveys. Additional records of two wildfowl species were collected during the raptor survey and are reported here.

3.3.1 Golden Plover

No confirmed territories were recorded. Five probable territories were observed, two of which occurred within the survey area. One probable territory was recorded south-east of T20 of the Operational Corriegarth Wind Farm and the other was recorded between T20 and T21 of the Operational Corriegarth Wind Farm. Two of the three remaining probable territories were located 50 m outwith the survey area. Another probable territory was located

770 m outside of the survey area on Carn na Laraiche Maoile and was recorded incidentally during other ornithological surveys. Three possible territories were recorded. Two occurred within the survey area, with one possible territory located approx. 320 m outside of the survey boundary on Carn Fliuch-bhaid.

3.3.2 Dunlin

Two confirmed territories were recorded during moorland breeding bird surveys, one of which was located within the survey area, close to T21 of the of the Operational Corriegarth Wind Farm. The other confirmed territory was located on the summit of Carn na Saobhaidhe, approx. 410m from the survey area. One probable territory was located within the north-western area of the survey area, between T15 and T16 of the of the Operational Corriegarth Wind Farm. One other probable territory was located approximately 375 m to the east of the survey area. Similarly, one possible territory was located within the survey area to the east and one other possible territory was located 770 m outwith the survey area, on Carn na Laraiche Maoile.

A further two possible dunlin territories were recorded during the flight activity surveys. One was located within the Operational Corriegarth Wind Farm, but 125 m south of the moorland bird survey area, to the north of Allt a Ghille Charaich , between T8 and T12. The other was located 240 m east of the moorland bird survey area, approximately 425 m from the nearby probable and possible dunlin territories also located in this area.

3.3.3 Common Sandpiper (BoCC Amber List)

Two confirmed territories of common sandpiper were recorded along an unnamed watercourse within the southern part of the survey area. Two probable territories and a further possible territory also occurred along the same watercourse. A further possible territory occurred within the site boundary to the south-west. Two possible territories occurred within the site boundary, one to the west and the other to the south.

3.3.4 Red Grouse (BoCC Amber List)

Three confirmed territories of red grouse were recorded in the southern part of the survey area. A further five probable territories were also recorded, mainly in the southern and western parts of the survey area.

3.3.5 Other Target Species

A possible teal territory and a possible wigeon (BoCC Amber List) territory were recorded during the raptor survey on an unnamed watercourse to the north-west of Beinn Mheadhoin. A single fly-over record of teal was made in early May.

3.3.6 Secondary Species

Several additional species were recorded during the survey, comprising of two species of passerines; wheatear *Oenanthe Oenanthe* and grey wagtail *Motacilla flava*. However, evaluation of passerine species is not recommended by SNH (2017) and they are therefore not considered any further by this assessment.

3.4 Breeding Raptor Survey

Results of the 2019 raptor surveys are presented in Confidential Annex A8.5 and on Confidential Figure 8.2.3. A total of seven species of raptors were recorded within the survey area, four of which were considered to be non-

breeders. Records of raptors collected during the moorland breeding bird survey are also discussed here. All information on breeding Schedule 1 raptor species must be kept **strictly confidential**.

3.4.1 Buzzard

A pair of buzzards was first recorded to the west of Carn Ruighe na Gaoithe (NH 562161) in mid-May in this area and were subsequently recorded in the same area throughout the season. Buzzards can nest on cliffs, bluffs and steep slopes in moorland without trees or crags (Hardy *et al*, 2013), however, no evidence of a nest or young was recorded in this location. Incidental records of buzzard were also made during vantage point and moorland breeding bird surveys. One adult bird was observed hunting in late April, with further buzzard flight lines observed in May and June.

3.4.2 Peregrine

One probable peregrine territory was recorded to the north-west of the site (see Confidential Annex A8.5 for details). The location offers good nesting habitat for peregrines as it is relatively steep with rocky outcrops and cliffs. A pair were seen together in flight in this location on one occasion and together on cliffs above Lochan na Leitrich on another occasion. A roost and plucking point was recorded nearby, with evidence of golden plover kills. Two other records of peregrines were made, one during a vantage point survey in August and one during a moorland breeding bird survey in June.

3.4.3 Golden Eagle

The locations of known breeding sites for golden eagle in 2019 and 2018 are summarised in Section 4.5 and detailed in Confidential Annex A8.5 and Confidential Figure 8.2.1. Numerous records of golden eagle were made during the raptor survey. Most were flight lines or roost site registrations associated with the western part of the survey area, including soaring activity around Carn Suidhe Goiril and Carn Liath Bhaid, and therefore likely to be associated with the closest nest to that area (Confidential Figure 8.2.1). Most flight lines were associated with hunting behaviour and mountain hare *Lepus timidus* were considered to be the main prey species within the survey area. Six roost sites were also recorded, usually on prominent rocks on a slope. The use of these sites as roosts was evidenced by the presence of feathers, pellets and splashing. Incidental ground-based registrations of golden eagles were made in the northern and southern parts of the survey area.

3.4.4 Red Kite

Red kite were the most commonly recorded raptor species within the survey area during the raptor survey. Activity was evenly distributed within the survey area, with flights and ground-based observations recorded in most parts of the survey area. Relatively high levels of activity by red kite were also recorded during the vantage point and moorland breeding bird surveys. No evidence of breeding was recorded on within the survey area, likely due to the absence of woodland or forestry plantation. Most records were of foraging birds.

3.4.5 Osprey

One flight line of an adult osprey was recorded in June 2019. This bird was considered to be commuting over the site. The survey area provides very limited foraging habitat for osprey, as there are no large water bodies. The

survey area also provides very limited breeding, as there are no large, mature trees within the survey area and therefore no breeding habitat for osprey.

3.4.6 Kestrel

No evidence of breeding kestrel was recorded within the survey area. Two records of adults foraging were made during the raptor surveys.

3.4.7 White-tailed Eagle

The location of a known breeding site for white-tailed eagle in 2019 is detailed in Confidential Annex A8.5. Four records of white-tailed eagle were collected during the raptor survey. Two flight lines were of adult birds in the northern part of the survey area and there was one ground-based record of an adult with prey on the western side of Doire Meurach, which flew off to the south-west in the direction of the known nest site. A further record of an immature bird was made 0.5 km east of the survey area boundary.

3.5 Breeding Eagle Survey.

Information on known breeding sites for golden eagle and white-tailed eagle in 2019 and 2018 are presented in Confidential Appendix A8.5 and in Confidential Figure 8.2.1.

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Appendix 1 – Survey Details

Flight Activity Survey Details

VP	Survey Date	Surveyor	Start Time	End Time	Sunrise	Sunset	Type	Cloud Cover (Eighths)	Temp (°C)	Visibility	Wind Speed (Beaufort)	Wind Direction	Precipitation
6	26-Apr-19	PS	08:05	11:05			Diurnal	6	10.9	2km	3	South east	None
6	26-Apr-19	PS	11:35	14:35			Diurnal	4	12	2km	3	South east	None
6	29-Apr-19	LW	14:30	17:30			Diurnal	3	10	2km	4	South south west	None
6	29-Apr-19	LW	18:00	21:00		20.57	Dusk	4	7	2km	3	South west	None
6	30-May-19	PS	05:00	08:00	04.31		Dawn	8	7.6	2km	2	North east	None
6	30-May-19	PS	08:30	11:30			Diurnal	8	8	2km	2	North east	None
6	27-Jun-19	CM	15:49	18:49			Diurnal	0	23.6	2km	2	West	None
6	27-Jun-19	CM	19:19	22:19		22.19	Dusk	0	20	2km	2	West	None
6	19-Jul-19	JM	05:30	08:30	05.03		Dawn	6	10.5	2km	3	South west	None
6	25-Jul-19	JM	11:30	14:30			Diurnal	5	16	2km	6	South south east	None
6	23-Aug-19	MM	10:00	13:00			Diurnal	7	14.3	2km	5	South west	None
6	23-Aug-19	MM	13:30	16:00			Diurnal	7	14.3	2km	5	South west	None

VP	Survey Date	Surveyor	Start Time	End Time	Sunrise	Sunset	Type	Cloud Cover (Eighths)	Temp (°C)	Visibility	Wind Speed (Beaufort)	Wind Direction	Precipitation
7	25-Apr-19	LW	10:45	13:45			Diurnal	2	11	2km	5	South west	None
7	26-Apr-19	LW	18:35	21:35		20.45	Dusk	7	10	2km	5	South west	None
7	30-Apr-19	PS	06:30	09:30			Diurnal	3	7	2km	3	South west	None
7	30-Apr-19	PS	10:00	13:00			Diurnal	3	7	2km	3	South west	None
7	17-May-19	LW	05:15	08:15	04.55		Dawn	6	9	2km	1	South east	None
7	17-May-19	LW	08:45	11:45			Diurnal	5	10	2km	2	South east	None
7	07-Jun-19	JW	06:10	09:10			Diurnal	7	6.6	2km	3	West	None
7	26-Jun-19	JM	17:05	20:05			Diurnal	1	19.3	2km	5	North	None
7	17-Jul-19	JM	18:45	21:45		22.00	Dusk	8	12	2km	4	South south west	Light Intermittent
7	19-Jul-19	CM & MM	09:14	10:28			Diurnal	8	12.2	200m – 1km	4	South west	Heavy Persistent
7	25-Jul-19	JM	09:20	10:50			Diurnal	3	22	2km	6	South south east	None
7	19-Aug-19	MM	11:55	14:55			Diurnal	7	14.8	2km	4	South west	None
7	29-Aug-19	MM	17:25	20:25		20.23	Dusk	7	13.6	2km	7	South west	None
8	24-Apr-19	LW	14:20	17:20			Diurnal	3	10	2km	3	South	None

VP	Survey Date	Surveyor	Start Time	End Time	Sunrise	Sunset	Type	Cloud Cover (Eighths)	Temp (°C)	Visibility	Wind Speed (Beaufort)	Wind Direction	Precipitation
8	24-Apr-19	LW	17:50	20:50		20.47	Dusk	4	7	2km	3	South	None
8	01-May-19	LW	06:35	09:45	05:37		Dawn	6	8	2km	2	South west	None
8	01-May-19	LW	10:05	13:05			Diurnal	7	10	2km	1	South west	None
8	07-May-19	JW	10:15	13:15			Diurnal	8	4.3	2km	4	South east	Light Intermittent
8	07-May-19	JW	13:45	16:45			Diurnal	8	4	2km	1	South east	None
8	03-Jun-19	JM	10:00	13:00			Diurnal	8	9	2km	7	South west	Heavy Intermittent
8	03-Jun-19	JM	13:30	15:30			Diurnal	8	7	2km	7	South west	Light Persistent
8	04-Jun-19	JW	04:30	05:30	04.30		Dawn	8	6	2km	3	West	Light Intermittent
8	26-Jun-19	JM	21:15	22:15		22.19	Dusk	0	13.7	2km	2	North	None
8	04-Jul-19	JW	04:20	07:20	04.28		Dawn	8	7.7	1km 2km	4	West	None
8	04-Jul-19	JW	07:50	10:50			Diurnal	8	8	1km 2km	5	West	None
8	16-Aug-19	JM	08:10	11:10			Diurnal	8	11	2km	7	South	Light Persistent
8	30-Aug-19	MM	06:20	09:20	06.13		Dawn	8	10	2km	5	South west	Light Intermittent

Moorland Bird Survey Details

Visit Number	Survey Date	Surveyor	Start Time	End Time	Cloud Cover (Eighths)	Temp (°C)	Visibility	Wind Speed (Beaufort)	Wind Direction	Precipitation
1	30-Apr-19	JW	10.45	16.15	8	14	> 2km	4	S	Light intermittent
1	01-May-19	JW	09.35	16.00	8	15	> 2km	3	S	None
2	14-May-19	JM	09.40	16.20	3	22	> 2km	3	SSE	None
2	15-May-19	JM	09.30	15.00	3	25	> 2km	2	SSW	None
2	16-May-19	JW	10.10	16.00	2	16	> 2km	4	SSE	None
3	17-Jun-19	JM	10.05	14.20	7	12	> 2km	6	SW	Light persistent
3	21-Jun-19	CM	08.30	13.30	7	9	> 2km	3	N	None
3	26-Jun-19	CM	09.30	14.30	1	21	> 2km	2	W	None
4	08-Jul-19	PS	07.30	16.00	1	9	> 2km	0	-	None
4	09-Jul-19	PS	12.15	16.15	8	9	> 2km	2	NW	None
4	10-Jul-19	PS	09.30	13.30	7	14	> 2km	1	NW	None

Raptor Survey Details

Visit Number	Survey Date	Surveyor	Start Time	End Time	Cloud Cover (Eighths)	Temp (°C)	Visibility	Wind Speed (Beaufort)	Wind Direction	Precipitation
1	25-Apr-19	PS	09.00	15.00	2	11	> 2km	3	SE	None
1	29-Apr-19	PS	09.00	15.00	5	13	> 2km	2	SW	None
1	15-May-19	PS	09.00	15.00	0	18	> 2km	0	-	None
2	16-May-19	JM	10.00	16.00	1	18	> 2km	5	SSE	None
2	23-May-19	PS	05.45	13.15	8	7	> 2km	3	WSW	None
2	28-May-19	LW	10.00	14.05	6	13	> 2km	3	SW	Light intermittent
3	19-Jun-19	JM	09.35	15.00	7	15	> 2km	6	S	Light intermittent
3	21-Jun-19	JM	08.50	15.00	8	9	> 2km	5	W	None
3	27-Jun-19	JM	09.55	15.00	0	24	> 2km	2	NNE	None
3	28-Jun-19	JM	09.30	15.00	0	25	> 2km	6	E	None
4	16-Jul-19	CM	09.30	15.00	6	19	> 2km	4	SW	None
4	24-Jul-19	MM	10.35	13.40	6	20	> 2km	5	S	None
4	24-Jul-19	JM	10.40	15.00	5	20	> 2km	4	N	None
4	29-Jul-19	MM	10.55	13.40	7	18	> 2km	2	SW	None

Appendix 2 – Survey Results

Flight Activity Survey Results

VP Number	Survey Date	Species	Number of Birds	Time First Observed	Notes
6	26-Apr-19	White-tailed Eagle	1	13:45	flew under 2 turbines
6	29-Apr-19	Raven	1	18:03	
6	29-Apr-19	Merlin	1	18:07	low over ground
6	30-May-19	Golden Plover	1	07:58	
6	30-May-19	Red Kite	1	09:53	
6	30-May-19	Red Kite	1	10:17	
6	27-Jun-19	Red Kite	1	17:04	
6	27-Jun-19	Red Kite	1	17:08	same bird flew behind me and back out
6	27-Jun-19	Red Kite	1	17:30	
6	27-Jun-19	Raven	1	18:24	calling and seen flying
6	27-Jun-19	Red Kite	1	18:25	
6	27-Jun-19	Red Kite	1	18:26	circling very high
6	27-Jun-19	Golden Eagle	1	19:24	
6	27-Jun-19	Red Kite	1	21:35	
7	25-Apr-19	Raven	1	11:17	
7	30-Apr-19	Dunlin	1	06:41	displaying
7	30-Apr-19	Golden Plover	1	06:43	displaying
7	30-Apr-19	Dunlin	1	07:13	displaying
7	30-Apr-19	Golden Plover	1	08:20	displaying
7	30-Apr-19	Raven	1	09:13	flying
7	30-Apr-19	Golden Eagle	1	10:01	hunting landed attempting to catch hare

VP Number	Survey Date	Species	Number of Birds	Time First Observed	Notes
7	30-Apr-19	Golden Eagle	1	10:21	took off then out of view
7	30-Apr-19	Raven	2	10:28	hunting
7	30-Apr-19	Golden Eagle	1	11:03	hunting, flew through turbine
7	30-Apr-19	Golden Eagle	1	11:09	different bird than in 3, hunting
7	30-Apr-19	Red Kite	1	11:16	hunting
7	30-Apr-19	Golden Eagle	1	11:18	hunting
7	30-Apr-19	Buzzard	1	11:32	hunting
7	30-Apr-19	Red Kite	1	11:47	hunting
7	30-Apr-19	Buzzard	1	12:26	hunting
7	30-Apr-19	Red Kite	1	12:31	hunting
7	30-Apr-19	Red Kite	1	12:42	hunting
7	30-Apr-19	Red Kite	1	12:47	hunting
7	30-Apr-19	Red Kite	1	12:55	hunting
7	17-May-19	White-tailed Eagle	1	08:12	
7	26-Jun-19	Buzzard	1	17:32	
7	29-Aug-19	Raven	1	19:00	
7	29-Aug-19	Raven	1	19:36	
8	24-Apr-19	Buzzard	1	17:03	Direct flight
8	01-May-19	Raven	1	07:13	
8	01-May-19	Red Kite	1	08:57	
8	01-May-19	Kestrel	1	11:57	foraging
8	01-May-19	Red Kite	1	12:11	using thermals to gain height
8	07-May-19	Red Kite	1	10:32	

VP Number	Survey Date	Species	Number of Birds	Time First Observed	Notes
8	07-May-19	Teal	1	13:45	landed on pool
8	07-May-19	Teal	1	14:10	
8	16-Aug-19	Peregrine	1	08:37	

Moorland Bird Survey Results – Wader Territories

Common Name	Scientific Name	Annex 1	Schedule 1	Inverness & Nairn BAP Priority Species	BoCC	Confirmed	Probable	Possible
Common Sandpiper	<i>Actitis hypoleucos</i>				Amber	2	2	2
Dunlin	<i>Calidris alpina schinzii</i>	Yes			Amber	2	2	2
Golden Plover	<i>Pluvialis apricaria</i>	Yes		Yes	Green	0	5	3

Moorland Bird Survey Results – Secondary Species

Common Name	Scientific Name	Annex 1	Schedule 1	Inverness & Nairn BAP Priority Species	BoCC	Confirmed	Probable	Possible
Grey Wagtail	<i>Motacilla flava</i>				Red	1	0	1
Wheatear	<i>Oenanthe oenanthe</i>				Green	1	0	1
Red Grouse	<i>Lagopus lagopus scotica</i>				Amber	3	5	0

Raptor Survey Results

Common Name	Scientific Name	Annex 1	Schedule 1	Inverness & Nairn BAP Priority Species	BoCC	Highest Breeding Status
Buzzard	<i>Buteo buteo</i>					Possible
Golden eagle	<i>Aquila chrysaetos</i>	Yes	Yes	Yes		Confirmed
Kestrel	<i>Falco tinnunculus</i>				Amber	Non-breeding
Peregrine	<i>Falco peregrinus</i>	Yes	Yes	Yes		Probable
Red kite	<i>Milvus milvus</i>	Yes	Yes	Yes		Non-breeding
White-tailed eagle	<i>Haliaeetus albicilla</i>	Yes	Yes		Red	Non-breeding
Osprey	<i>Pandion haliaetus</i>	Yes	Yes	Yes	Amber	Non-breeding

CORRIEGARTH 2

TECHNICAL APPENDIX 8.2: ORNITHOLOGICAL MONITORING 2015-2018

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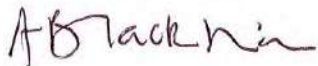
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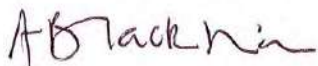
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1 Introduction

1.1 Background

The Operational Corriegarth Wind Farm site is located 15 km northeast of Fort Augustus and southeast of Loch Mhor off the B862. The original planning application was submitted in July 2007. Consent for a wind farm with 20 turbines with a tip height of 120 m and a maximum output of 49 MW was issued in May 2013 (planning ref: 07/00673/FULIN), together with approval for a variation to part of the access route (planning ref: 11/04358/FULIN).

A proposal for an extension of the Operational Corriegarth Wind Farm was submitted in 2013 to extend the maximum capacity of the Consented Scheme to up to 61 MW by increasing the capacity of each of the existing turbines to up to 3.04 MW. In addition, consent was sought for the erection of three further turbines to increase the total number of turbines to 23 and the total capacity to 70 MW.

Construction started in 2014 with the enabling works, followed by the main site construction in 2015. Wind turbine erection started in 2015 and was completed in 2016, consisting of 23 wind turbines with a generating capacity of up to 70 MW. The project was developed and built by Invenergy and since August 2017 has been wholly owned by Greencoat Wind.

As part of the consent for the project, the preparation and implementation of a Habitat Management Plan (HMP) and compliance with environmental legislation are required during the operational phase. Nevis Environmental (NE) was commissioned in 2016 to implement the HMP for Years 1-5 of operation at the Operational Corriegarth Wind Farm. The purpose of the ornithological monitoring aspect of the HMP is to provide information in relation to golden eagle flight activity within and around the turbine areas and to compare with the results of baseline collision risk modelling. The results of the surveys are reported to The Highland Council and Scottish Natural Heritage in the year following completion.

1.2 Purpose of Report

The purpose of this report is to present the results of the ornithological surveys undertaken by Nevis between 2015 and 2018 to implement the HMP. The results are taken from the following documents:

- ✔ Corriegarth Wind Farm Operational Monitoring and HMP Implementation Annual Report 2016 (Nevis Environmental 2017) – containing results of Year 1 of Vantage Point surveys of the Operational Corriegarth Wind Farm;
- ✔ Corriegarth Wind Farm Operational Monitoring and HMP Implementation Annual Report 2017 (Nevis Environmental 2018) – containing results of Year 2 of Vantage Point surveys of the Operational Corriegarth Wind Farm; and
- ✔ Corriegarth Wind Farm HMP Implementation Annual Report 2018 (Nevis Environmental 2019) – containing results of Year 3 of Vantage Point surveys of the Operational Corriegarth Wind Farm.

2 Methods

2.1 Vantage Point Surveys

The Vantage Point (VP) surveys are completed from five VP locations which are identical or very close to those used during the baseline surveys completed for the planning application (Figure 8.3). The VP survey effort is to consist of 36 survey hours per VP per season (Breeding season: February to August and non-breeding season: September to January). The main focus of the VP surveys is to record golden eagle, but all other potentially sensitive species such as raptors, waders and wildfowl are recorded. The surveys are conducted following the methodology outlined by SNH (2014, updated 2017) which is similar to the methods used during baseline flight activity surveys for the Operational Corriegarth Wind Farm.

The programme of activities in Section 7 of the HMP listed years 1, 2, 3, 5, 10 and 15. The VPs were started in September 2015 with year 1 of the surveys completed in August 2016. Year 2 was completed in August 2017 and year 3 was completed in August 2018. Year 5 monitoring began in September 2019 and will conclude end of August 2020. Tables 1 – 3 summarise the VP survey effort for years 1 – 3 of monitoring. Full survey visit details are presented in Appendix A and survey weather details are presented in Appendix B.

Table 1 summarises the VP survey effort for the first year covering the period 1 September 2015 to 31 August 2016 which comprises a full breeding and non-breeding season. A total of 138 hours was completed during the non-breeding season (September 2015 – January 2016 inclusive) and 211.5 hours for the breeding season between February and August 2016.

Table 1 VP Survey Effort Sep 2015 - Aug 2016 (Year 1)

Month	VP 1	VP 2	VP 3	VP 4	VP 5	Total
Sep	6	6	6	6	6	30
Oct	6	6	6	6	6	30
Nov	9	9	6	6	6	36
Dec	3	0	3	3	0	9
Jan	6	9	6	6	6	33
Total non-breeding season	30	30	27	27	24	138
Feb	6	6	6	9	3	30
Mar	7.5	6	6	6	6	31.5
Apr	6	6	6	6	6	30
May	6	6	6	6	6	30
Jun	6	6	6	6	3	27
Jul	6	6	6	3	0	21
Aug	6	6	6	9	15	42
Total breeding season	43.5	42	42	45	39	211.5

Total per year	73.5	72	69	72	63	349.5
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Table 2 summarises the VP survey effort for the second year covering the period 1 September 2016 to 31 August 2017 which comprises a full breeding and non-breeding season. A total of 183 hours was completed during the non-breeding season (September 2016 – January 2017 inclusive) and 180 hours for the breeding season between February and August 2017.

Table 2 VP Survey Effort Sep 2016 - Aug 2017 (Year 2)

Month	VP 1	VP 2	VP 3	VP 4	VP 5	Total
Sep	9	9	6	6	6	36
Oct	9	9	9	9	9	45
Nov	3	9	6	9	9	36
Dec	6	0	6	6	6	24
Jan	9	9	12	6	6	42
Total non-breeding season	36	36	39	36	36	183
Feb	6	3	3	6	6	24
Mar	6	9	9	6	6	36
Apr	3	9	3	3	0	18
May	6	0	3	6	9	24
Jun	0	3	6	6	3	18
Jul	6	6	3	0	3	18
Aug	9	6	9	9	9	42
Total breeding season	36	36	36	36	36	180
Total per year	72	72	75	72	72	363

Table 3 summarises the VP survey effort for the third year covering the period 1 September 2017 to 31 August 2018 which comprises a full breeding and non-breeding season. A total of 159 hours was completed during the non-breeding season (September 2017 – January 2018 inclusive) and 180 hours for the breeding season between February 2018 and August 2018.

Table 3 VP Survey Effort Sep 2017 - Aug 2018 (Year 3)

Month	VP 1	VP 2	VP 3	VP 4	VP 5	Total
Sep	9	9	3	6	6	33
Oct	6	6	3	6	9	30
Nov	3	3	12	6	6	30
Dec	6	6	6	9	6	33
Jan	12	0	6	9	6	33

Total non-breeding season	36	24	30	36	33	159
Feb	6	0	0	6	0	12
Mar	15	0	3	15	0	33
Apr	0	3	0	0	3	6
May	3	15	12	6	9	45
Jun	0	6	6	0	12	24
Jul	3	3	6	0	6	18
Aug	9	9	9	9	6	42
Total breeding season	36	36	36	36	36	180
Total per year	72	60	66	72	69	339

2.2 Limitations

2.2.1 2015/16

There was a shortfall of the recommended 36 survey hours per VP per for the five-month non-breeding period which was due to access issues. Due to the significant snow between December and March with the site being partly closed, access was only partly possible and VP 5 in particular could not be reached for extended periods of time. Appendix B1 shows the days where VP surveys were attempted and had to be aborted due the weather conditions, the site being closed or access to VPs not being possible. The site was closed or access restricted for a total of 57 days for the time between 1 December 2015 and 8 March 2016.

The recommended 36 hours for the breeding season between February and September were exceeded for all 5 VP locations and additional hours were accrued to make up for the shortfall during the non-breeding season surveys. The total survey effort for the year should amount to 72 hours per VP which was achieved for VPs 1, 2 and 4. VPs 3 and 5 however fell short by 3 and 9 survey hours respectively.

2.2.2 2016/17

The site was closed for a total of 21 days for between 1 December 2017 and 8 March 2017. However, the recommended 36 hours for the breeding and non-breeding seasons was achieved for all 5 VP locations, totalling a minimum of 72 hours at each VP.

2.2.3 2017/18

Adverse weather during the non-breeding season (September 2017 – Jan 2018) with deep snow on the site meant that access was restricted to the VPs at lower altitudes (namely VPs 1, 4 and 5). Therefore, there are 18 hrs less than the expected survey effort for VPs 2 and 3 which are at high altitudes (600-800m) and only accessible by estate tracks which are not ploughed during winter. This is unfortunate but unavoidable due to the remote nature of the site. VP5 was also short of 3 hrs; this was likewise due to lack of snow ploughing on estate tracks.

3 Results

Table 4 provides a summary of all the flight lines recorded within the survey area between September 2015 and August 2018.

Table 4 Summary of Flight Lines Recorded During VP Surveys 2015 -2018

Species	Designations	2015 /16	2016 /17	2017 /18	Total
Red kite <i>Milvus milvus</i>	Annex I, Sched 1, SBL, LBAP	78	128	108	314
Golden eagle <i>Aquila chrysaetos</i>	Annex I, Schedule 1, SBL, LBAP	15	23	44	82
Buzzard <i>Buteo buteo</i>	-	33	25	24	82
Peregrine <i>Falco peregrinus</i>	Annex I, Sched 1, SBL, LBAP	19	15	9	43
Raven <i>Corvus corax</i>	-	1	-	8	9
White-tailed eagle <i>Haliaeetus albicilla</i>	Annex I, Sched 1, SBL, BoCC Red List	1	10	13	24
Kestrel <i>Falco tinnunculus</i>	BoCC Amber List	3	4	13	20
Golden plover <i>Pluvialis apricaria</i>	Annex I, SBL, LBAP	8	1	3	12
Hen harrier <i>Circus cyaneus</i>	Annex I, Sched 1, SBL, LBAP, BoCC Red List	8	3	1	12
Pink-footed goose <i>Anser brachyrhynchus</i>	LBAP, BoCC Amber List	1	1	2	4
Greylag goose <i>Anser anser</i>	Sched 1 (part 2) , BoCC Amber List	3	2	1	6
Fieldfare <i>Turdus pilaris</i>	Sched 1, BoCC Red List	-	4	-	4
Merlin <i>Falco columbarius</i>	Annex I, Sched 1, SBL, LBAP, BoCC Red List	1	2	1	4
Common gull <i>Larus canus</i>	BoCC Amber List	2	-	-	2
Snow bunting <i>Plectrophenax nivalis</i>	Sched 1, LBAP	1	-	1	2
Dunlin <i>Calidris alpina schinzii</i>	Annex I, SBL	1	-	-	1
Goosander <i>Mergus merganser</i>	-	-	-	1	1
Short-eared owl <i>Asio flammeus</i>	Annex I, SBL, LBAP, BoCC Amber List	-	1	-	1
Snipe <i>Gallinago gallinago</i>	LBAP, BoCC Amber List	1	-	-	1
Whooper swan <i>Cygnus cygnus</i>	Annex I, Sched 1, SBL, LBAP, BoCC Amber List	1	-	-	1

3.1 Year 1 - 2015/16

The most frequently recorded species on site over the 2015/16 survey period was red kite with peregrine the second most common species. In 2006, red kites were completely absent from site and peregrine was only recorded twice. This shift could relate to the expansion of red kites across the Highland region as a result of the reintroduction on the Black Isle and a peregrine having taken up territory in the vicinity of the Operational Corriegarth Wind Farm.

Kestrel flights were recorded very frequently during the 2006 surveys with 31 flights, but during the 2015/16 surveys, this species was noted very infrequently. The reasons for this shift are unclear. The number of golden plover flights was also significantly lower during the 2015/16 surveys with only 9 flights recorded when compared to the 2006 surveys where 28 flights were noted. However, the 2015/16 surveys consisted mainly of diurnal surveys with on average 6 hours or less per month whereas the 2006 surveys are understood to have higher survey efforts and could have included dawn or dusk surveys.

3.2 Year 2 - 2016/17

The most frequently recorded species on site over the 2016/17 survey period was red kite again with 128 flights. The second most commonly recorded species was buzzard (26 flights) followed by golden eagle (23 flights). The increase in the number of golden eagle flights observed from the 16 flights observed in 2015/2016 and can be explained by the fact that a pair of eagles successfully nested and fledged a chick from a territory in the north east of Corriegarth Estate during the 2017 breeding season (several kilometres from the nearest wind turbine). Therefore, there was a noticeable increase in adult golden eagle activity, as well as several sightings of the adults out with the juvenile towards the end of the breeding season.

There were 15 peregrine flights recorded, comprising adult and juvenile/immature birds which suggests they were breeding locally to the Estate. This is slightly fewer than the 19 recorded in 2015/16. In addition, there were 10 white-tailed eagle records including both adults and immature birds from predominantly VP1, VP4 and VP5, a significant increase from the single flight observed during the previous year. There were some records of the birds flying within the main wind farm area, but the majority of these birds were observed away from the wind turbines.

Other raptors recorded on site included hen harrier, kestrel, merlin and a single short-eared owl sighting. The number of hen harrier flights decreased from eight in 2015/16 to just three in 2016/17. Kestrel records remained low, but with an increase of one to four sightings. There was a similar pattern with merlin - with an increase from one to two flight lines observed.

In 2016/17 only one golden plover flight was observed, compared to nine flights recorded in the previous year. There were however several records of birds calling from the ground.

3.3 Year 3 - 2017/18

3.3.1 Golden Eagle

During the 2017/18 golden eagle VP survey there were more golden eagle flight lines recorded than in the last two previous years of operational monitoring, with 45 golden eagle flights recorded in Year 3 (2017/18), 23 in Year 2 (2016/17) and 16 in Year 1 (2015/16). This large increase in observed golden eagle activity can be attributed to the fact that a young individual that fledged from a nearby territory was still using the site in 2017/18. This is known from communication with the estate team, communication with Stuart Benn of the Regional Eagle Conservation Management Plan (RECMMP) and further reinforced by looking at the percentage of different age classes of golden eagles seen during VP surveys in 2017/18. Table 5 shows that 46 % of all golden eagles seen in 2017/18 were non-adults (either juvenile/ immature/ first calendar year or second calendar year).

Table 5 Proportions of Golden Eagle Flight Lines Per Age Class 2017/18

Adult	Juvenile/Immature / Y1 /Y2	Mixed age	Unknown age (distant sighting)
20 %	46 %	29 %	5 %

This increase in the use of the site by younger less experienced golden eagles may also explain why there has been a steep increase in flight lines within the wind turbine array. Whereas, in operational year 2 (2016/17) the vast majority of golden eagle flight lines were to the north of the core wind turbine area and in operational year 1 (2015/16) the majority of the flight lines were to the west of the core wind turbine area.

In the year 2 operational monitoring report (Nevis, 2018) it was reasoned that although golden eagle activity and potentially collision risk had subsequently increased, it was still clear from the recorded flight lines that the eagles were avoiding the core wind turbine area. However, in 2018, there were more flight lines in the core wind turbine area and several were at risk height.

This trend of increased golden eagle activity, increased number of flight lines within the core wind turbine area by young eagles and possible increased collision risk is likely to continue as more local territories become occupied and successfully fledge more young. In recent years this has been the case with a pair of eagles successfully fledging a chick from a territory in the north east of Corriegarth Estate during the 2017 breeding season (several kilometres from the nearest turbine) and again during the 2018 breeding season.

3.3.2 White-tailed Eagle

During the 2017/18 surveys there was more white-tailed eagle activity recorded than in all previous years combined with 13 white-tailed eagle flights recorded in Year 3 (2017/18), 10 in Year 2 (2016/17), 1 in Year 1 (2015/16) and 0 in 2006 during EIA surveys (See Table 4).

At present white-tailed eagle appear to be occasionally using the site and the wider surrounding area for foraging. For example, on the 20th March 2018 a bird was seen carrying carrion away from the Carn a'Chorie Sheilich area and subsequently landing to feed; the majority of the white-tailed eagle activity was concentrated in this area.

3.3.3 Red Kite

Red kite was recorded marginally less frequently than in 2016/17, with 108 flight lines recorded in Year 3 (2017/18) compared to 127 in Year 2 (2016/17). However, this could simply reflect the fact that there was 21 hours less effort conducted in Year 3 (2017/18) due to adverse weather conditions and limited site access. Therefore, it is unlikely that the local red kite population or site usage has changed.

Red Kite was not given consideration in the planning conditions for the Operational Corriegarth Wind Farm as during the EIA surveys they were not found in the area. However, they are now the most frequently observed Schedule 1 species recorded during the golden eagle VP surveys with more than twice as many flights as the next most frequently observed species for the last 3 consecutive years (see Table 4). Their flight line distribution is spread evenly over the whole site.

3.3.4 Peregrine Falcon

Peregrine falcon was recorded less frequently than in 2016/17, with 9 flight lines recorded in Year 3 (2017/18) compared to 14 in Year 2 (2016/17) (see Table 4). However, this again could be due to less survey effort in the non-breeding season due to adverse weather conditions and limited site access. Again, it is unlikely that the local population has changed, and it is thought that they were still breeding locally to the estate during the 2018 breeding season.

3.3.5 Other Raptors

Hen harrier and merlin were seen very infrequently during the Year 3 (2017/18) surveys with just one flight line each during VP surveys (Table 4) and one incidental record of a merlin on route to VP 3 (See Figure 4) and one incidental record of male merlin during a site audit in September 2018. Merlin are very difficult species to detect on VP due to their size and habit of flying close to the ground, however, it is not thought that either merlin or hen harrier breed on the site.

Buzzard and kestrel were frequently as secondary species with 27 and 14 flights respectively. It is thought that these species would have breed further down the hill where there are more suitable nesting trees and used the wind farm site for hunting and foraging.

3.3.6 Waders

In 2017/18 there were four golden plover flight lines recorded. This is comparable to the similarly low numbers recorded in Year 2 (2016/17), just 1 flight and Year 1 (2015/16), nine flights. There were 15 ground registrations of golden plover or incidental records of golden plover flushed on route to VP3. The only other wader species recorded was an incidental record of snipe.

3.3.7 Geese and Wildfowl

Geese and other wildfowl were recorded very infrequently with just two pink-footed geese flocks and one greylag goose flock passing over the site.

4 References

Nevis Environmental (2019). Corriegarth Wind Farm HMP Implementation Annual Report 2018.

Nevis Environmental (2018). Corriegarth Wind Farm Operational Monitoring and HMP Implementation Annual Report 2017.

Nevis Environmental (2017). Corriegarth Wind Farm Operational Monitoring and HMP Implementation Annual Report 2016.

SNH (2017). Recommended bird survey methods to inform impact assessment of onshore wind farms.

SNH (2014). Recommended bird survey methods to inform impact assessment of onshore wind farms

Appendix A Survey Visit Details

Table A1 – Survey Visit Details 2015/16

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
16/09/2015	08:00:00	11:00:00	3	JW	1	Diurnal
16/09/2015	11:30:00	14:30:00	3	JW	2	Diurnal
18/09/2015	07:00:00	10:00:00	3	JW	3	Dawn
18/09/2015	11:00:00	14:00:00	3	JW	4	Diurnal
21/09/2015	09:00:00	12:00:00	3	JW	1	Diurnal
21/09/2015	12:30:00	15:30:00	3	JW	5	Diurnal
22/09/2015	11:45:00	14:45:00	3	JW	2	Diurnal
22/09/2015	15:15:00	18:15:00	3	JW	3	Diurnal
29/09/2015	08:00:00	11:00:00	3	JW	5	Diurnal
29/09/2015	11:30:00	14:30:00	3	JW	4	Diurnal
01/10/2015	11:00:00	14:00:00	3	JW	3	Diurnal
01/10/2015	14:30:00	17:30:00	3	JW	4	Diurnal
08/10/2015	09:00:00	12:00:00	3	JW	1	Diurnal
08/10/2015	12:30:00	15:30:00	3	JW	2	Diurnal
21/10/2015	09:00:00	12:00:00	3	JW	5	Diurnal
21/10/2015	12:30:00	15:30:00	3	JW	4	Diurnal
23/10/2015	09:00:00	12:00:00	3	JW	2	Diurnal
23/10/2015	12:30:00	15:30:00	3	JW	3	Diurnal
26/10/2015	09:00:00	12:00:00	3	JW	1	Diurnal
26/10/2015	12:30:00	15:30:00	3	JW	5	Diurnal
03/11/2015	09:00:00	12:00:00	3	JW	1	Diurnal
03/11/2015	12:30:00	15:30:00	3	JW	2	Diurnal
04/11/2015	09:00:00	12:00:00	3	JW	4	Diurnal
04/11/2015	12:30:00	15:30:00	3	JW	3	Diurnal
11/11/2015	08:45:00	11:45:00	3	JW	1	Diurnal
11/11/2015	12:15:00	15:15:00	3	JW	5	Diurnal
17/11/2015	08:15:00	11:15:00	3	JW	2	Diurnal
17/11/2015	11:45:00	14:45:00	3	JW	3	Diurnal
26/11/2015	08:20:00	11:20:00	3	JW	5	Dawn
26/11/2015	11:50:00	14:50:00	3	JW	4	Diurnal

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
30/11/2015	09:00:00	12:00:00	3	JW	1	Diurnal
30/11/2015	12:30:00	15:30:00	3	JW	2	Diurnal
08/12/2015	09:00:00	12:00:00	3	JW	4	Diurnal
08/12/2015	12:30:00	15:30:00	3	JW	3	Diurnal
14/12/2015	09:00:00	12:00:00	3	JW	1	Diurnal
05/01/2016	08:55:00	11:55:00	3	JW	2	Dawn
05/01/2016	12:30:00	15:30:00	3	JW	3	Diurnal
06/01/2016	08:55:00	11:55:00	3	JW	4	Dawn
06/01/2016	12:30:00	15:30:00	3	JW	5	Diurnal
08/01/2016	08:55:00	11:55:00	3	JW	2	Dawn
08/01/2016	12:55:00	15:55:00	3	JW	1	Dusk
19/01/2016	09:30:00	12:30:00	3	JW	1	Diurnal
19/01/2016	13:00:00	16:00:00	3	JW	2	Diurnal
20/01/2016	09:30:00	12:30:00	3	JW	4	Diurnal
20/01/2016	13:00:00	16:00:00	3	JW	3	Diurnal
21/01/2016	09:30:00	12:30:00	3	JW	5	Diurnal
03/02/2016	09:30:00	12:30:00	3	JW	2	Diurnal
03/02/2016	13:00:00	16:00:00	3	JW	1	Diurnal
04/02/2016	09:30:00	12:30:00	3	JW	1	Diurnal
04/02/2016	13:00:00	16:00:00	3	JW	2	Diurnal
08/02/2016	09:30:00	12:30:00	3	JW	4	Diurnal
08/02/2016	13:00:00	16:00:00	3	JW	3	Diurnal
09/02/2016	09:15:00	12:15:00	3	JW	5	Diurnal
09/02/2016	12:45:00	15:45:00	3	JW	4	Diurnal
18/02/2016	09:00:00	12:00:00	3	JW	3	Diurnal
18/02/2016	12:30:00	15:30:00	3	JW	4	Diurnal
04/03/2016	09:00:00	10:30:00	1.5	JW	1	Diurnal
09/03/2016	09:30:00	12:30:00	3	JW	3	Diurnal
09/03/2016	13:00:00	16:00:00	3	JW	1	Diurnal
10/03/2016	09:30:00	12:30:00	3	JW	5	Diurnal
10/03/2016	13:00:00	16:00:00	3	JW	4	Diurnal
11/03/2016	09:00:00	12:00:00	3	JW	1	Diurnal
14/03/2016	11:50:00	14:50:00	3	JW	5	Diurnal

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
14/03/2016	15:20:00	18:20:00	3	JW	2	Dusk
18/03/2016	06:18:00	09:18:00	3	JW	3	Dawn
18/03/2016	09:48:00	12:48:00	3	JW	4	Diurnal
23/03/2016	06:15:00	09:15:00	3	JW	2	Dawn
06/04/2016	09:00:00	12:00:00	3	JW	3	Diurnal
06/04/2016	12:30:00	15:30:00	3	JW	4	Diurnal
07/04/2016	07:30:00	10:30:00	3	JW	1	Diurnal
07/04/2016	11:00:00	14:00:00	3	JW	2	Diurnal
08/04/2016	09:00:00	12:00:00	3	JW	4	Diurnal
08/04/2016	12:30:00	15:30:00	3	JW	5	Diurnal
21/04/2016	09:00:00	12:00:00	3	JW	2	Diurnal
21/04/2016	12:30:00	15:30:00	3	JW	3	Diurnal
22/04/2016	07:45:00	10:45:00	3	JW	1	Diurnal
22/04/2016	11:15:00	14:15:00	3	JW	5	Diurnal
04/05/2016	13:00:00	16:00:00	3	JW	1	Diurnal
04/05/2016	16:30:00	19:30:00	3	JW	2	Diurnal
05/05/2016	08:45:00	11:45:00	3	JW	3	Diurnal
05/05/2016	12:15:00	15:15:00	3	JW	4	Diurnal
06/05/2016	07:00:00	10:00:00	3	JW	5	Diurnal
06/05/2016	10:30:00	13:30:00	3	JW	1	Diurnal
17/05/2016	10:00:00	13:00:00	3	JW	2	Diurnal
17/05/2016	13:30:00	16:30:00	3	JW	3	Diurnal
18/05/2016	06:00:00	09:00:00	3	JW	4	Diurnal
18/05/2016	09:30:00	12:30:00	3	JW	5	Diurnal
01/06/2016	10:15:00	13:15:00	3	JW	1	Diurnal
01/06/2016	13:45:00	16:45:00	3	JW	2	Diurnal
03/06/2016	04:28:00	07:28:00	3	JW	4	Dawn
03/06/2016	07:58:00	10:58:00	3	JW	3	Diurnal
08/06/2016	15:40:00	18:40:00	3	JW	1	Diurnal
08/06/2016	19:10:00	22:10:00	3	JW	5	Dusk
09/06/2016	10:00:00	13:00:00	3	JW	2	Diurnal
09/06/2016	13:30:00	16:30:00	3	JW	3	Diurnal
10/06/2016	04:20:00	07:20:00	3	JW	4	Dawn

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
07/07/2016	09:30:00	12:30:00	3	JW	1	Diurnal
07/07/2016	13:00:00	16:00:00	3	JW	2	Diurnal
26/07/2016	05:05:00	08:05:00	3	JW	2	Dawn
26/07/2016	08:35:00	11:35:00	3	JW	1	Diurnal
10/08/2016	05:35:00	08:35:00	3	JW	5	Dawn
11/08/2016	16:40:00	19:40:00	3	JW	2	Diurnal
16/08/2016	14:35:00	17:35:00	3	JW	4	Diurnal
18/08/2016	14:20:00	17:20:00	3	JW	5	Diurnal
18/08/2016	17:50:00	20:50:00	3	JW	1	Dusk
23/08/2016	14:10:00	17:10:00	3	JW	5	Diurnal
23/08/2016	17:40:00	20:40:00	3	JW	4	Dusk
24/08/2016	08:45:00	11:45:00	3	JW	3	Diurnal
24/08/2016	12:15:00	15:15:00	3	JW	5	Diurnal
25/08/2016	14:05:00	17:05:00	3	JW	5	Diurnal
25/08/2016	17:35:00	20:35:00	3	JW	4	Dusk
29/08/2016	17:30:00	20:30:00	3	JW	1	Dusk
30/08/2016	13:50:00	16:50:00	3	JW	2	Diurnal
30/08/2016	17:20:00	20:20:00	3	JW	3	Dusk

Table A2 – Survey Visit Details 2016/17

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
12/09/2016	16:43	19:43	3	JW	2	Dusk
15/09/2016	09:30	12:30	3	JW	3	Diurnal
15/09/2016	13:00	16:00	3	JW	3	Diurnal
19/09/2016	12:50	15:50	3	JW	5	Diurnal
19/09/2016	16:20	19:20	3	JW	1	Dusk
20/09/2016	08:45	11:45	3	JW	2	Diurnal
20/09/2016	12:15	15:15	3	JW	3	Diurnal
26/09/2016	10:45	13:45	3	JW	4	Diurnal
26/09/2016	14:15	17:15	3	JW	5	Diurnal
30/09/2016	09:00	12:00	3	JW	1	Diurnal
30/09/2016	12:30	15:30	3	JW	2	Diurnal
03/10/2016	09:30	12:30	3	JW	3	Diurnal

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
03/10/2016	13:00	16:00	3	JW	4	Diurnal
05/10/2016	12:45	15:45	3	JW	1	Diurnal
06/10/2016	09:15	12:15	3	JW	5	Diurnal
11/10/2016	09:00	12:00	3	JW	1	Diurnal
11/10/2016	12:30	15:30	3	JW	3	Diurnal
21/10/2016	09:15	12:15	3	JW	4	Diurnal
21/10/2016	12:45	15:45	3	JW	5	Diurnal
24/10/2016	09:30	12:30	3	JW	1	Diurnal
24/10/2016	13:00	16:00	3	JW	2	Diurnal
25/10/2016	09:45	12:45	3	JW	3	Diurnal
25/10/2016	13:15	16:15	3	JW	4	Diurnal
28/10/2016	08:20	11:20	3	JW	1	Dawn
28/10/2016	11:50	14:50	3	JW	5	Diurnal
28/10/2016	11:50	14:50	3	JW	5	Diurnal
31/10/2016	09:00	12:00	3	JW	2	Diurnal
01/11/2016	10:05	13:05	3	JW	4	Diurnal
01/11/2016	13:35	16:35	3	JW	5	Dusk
02/11/2016	09:54	12:54	3	JW	1	Diurnal
02/11/2016	13:24	16:24	3	JW	2	Dusk
07/11/2016	09:49	12:49	3	JW	3	Diurnal
07/11/2016	13:19	16:19	3	JW	4	Dusk
10/11/2016	07:43	10:43	3	JW	5	Dawn
10/11/2016	11:30	14:30	3	GR	3	Diurnal
29/11/2016	09:05	12:05	3	GR	2	Diurnal
29/11/2016	13:05	16:05	3	GR	2	Diurnal
30/11/2016	08:45	11:45	3	GR	5	Diurnal
30/11/2016	12:45	15:45	3	GR	4	Dusk
01/12/2016	07:50	10:50	3	GR	1	Dawn
01/12/2016	11:50	14:50	3	GR	4	Diurnal
05/12/2016	08:00	11:00	3	GR	1	Dawn
05/12/2016	12:00	15:00	3	GR	5	Diurnal
06/12/2016	08:45	11:45	3	GR	3	Diurnal
06/12/2016	13:05	16:05	3	JW	3	Dusk

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
19/12/2016	08:55	11:55	3	JW	4	Dawn
19/12/2016	12:25	15:25	3	JW	5	Dusk
03/01/2017	09:50	12:50	3	JW	3	Diurnal
10/01/2017	09:00	12:00	3	JW	1	Diurnal
10/01/2017	12:30	15:30	3	JW	2	Diurnal
17/01/2017	08:43	11:43	3	JW	3	Dawn
17/01/2017	12:15	15:15	3	JW	4	Diurnal
19/01/2017	08:40	11:40	3	JW	1	Dawn
19/01/2017	12:10	15:10	3	JW	1	Diurnal
20/01/2017	12:40	15:40	3	JW	2	Diurnal
21/01/2017	07:31	10:31	3	JW	1	Dawn
23/01/2017	09:00	12:00	3	JW	3	Diurnal
23/01/2017	12:30	15:30	3	JW	1	Diurnal
24/01/2017	08:32	11:32	3	JW	5	Dawn
24/01/2017	12:02	15:02	3	JW	3	Diurnal
27/01/2017	08:27	11:27	3	JW	3	Dawn
27/01/2017	11:57	14:57	3	JW	2	Diurnal
30/01/2017	09:00	12:00	3	JW	4	Diurnal
09/02/2017	13:20	16:20	3	JW	4	Diurnal
21/02/2017	11:01	14:01	3	JW	5	Diurnal
22/02/2017	10:25	13:25	3	JW	4	Diurnal
22/02/2017	13:55	16:55	3	JW	5	Diurnal
28/02/2017	09:30	12:30	3	JW	1	Diurnal
28/02/2017	13:00	16:00	3	JW	2	Diurnal
01/03/2017	09:00	12:00	3	JW	2	Diurnal
01/03/2017	12:30	15:30	3	JW	1	Diurnal
03/03/2017	08:15	11:15	3	JW	3	Diurnal
09/03/2017	09:00	12:03	3	JW	2	Diurnal
09/03/2017	12:30	15:30	3	JW	1	Diurnal
23/03/2017	09:15	12:15	3	JW	2	Diurnal
23/03/2017	12:45	15:45	3	JW	3	Diurnal
27/03/2017	13:15	16:15	3	JW	3	Diurnal
27/03/2017	16:47	19:47	3	JW	5	Dusk

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
13/04/2017	06:14	09:14	3	JW	2	Dawn
13/04/2017	09:44	12:44	3	JW	2	Diurnal
26/04/2017	09:10	12:10	3	JW	1	Diurnal
26/04/2017	12:40	15:40	3	JW	2	Diurnal
27/04/2017	08:30	11:30	3	JW	3	Diurnal
27/04/2017	12:00	15:00	3	JW	4	Diurnal
08/05/2017	14:50	17:50	3	JW	5	Diurnal
08/05/2017	18:20	21:20	3	JW	4	Dusk
25/05/2017	12:00	15:00	3	JW	5	Diurnal
25/05/2017	15:30	18:30	3	JW	1	Diurnal
26/05/2017	06:30	09:30	3	JW	4	Diurnal
26/05/2017	10:00	13:00	3	JW	5	Diurnal
30/05/2017	15:30	18:30	3	JW	1	Diurnal
30/05/2017	19:00	22:00	3	JW	3	Dusk
07/06/2017	15:38	18:38	3	JW	3	Diurnal
07/06/2017	19:08	22:08	3	JW	2	Dusk
13/06/2017	04:18	07:18	3	JW	3	Dawn
13/06/2017	07:48	10:48	3	JW	4	Diurnal
15/06/2017	04:18	07:18	3	JW	4	Dawn
15/06/2017	07:48	10:48	3	JW	5	Diurnal
05/07/2017	04:30	07:30	3	JW	5	Dawn
05/07/2017	08:00	11:00	3	JW	1	Diurnal
06/07/2017	12:30	15:30	3	JW	2	Diurnal
12/07/2017	07:50	10:50	3	JW	2	Diurnal
12/07/2017	11:20	14:20	3	JW	3	Diurnal
24/07/2017	10:20	13:20	3	JW	1	Diurnal
24/07/2017	13:50	16:50	3	JW	2	Diurnal
28/07/2017	12:30	15:30	3	JW	5	Diurnal
28/07/2017	12:30	15:30	3	JW	5	Diurnal
07/08/2017	12:50	15:50	3	JW	5	Diurnal
07/08/2017	16:20	19:20	3	JW	1	Diurnal
08/08/2017	09:10	12:10	3	JW	3	Diurnal
08/08/2017	12:40	15:40	3	JW	4	Diurnal

Date	Start Time	End time	Duration	Surveyor	VP Number	VP Type
10/08/2017	05:32	08:32	3	JW	2	Dawn
10/08/2017	09:02	12:02	3	JW	4	Diurnal
23/08/2017	10:30	13:30	3	JW	5	Diurnal
23/08/2017	14:00	17:00	3	JW	1	Diurnal
24/08/2017	05:35	08:35	3	JW	1	Dawn
24/08/2017	09:05	12:05	3	JW	3	Diurnal
25/08/2017	08:45	11:45	3	JW	3	Diurnal
25/08/2017	12:15	15:15	3	JW	2	Diurnal
28/08/2017	09:00	12:00	3	JW	4	Diurnal

Table A3 – Survey Visit Details 2017/18

Date	Start Time	End time	Duration	VP Number	VP Type
06-Sep-17	09:00	12:00	3	1	Diurnal
06-Sep-17	12:30	15:30	3	2	Diurnal
12-Sep-17	09:30	12:30	3	1	Diurnal
12-Sep-17	13:00	16:00	3	5	Diurnal
15-Sep-17	08:50	11:50	3	2	Diurnal
18-Sep-17	09:00	12:00	3	4	Diurnal
18-Sep-17	12:30	15:30	3	5	Diurnal
19-Sep-17	08:50	11:50	3	1	Diurnal
19-Sep-17	12:20	15:20	3	2	Diurnal
20-Sep-17	09:00	12:00	3	3	Diurnal
20-Sep-17	12:30	15:30	3	4	Diurnal
11-Oct-17	09:15	12:15	3	4	Diurnal
11-Oct-17	12:45	15:45	3	5	Diurnal
12-Oct-17	09:00	12:00	3	1	Diurnal
12-Oct-17	12:30	15:30	3	5	Diurnal
24-Oct-17	10:00	13:00	3	1	Diurnal
24-Oct-17	13:30	16:30	3	2	Diurnal
25-Oct-17	08:15	11:15	3	2	Diurnal
25-Oct-17	11:45	14:45	3	4	Diurnal
27-Oct-17	09:45	12:45	3	1	Diurnal
27-Oct-17	13:15	16:15	3	5	Diurnal

Date	Start Time	End time	Duration	VP Number	VP Type
02-Nov-17	07:50	10:50	3	3	Diurnal
02-Nov-17	11:20	14:20	3	4	Diurnal
07-Nov-17	10:00	13:00	3	2	Diurnal
07-Nov-17	13:19	16:19	3	3	Dusk
08-Nov-17	07:45	10:45	3	1	Dawn
08-Nov-17	11:15	14:15	3	5	Diurnal
14-Nov-17	09:35	12:35	3	3	Diurnal
14-Nov-17	13:05	16:05	3	4	Dusk
15-Nov-17	08:00	11:00	3	3	Diurnal
15-Nov-17	11:30	14:30	3	5	Dawn
05-Dec-17	08:55	11:55	3	2	Dusk
05-Dec-17	12:37	15:37	3	4	Diurnal
06-Dec-17	08:40	11:40	3	3	Dusk
06-Dec-17	12:36	15:36	3	5	Dawn
12-Dec-17	09:30	12:30	3	1	Diurnal
12-Dec-17	12:33	15:33	3	4	Dusk
18-Dec-17	08:54	11:54	3	1	Dawn
20-Dec-17	08:55	11:55	3	2	Dawn
20-Dec-17	12:35	15:35	3	3	Dusk
21-Dec-17	08:57	11:57	3	4	Dawn
21-Dec-17	12:35	15:35	3	4	Dusk
09-Jan-18	09:10	12:10	3	1	Diurnal
09-Jan-18	12:40	15:40	3	5	Diurnal
10-Jan-18	09:15	12:15	3	3	Dusk
10-Jan-18	12:45	15:45	3	4	Diurnal
12-Jan-18	09:10	12:10	3	1	Dusk
12-Jan-18	12:50	15:50	3	4	Diurnal
18-Jan-18	10:45	13:45	3	1	Diurnal
21-Jan-18	13:00	16:00	3	4	Diurnal
25-Jan-18	08:50	11:50	3	3	Diurnal
25-Jan-18	12:20	15:20	3	4	Diurnal
26-Jan-18	08:30	11:30	3	1	Diurnal
26-Jan-18	12:00	15:00	3	5	Dawn

Date	Start Time	End time	Duration	VP Number	VP Type
23-Feb-18	09:10	12:10	3	1	Diurnal
23-Feb-18	12:40	15:40	3	4	Diurnal
26-Feb-18	10:15	13:15	3	1	Diurnal
26-Feb-18	13:45	16:45	3	4	Diurnal
09-Mar-18	10:30	13:30	3	1	Diurnal
13-Mar-18	12:30	15:30	3	1	Diurnal
13-Mar-18	16:00	19:00	3	1	Dusk
19-Mar-18	09:30	12:30	3	1	Diurnal
19-Mar-18	09:30	12:30	3	1	Diurnal
19-Mar-18	13:15	16:15	3	4	Diurnal
19-Mar-18	13:15	16:15	3	4	Diurnal
20-Mar-18	06:45	09:45	3	3	Diurnal
20-Mar-18	10:15	13:15	3	4	Diurnal
21-Mar-18	09:30	12:30	3	4	Diurnal
22-Mar-18	13:00	16:00	3	4	Diurnal
09-Apr-18	09:05	12:05	3	2	Diurnal
09-Apr-18	12:35	15:35	3	5	Diurnal
01-May-18	09:45	12:45	3	2	Diurnal
01-May-18	13:15	16:15	3	3	Diurnal
02-May-18	06:50	09:50	3	2	Diurnal
02-May-18	10:20	13:20	3	5	Diurnal
03-May-18	05:15	08:15	3	2	Diurnal
03-May-18	08:45	11:45	3	3	Dawn
10-May-18	09:00	12:00	3	2	Diurnal
10-May-18	12:30	15:30	3	3	Diurnal
11-May-18	09:30	12:30	3	5	Diurnal
11-May-18	13:00	16:00	3	5	Diurnal
15-May-18	07:15	10:15	3	3	Diurnal
15-May-18	10:45	13:45	3	4	Diurnal
16-May-18	07:50	10:50	3	1	Diurnal
16-May-18	11:20	14:20	3	2	Diurnal
31-May-18	11:35	14:35	3	4	Diurnal
08-Jun-18	09:30	12:30	3	2	Diurnal

Date	Start Time	End time	Duration	VP Number	VP Type
08-Jun-18	13:00	16:00	3	5	Diurnal
15-Jun-18	04:25	07:25	3	2	Diurnal
15-Jun-18	08:00	11:00	3	5	Dawn
19-Jun-18	09:15	12:15	3	3	Diurnal
19-Jun-18	12:45	15:45	3	5	Diurnal
25-Jun-18	16:30	19:30	3	3	Diurnal
25-Jun-18	20:00	23:00	3	5	Dusk
16-Jul-18	14:00	17:00	3	1	Diurnal
16-Jul-18	17:30	20:30	3	3	Diurnal
17-Jul-18	07:30	10:30	3	3	Diurnal
17-Jul-18	11:00	14:00	3	5	Diurnal
31-Jul-18	12:00	15:00	3	2	Diurnal
31-Jul-18	15:30	18:30	3	5	Diurnal
02-Aug-18	11:00	14:00	3	3	Diurnal
02-Aug-18	14:30	17:30	3	4	Diurnal
08-Aug-18	15:00	18:00	3	1	Dusk
08-Aug-18	18:30	21:30	3	2	Diurnal
09-Aug-18	12:30	15:30	3	3	Diurnal
09-Aug-18	16:15	19:15	3	4	Diurnal
28-Aug-18	14:30	17:30	3	2	Diurnal
28-Aug-18	18:00	21:00	3	2	Dusk
29-Aug-18	14:45	17:45	3	3	Diurnal
29-Aug-18	18:15	21:15	3	4	Dusk
30-Aug-18	13:00	16:00	3	1	Diurnal
30-Aug-18	16:30	19:30	3	5	Diurnal
31-Aug-18	11:30	14:30	3	1	Diurnal
31-Aug-18	15:00	18:00	3	5	Diurnal

Appendix B – Survey Weather Details

Table B1 – Weather Details 2015/16

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
16/09/2015	1	Diurnal	6	11.4	> 2km	0		None
16/09/2015	2	Diurnal	7	14.4	> 2km	0		None
18/09/2015	3	Dawn	7	6.7	> 2km	2	North west	None
18/09/2015	4	Diurnal	5	12.7	> 2km	0		None
21/09/2015	1	Diurnal	7	12	> 2km	2	North west	None
21/09/2015	5	Diurnal	7	13	> 2km	1	West	None
22/09/2015	2	Diurnal	8	13	> 2km	1	North west	None
22/09/2015	3	Diurnal	8	8.9	> 2km	1	North west	None
29/09/2015	4	Diurnal	2	14.3	> 2km	2	South west	None
29/09/2015	5	Diurnal	4	12.6	> 2km	2	South west	None
01/10/2015	3	Diurnal	0	18	> 2km	2	South	None
01/10/2015	4	Diurnal	0	18.7	> 2km	2	South west	None
08/10/2015	1	Diurnal	5	11.3	> 2km	2	South west	None
08/10/2015	2	Diurnal	5	15	> 2km	2	South west	None
21/10/2015	4	Diurnal	7	11	> 2km	3	South west	None
21/10/2015	5	Diurnal	7	11.9	> 2km	2	South west	None
23/10/2015	2	Diurnal	7	7	> 2km	5	South west south west	None
23/10/2015	3	Diurnal	5	6	> 2km	6	South west south west	None
26/10/2015	1	Diurnal	4	7	> 2km	4	South west south west	None
26/10/2015	5	Diurnal	4	6	> 2km	2	South west south west	None
03/11/2015	1	Diurnal	1	13	> 2km	1	South	None
03/11/2015	2	Diurnal	0	15	1km - 2km	0		None
04/11/2015	3	Diurnal	8	11.4	1km - 2km	0		None
04/11/2015	4	Diurnal	7	13	> 2km	0		None
11/11/2015	1	Diurnal	7	6.1	> 2km	3	South west	None
11/11/2015	5	Diurnal	4	7.3	> 2km	0		None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
17/11/2015	2	Diurnal	7	4	1km - 2km	3	South west	None
17/11/2015	3	Diurnal	8	4	> 2km	2	South west	None
26/11/2015	4	Diurnal	8	8.3	> 2km	3	South west	None
26/11/2015	5	Dawn	8	9	> 2km	2	South west	None
30/11/2015	1	Diurnal	7	0.3	> 2km	2	South west	None
30/11/2015	2	Diurnal	6	0.6	> 2km	2	South west	None
08/12/2015	3	Diurnal	7	7	> 2km	4	South west	None
08/12/2015	4	Diurnal	5	7	> 2km	4	South west	None
14/12/2015	1	Diurnal	5	0	1km - 2km	2	North east	None
05/01/2016	2	Dawn	5	2	> 2km	3	South east	None
05/01/2016	3	Diurnal	8	2	> 2km	5	South east	None
06/01/2016	4	Dawn	6	2	> 2km	6	South east	Light intermittent
06/01/2016	5	Diurnal	7	2	> 2km	6	South east	None
08/01/2016	1	Dusk	2	1.7	> 2km	0		None
08/01/2016	2	Dawn	0	1	> 2km	0		None
19/01/2016	1	Diurnal	8	0	> 2km	0		None
19/01/2016	2	Diurnal	8	0	> 2km	0		None
20/01/2016	3	Diurnal	8	0.1	> 2km	1	South east	None
20/01/2016	4	Diurnal	8	1	> 2km	0		None
21/01/2016	5	Diurnal	8	1	> 2km	4	South east	None
03/02/2016	1	Diurnal	7	0.4	> 2km	2	North west	None
03/02/2016	2	Diurnal	5	0.6	> 2km	1	North west	None
04/02/2016	1	Diurnal	8	1	> 2km	3	South west	None
04/02/2016	2	Diurnal	8	1	> 2km	1	South west	Light intermittent
08/02/2016	3	Diurnal	8	2	> 2km	2	West	Light intermittent
08/02/2016	4	Diurnal	7	1	> 2km	0		None
09/02/2016	4	Diurnal	8	-0.6	> 2km	2	North west	None
09/02/2016	5	Diurnal	7	0	> 2km	0		None
18/02/2016	3	Diurnal	6	0	> 2km	2	West	None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
18/02/2016	4	Diurnal	7	0	> 2km	2	West	None
04/03/2016	1	Diurnal	8	0	> 2km	1	South east	None
09/03/2016	1	Diurnal	5	3.9	> 2km	0		None
09/03/2016	3	Diurnal	6	2	> 2km	0		None
10/03/2016	4	Diurnal	1	0.4	> 2km	2	South west	None
10/03/2016	5	Diurnal	0	0.7	> 2km	2	South south west	None
11/03/2016	1	Diurnal	8	3	> 2km	5	South west	Light intermittent
14/03/2016	2	Dusk	1	6.1	> 2km	2	South west	None
14/03/2016	5	Diurnal	0	8	> 2km	2	South west	None
18/03/2016	3	Dawn	0	1.7	> 2km	0		None
18/03/2016	4	Diurnal	0	6.5	1km - 2km	0		None
23/03/2016	2	Dawn	8	2	> 2km	2	South	None
06/04/2016	3	Diurnal	8	2	> 2km	2	South west	None
06/04/2016	4	Diurnal	7	2	> 2km	3	South west	None
07/04/2016	1	Diurnal	8	2	> 2km	1	West	None
07/04/2016	2	Diurnal	8	2	> 2km	1	West	None
08/04/2016	4	Diurnal	8	4	> 2km	1	South west	None
08/04/2016	5	Diurnal	7	5	> 2km	1	South west	None
21/04/2016	2	Diurnal	5	5	> 2km	0		None
21/04/2016	3	Diurnal	7	5.1	> 2km	1	North west	None
22/04/2016	1	Diurnal	7	4.7	> 2km	1	North east	None
22/04/2016	5	Diurnal	6	5.7	> 2km	1	North east	None
04/05/2016	1	Diurnal	8	5.7	> 2km	6	South west	None
04/05/2016	2	Diurnal	8	5	> 2km	6	South west	Light intermittent
05/05/2016	3	Diurnal	6	9	> 2km	6	South south west	None
05/05/2016	4	Diurnal	6	9	> 2km	6	South south west	None
06/05/2016	1	Diurnal	6	8.4	> 2km	0		None
06/05/2016	5	Diurnal	1	9	> 2km	0		None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
17/05/2016	2	Diurnal	8	9	> 2km	2	West	None
17/05/2016	3	Diurnal	8	8.3	> 2km	2	West	Light intermittent
18/05/2016	4	Diurnal	8	7.7	> 2km	0		Light intermittent
18/05/2016	5	Diurnal	8	8	1km - 2km	1	South west	Light intermittent
01/06/2016	1	Diurnal	6	12	> 2km	1	North east	None
01/06/2016	2	Diurnal	2	13	> 2km	2	North east	None
03/06/2016	3	Diurnal	8	9	1km - 2km	1	North east	None
03/06/2016	4	Dawn	8	9	> 2km	1	North east	None
08/06/2016	1	Diurnal	7	12	> 2km	1	North west	None
08/06/2016	5	Dusk	3	12.4	> 2km	0		None
09/06/2016	2	Diurnal	3	16.7	> 2km	0		None
09/06/2016	3	Diurnal	3	18	> 2km	1	North west	None
10/06/2016	4	Dawn	8	12	1km - 2km	0		None
07/07/2016	1	Diurnal	8	12	> 2km	2	South west	None
07/07/2016	2	Diurnal	8	12	> 2km	3	South west	None
26/07/2016	1	Diurnal	8	9.8	> 2km	2	South west	None
26/07/2016	2	Dawn	8	8.1	> 2km	3	South west	None
10/08/2016	5	Dawn	4	3.6	> 2km	1	South west	None
11/08/2016	2	Diurnal	8	12.9	> 2km	2	South west	None
16/08/2016	4	Diurnal						
18/08/2016	1	Dusk	3	11.9	> 2km	2	South west	None
18/08/2016	5	Diurnal	7	15	> 2km	0		None
23/08/2016	4	Dusk	8	13.4	> 2km	1	South east	None
23/08/2016	5	Diurnal	8	14.6	> 2km	1	South east	None
24/08/2016	3	Diurnal	0	14	> 2km	1	South west	None
24/08/2016	5	Diurnal	0	15	> 2km	1	South west	None
25/08/2016	4	Dusk	1	13.4	> 2km	1	South west	None
25/08/2016	5	Diurnal	2	15	> 2km	2	South west	None
29/08/2016	1	Dusk	8	12.4	> 2km	5	South west	None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
30/08/2016	2	Diurnal	4	16	> 2km	3	South west	None
30/08/2016	3	Dusk	3	14.6	> 2km	3	South west	None

Table B2 – Weather Details 2016/17

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
12/09/2016	2	8	14.6	> 2km	1	South	Light intermittent	12/09/2016
15/09/2016	3	7	15.1	> 2km	1	South west	None	15/09/2016
19/09/2016	1	8	12.4	> 2km	1	South west	None	19/09/2016
19/09/2016	5	8	14	> 2km	1	South west	None	19/09/2016
20/09/2016	2	6	9	> 2km	1	South west	None	20/09/2016
20/09/2016	3	6	9.9	> 2km	2	South west	None	20/09/2016
26/09/2016	4	4	10	> 2km	2	South west	None	26/09/2016
26/09/2016	5	3	9.4	> 2km	2	South west	None	26/09/2016
30/09/2016	1	7	9	> 2km	1	South west	None	30/09/2016
30/09/2016	2	6	9	> 2km	1	South west	None	30/09/2016
03/10/2016	3	7	9	> 2km	5	South west	None	03/10/2016
03/10/2016	4	7	10	> 2km	5	South	None	03/10/2016
05/10/2016	1	5	9	> 2km	6	South east	None	05/10/2016
06/10/2016	5	5	8	> 2km	5	South east	None	06/10/2016
11/10/2016	1	1	7.7	> 2km	1	South east	None	11/10/2016
11/10/2016	3	3	10	> 2km	1	South east	None	11/10/2016
21/10/2016	4	7	10	> 2km	0	-	None	21/10/2016
21/10/2016	5	7	10	> 2km	0	-	None	21/10/2016
24/10/2016	1	2	4.6	> 2km	0	-	None	24/10/2016
24/10/2016	2	8	5	> 2km	0	-	None	24/10/2016
25/10/2016	3	3	4	> 2km	2	South east	None	25/10/2016
25/10/2016	4	8	4	> 2km	2	South east	None	25/10/2016
28/10/2016	1	7	4	> 2km	2	South west	None	28/10/2016

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
28/10/2016	5	8	4	> 2km	2	South west	None	28/10/2016
31/10/2016	2	8	9	> 2km	0	-	None	31/10/2016
01/11/2016	4	8	3	> 2km	1	North west	None	01/11/2016
01/11/2016	5	7	3	> 2km	1	West	None	01/11/2016
02/11/2016	1	8	4	> 2km	1	West	None	02/11/2016
02/11/2016	2	8	2.9	> 2km	1	West	None	02/11/2016
07/11/2016	3	7	2	> 2km	1	North	None	07/11/2016
07/11/2016	4	8	2	> 2km	0	-	None	07/11/2016
10/11/2016	3	8	2	> 2km	1	North west	None	10/11/2016
10/11/2016	5	8	2	> 2km	1	West	None	10/11/2016
29/11/2016	2	8	1.6	> 2km	5	South west	None	29/11/2016
29/11/2016	2	7	1	> 2km	4	West	None	29/11/2016
30/11/2016	4	6	2.3	> 2km	4	West south west	None	30/11/2016
30/11/2016	5	8	2.3	> 2km	4	West south west	None	30/11/2016
01/12/2016	1	8	1.9	> 2km	3	West	Light intermittent	01/12/2016
01/12/2016	4	8	3	> 2km	3	West	None	01/12/2016
05/12/2016	1	1	-4.7	> 2km	0	-	None	05/12/2016
05/12/2016	5	0	-2.7	> 2km	0	-	None	05/12/2016
06/12/2016	3	8	1.9	> 2km	6	South south west	None	06/12/2016
06/12/2016	3	8	3.9	> 2km	6	South	None	06/12/2016
19/12/2016	4	8	5	> 2km	3	South west	None	19/12/2016
19/12/2016	5	5	4.4	> 2km	2	South west	None	19/12/2016
03/01/2017	3	4	0	> 2km	3	South south east	None	03/01/2017
10/01/2017	1	8	6	> 2km	4	South west	None	10/01/2017
10/01/2017	2	8	6	> 2km	4	South west	Light intermittent	10/01/2017
17/01/2017	3	8	6	> 2km	2	South west	None	17/01/2017

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
17/01/2017	4	8	6	1km - 2km	2	South west	None	17/01/2017
19/01/2017	1	7	6	> 2km	4	South south west	None	19/01/2017
19/01/2017	1	7	6	> 2km	2	South west	None	19/01/2017
20/01/2017	2	0	10	> 2km	0	-	None	20/01/2017
21/01/2017	1	7	4	> 2km	5	West south west	None	21/01/2017
23/01/2017	1	4	0	> 2km	3	South	None	23/01/2017
23/01/2017	3	1	0	> 2km	2	South	None	23/01/2017
24/01/2017	3	8	4	> 2km	3	South west	None	24/01/2017
24/01/2017	5	8	6.6	> 2km	3	South	None	24/01/2017
27/01/2017	2	1	1.5	> 2km	3	South south east	None	27/01/2017
27/01/2017	3	1	2	> 2km	2	South	None	27/01/2017
30/01/2017	4	2	3	> 2km	2	South south east	None	30/01/2017
09/02/2017	4	5	0	> 2km	3	South south east	None	09/02/2017
21/02/2017	5	8	4	> 2km	3	South south west	None	21/02/2017
22/02/2017	4	7	4.1	> 2km	2	West	None	22/02/2017
22/02/2017	5	8	3.7	> 2km	2	West	None	22/02/2017
28/02/2017	1	2	-0.4	> 2km	1	North east	None	28/02/2017
28/02/2017	2	5	0	> 2km	1	North east	None	28/02/2017
01/03/2017	1	7	-1	> 2km	2	West	None	01/03/2017
01/03/2017	2	6	0	> 2km	2	West	None	01/03/2017
03/03/2017	3	1	-0.4	> 2km	0	-	None	03/03/2017
09/03/2017	1	5	4	> 2km	3	West	None	09/03/2017
09/03/2017	2	5	2	> 2km	2	West	None	09/03/2017
23/03/2017	2	3	3	> 2km	1	South east	None	23/03/2017
23/03/2017	3	4	3	> 2km	1	South	None	23/03/2017
27/03/2017	3	0	12	> 2km		-	None	27/03/2017

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
27/03/2017	5	1	6.7	> 2km		-	None	27/03/2017
13/04/2017	2	8	5	> 2km	2	West	None	13/04/2017
13/04/2017	2	8	5	> 2km	2	West	None	13/04/2017
26/04/2017	1	8	2	> 2km	1	North west	None	26/04/2017
26/04/2017	2	8	3	> 2km	1	West north west	None	26/04/2017
27/04/2017	3	8	5	1km - 2km	2	West north west	None	27/04/2017
27/04/2017	4	8	6	> 2km	2	North north west	Heavy intermittent	27/04/2017
08/05/2017	4	1	4.3	> 2km	2	North east	None	08/05/2017
08/05/2017	5	0	6	> 2km	2	North east	None	08/05/2017
25/05/2017	1	0	19.6	> 2km	1	South west	None	25/05/2017
25/05/2017	5	1	19.6	> 2km	1	South south west	Light intermittent	25/05/2017
26/05/2017	4	4	12.9	> 2km	2	South west	None	26/05/2017
26/05/2017	5	2	16.6	> 2km	2	South west	None	26/05/2017
30/05/2017	1	8	12.1	> 2km	5	West	None	30/05/2017
30/05/2017	3	6	10.1	> 2km	3	West	None	30/05/2017
07/06/2017	2	5	8.4	> 2km	1	West	None	07/06/2017
07/06/2017	3	6	10	> 2km	2	West	None	07/06/2017
13/06/2017	3	7	5.9	> 2km	2	South west	None	13/06/2017
13/06/2017	4	7	8.6	> 2km	2	South west	None	13/06/2017
15/06/2017	4	7	12	> 2km	3	South south west	None	15/06/2017
15/06/2017	5	8	14.3	> 2km	2	South south west	None	15/06/2017
05/07/2017	1	1	13.1	> 2km	1	South	None	05/07/2017
05/07/2017	5	4	9.9	> 2km	1	South	None	05/07/2017
06/07/2017	2	8	10	> 2km	3	West	None	06/07/2017
12/07/2017	2	6	14	> 2km	0	-	None	12/07/2017
12/07/2017	3	5	15.3	> 2km	1	West north west	None	12/07/2017

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
24/07/2017	1	2	16	> 2km	1	North	None	24/07/2017
24/07/2017	2	3	16.4	> 2km	1	North	None	24/07/2017
28/07/2017	5	8	14	> 2km	3	South west	Light intermittent	28/07/2017
07/08/2017	1	6	13.1	> 2km	2	West	None	07/08/2017
07/08/2017	5	7	14	> 2km	2	West south west	None	07/08/2017
08/08/2017	3	8	15	> 2km	0	-	None	08/08/2017
08/08/2017	4	7	15	> 2km	0	-	Light intermittent	08/08/2017
10/08/2017	2	8	4.4	> 2km	2	South west	None	10/08/2017
10/08/2017	4	8	9.4	> 2km	2	West south west	None	10/08/2017
23/08/2017	1	7	15	> 2km	2	West south west	None	23/08/2017
23/08/2017	5	4	16	> 2km	2	South south east	None	23/08/2017
24/08/2017	1	7	7.1	> 2km	2	South south west	None	24/08/2017
24/08/2017	3	7	13.1	> 2km	2	South south west	None	24/08/2017
25/08/2017	2	5	14.7	> 2km	1	South	None	25/08/2017
25/08/2017	3	5	12.6	> 2km	1	South	None	25/08/2017
28/08/2017	4	7	15	> 2km	4	South west	None	28/08/2017

Table B3 – Weather Details 2017/18

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
06-Sep-17	1	Diurnal	7	10	> 2km	3	West	None
06-Sep-17	2	Diurnal	8	10	> 2km	3	West	None
12-Sep-17	1	Diurnal	8	11	> 2km	3	West	None
12-Sep-17	5	Diurnal	7	10.6	> 2km	3	West	None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
15-Sep-17	2	Diurnal	8	11	> 2km	2	North west	None
18-Sep-17	4	Diurnal	8	10	> 2km	1	North	None
18-Sep-17	5	Diurnal	7	12.7	> 2km	-	-	None
19-Sep-17	1	Diurnal	2	12.7	> 2km	1	West	None
19-Sep-17	2	Diurnal	1	13	> 2km	1	West	None
20-Sep-17	3	Diurnal	8	10	> 2km	2	South west	None
20-Sep-17	4	Diurnal	8	12	> 2km	2	South west	None
11-Oct-17	4	Diurnal	7	9	> 2km	4	West south west	None
11-Oct-17	5	Diurnal	5	9	> 2km	3	West south west	None
12-Oct-17	1	Diurnal	8	7	> 2km	5	South west	None
12-Oct-17	5	Diurnal	8	7	> 2km	3	West south west	None
24-Oct-17	1	Diurnal	8	10	> 2km	4	South west	None
24-Oct-17	2	Diurnal	7	9.7	> 2km	5	South west	None
25-Oct-17	2	Diurnal	8	6.6	> 2km	3	South west	None
25-Oct-17	4	Diurnal	8	9	1km - 2km	3	West	None
27-Oct-17	1	Diurnal	7	7	> 2km	4	West	None
27-Oct-17	5	Diurnal	8	7	> 2km	3	West	None
02-Nov-17	3	Diurnal	8	3.7	> 2km	1	East	None
02-Nov-17	4	Diurnal	2	5	> 2km	1	South west	None
07-Nov-17	2	Diurnal	4	4	> 2km	2	West	None
07-Nov-17	3	Dusk	6	4	> 2km	2	West	None
08-Nov-17	1	Dawn	8	2.3	> 2km	3	South west	None
08-Nov-17	5	Diurnal	8	4	> 2km	3	South south west	None
14-Nov-17	3	Diurnal	8	6	> 2km	1	West	None
14-Nov-17	4	Dusk	8	6	> 2km	2	West	None
15-Nov-17	3	Diurnal	8	3	> 2km	2	South south west	None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
15-Nov-17	5	Dawn	8	3	> 2km	1	South west	None
05-Dec-17	2	Dusk	8	6.7	> 2km	5	West south west	None
05-Dec-17	4	Diurnal	8	7	> 2km	5	West south west	None
06-Dec-17	3	Dusk	8	7	> 2km	4	South	Light intermittent
06-Dec-17	5	Dawn	8	7	> 2km	3	South	Light intermittent
12-Dec-17	1	Diurnal	6	3	> 2km	2	West south west	None
12-Dec-17	4	Dusk	8	0	> 2km	3	South west	None
18-Dec-17	1	Dawn	6	3.7	> 2km	3	West south west	None
20-Dec-17	2	Dawn	4	5	> 2km	2	South west	None
20-Dec-17	3	Dusk	7	5	> 2km	2	South west	None
21-Dec-17	4	Dawn	7	5	> 2km	2	West	None
21-Dec-17	4	Dusk	8	5.9	> 2km	2	South west	None
09-Jan-18	1	Diurnal	2	1.4	> 2km	5	South	None
09-Jan-18	5	Diurnal	3	3	> 2km	5	South south east	None
10-Jan-18	3	Dusk	6	4	> 2km	0	-	None
10-Jan-18	4	Diurnal	8	3	> 2km	1	West	None
12-Jan-18	1	Dusk	8	6	> 2km	5	South south east	None
12-Jan-18	4	Diurnal	8	6	> 2km	6	South south east	None
18-Jan-18	1	Diurnal	6	-1	> 2km	1	South west	None
21-Jan-18	4	Diurnal	8	6	1km - 2km	3	West	Light intermittent
25-Jan-18	3	Diurnal	8	1	> 2km	2	West south west	None
25-Jan-18	4	Diurnal	7	1	> 2km	1	South west	None
26-Jan-18	1	Diurnal	3	0	> 2km	2	South south west	None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
26-Jan-18	5	Dawn	3	-2	> 2km	0	-	None
23-Feb-18	1	Diurnal	2	-1	> 2km	5	South	None
23-Feb-18	4	Diurnal	4	0	> 2km	3	South	None
26-Feb-18	1	Diurnal	7	2	> 2km	2	South east	None
26-Feb-18	4	Diurnal	2	1	> 2km	1	South east	None
09-Mar-18	1	Diurnal	5	3	> 2km	3	West	None
13-Mar-18	1	Diurnal	5	5.6	> 2km	2	South west	None
13-Mar-18	1	Dusk	7	3.3	> 2km	2	South east	None
19-Mar-18	1	Diurnal	1	9.9	> 2km	1	East north east	None
19-Mar-18	1	Diurnal	0	0	> 2km	1	North east	None
19-Mar-18	4	Diurnal	3	-0.4	> 2km	1	East	None
19-Mar-18	4	Diurnal	0	6.4	> 2km	2	North	None
20-Mar-18	3	Diurnal	3	-0.3	> 2km	0	-	None
20-Mar-18	4	Diurnal	2	1	> 2km	2	North west	None
21-Mar-18	4	Diurnal	8	6	> 2km	4	West	None
22-Mar-18	4	Diurnal	8	6	1km - 2km	3	West	Light intermittent
09-Apr-18	2	Diurnal	2	5	> 2km	1	South	None
09-Apr-18	5	Diurnal	5	5	> 2km	1	South west	None
01-May-18	2	Diurnal	8	8	> 2km	4	South west	None
01-May-18	3	Diurnal	8	5	> 2km	5	South	None
02-May-18	2	Diurnal	8	3	> 2km	1	North west	Light persistent
02-May-18	5	Diurnal	8	5	> 2km	1	West	None
03-May-18	2	Diurnal	8	3	> 2km	3	South west	None
03-May-18	3	Dawn	8	0.6	> 2km	2	South west	None
10-May-18	2	Diurnal	6	5	> 2km	5	West	None
10-May-18	3	Diurnal	7	4.1	1km - 2km	4	South west	None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Wind	Modal Precip.
11-May-18	5	Diurnal	6	8	> 2km	5	South east	south east	None
11-May-18	5	Diurnal	8	8	> 2km	4	South east	south east	None
15-May-18	3	Diurnal	3	10	> 2km	2	South west	south west	None
15-May-18	4	Diurnal	6	10	> 2km	2	West west	south west	None
16-May-18	1	Diurnal	3	7.1	> 2km	1	North west	north west	None
16-May-18	2	Diurnal	2	10.7	> 2km	1	North		None
31-May-18	4	Diurnal	5	17	1km - 2km	2	East		None
08-Jun-18	2	Diurnal	5	17	> 2km	1	North west	north west	None
08-Jun-18	5	Diurnal	8	12.9	> 2km	0	-		None
15-Jun-18	2	Diurnal	7	8.9	> 2km	5	West		Light intermittent
15-Jun-18	5	Dawn	8	7	> 2km	5	West		Heavy intermittent
19-Jun-18	3	Diurnal	8	13	> 2km	3	West west	south west	None
19-Jun-18	5	Diurnal	8	11.6	> 2km	4	West west	south west	None
25-Jun-18	3	Diurnal	3	15.4	> 2km	2	West		None
25-Jun-18	5	Dusk	4	11.1	> 2km	1	South west		None
16-Jul-18	1	Diurnal	7	12	Not recorded	2	South west		None
16-Jul-18	3	Diurnal	8	12	> 2km	2	South west		None
17-Jul-18	3	Diurnal	8	14	> 2km	2	West		None
17-Jul-18	5	Diurnal	8	14.7	> 2km	1	West west	south west	None
31-Jul-18	2	Diurnal	6	12.6	> 2km	6	South west	south west	None
31-Jul-18	5	Diurnal	8	8.7	> 2km	3	South		Light intermittent
02-Aug-18	3	Diurnal	5	16.4	> 2km	3	South west		None

Date	VP No.	VP Type	Mean Cloud Cover (Octas)	Mean Temp °C	Modal Visibility	Mean Wind Sp. (Beaufort)	Modal Wind Dir.	Modal Precip.
02-Aug-18	4	Diurnal	8	14.7	> 2km	3	West	None
08-Aug-18	1	Dusk	5	12	> 2km	4	South west	None
08-Aug-18	2	Diurnal	7	13.6	> 2km	3	South west	None
09-Aug-18	3	Diurnal	6	12.7	> 2km	4	South west	None
09-Aug-18	4	Diurnal	7	12.6	> 2km	3	South west	None
28-Aug-18	2	Diurnal	8	13.4	1km - 2km	3	South east	None
28-Aug-18	2	Dusk	8	10.4	> 2km	4	South east	None
29-Aug-18	3	Diurnal	4	12.3	> 2km	4	South west	None
29-Aug-18	4	Dusk	5	7	> 2km	3	West	None
30-Aug-18	1	Diurnal	3	16.4	> 2km	1	West	None
30-Aug-18	5	Diurnal	5	13.3	> 2km	1	West	None
31-Aug-18	1	Diurnal	4	15.1	> 2km	4	South west	None
31-Aug-18	5	Diurnal	2	15.9	> 2km	4	South west	None



Corriegarth 2 Wind Farm Collision Modelling Appendix 8.3

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1 INTRODUCTION

MacArthur Green was commissioned by the Applicant to undertake collision modelling for the proposed Corriegarth 2 Windfarm (hereafter referred to as ‘the Development’). This technical report summarises the flight activity surveys and the collision model outputs (full details of which are contained in **Annex A**).

2 FLIGHT ACTIVITY SURVEY RESULTS

The flight activity surveys recorded all target species’ flight activity within the Site and beyond. These data have been used in the collision risk modelling. The flights used included those within the ‘Collision Risk Analysis Area’ (CRAA) (i.e. the area to be occupied by operational turbines, together with a 500 m buffer).

Flight activity surveys across the 2016, 2017, 2018 and 2019 breeding seasons and 2015/2016, 2016/2017, 2017/2018 and 2019/2020 non-breeding seasons were undertaken across up to eight VPs (**Figure 8.3** and **Figure 8.4**). Valid survey effort¹ is detailed in **Table 8-3-1** and full details of flight activity surveys are contained in **Technical Appendix 8.1** and **Technical Appendix 8.2**.

Table 8-3-1 Summary of total hours of valid survey per VP in each season

Period	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8
2015/2016 non-breeding season	41	37.5	36	38	32.5	-	-	-
2016 breeding season	30	32	29.5	31	29.5	-	-	-
2016/2017 non-breeding season	51	41	48	39	42	-	-	-
2017 breeding season	24	29.5	29	26.5	26.5	-	-	-
2017/2018 non-breeding season	54	22	27	47.5	29.5	-	-	-
2018 breeding season	18	35.5	35.5	29.5	34.5	-	-	-
2019 breeding season	-	-	-	-	-	35.5	35	35.5
2019/2020 non-breeding season	40.5	28.25	30	29	31	-	-	-

A total of 12 target species were recorded during the flight activity surveys. For each species across the whole flight activity survey period, **Table 8-3-2** shows the total number of flights recorded and the total number of birds recorded². The bird seconds are calculated for each observation as the product of flight duration and number of individuals. This is then summed per species to give the total bird seconds recorded across the entire surveyed period.

Table 8-3-2 Target species recorded and total number of flights recorded during flight activity surveys, 2015-2020

Species	Total number of flightlines recorded	Total number of birds recorded	Total bird seconds recorded
Dunlin	3	3	110
Golden eagle	106	117	23197
Golden plover	18	29	1172
Greylag goose	6	72	10838
Hen harrier	13	13	1010
Merlin	5	5	435

¹ Hours where visibility was >1 km are not considered valid for use in collision risk modelling as less than half the 2 km viewshed can be seen.

² This includes flights that would not technically be ‘at-risk’ of collision (e.g. recorded outwith the CRAA and/or not at rotor height).

Species	Total number of flightlines recorded	Total number of birds recorded	Total bird seconds recorded
Peregrine falcon	52	56	4209
Pink-footed goose	12	1145	85290
Red kite	373	413	60014
Short-eared owl	1	1	35
White-tailed eagle	33	35	8129
Whooper swan	1	22	6930

2.1 Flightlines Used in Collision Risk Modelling

Only flightlines identified to be within the CRAA and recorded within the 2 km viewshed of the associated VP were considered in the collision risk modelling and **Annex A** provides details of the bird seconds from flights identified to be ‘at-risk’.

- ‘At-risk’ is defined as – a flight having at least part of its duration (i) at Potential Collision Height (PCH)³; (ii) within the CRAA; and (iii) recorded within the 2 km viewshed of the associated VP.
- PCH is defined as – the altitude between the minimum and maximum blade height⁴ (taken to be from 16.9 m to 149.9 m for the Development).

Dunlin and short-eared owl were recorded during flight activity surveys but no flights were considered to be ‘at-risk’⁵. Full survey results detailing the findings from each survey visit (including target species’ flightlines considered not ‘at-risk’ and secondary species information) can be found within **Technical Appendix 8.1** and **Technical Appendix 8.2**. Only bird seconds for observations identified as within the CRAA and associated viewshed are considered in the following discussions.

³ In some cases, only part of a total flight duration was recorded at PCH, and it is assumed that this proportion is applicable for that part of the flight within the CRAA and 2 km viewshed area.

⁴ Where the actual rotor blade altitude differs from the prA-defined survey height bands, the collision risk model accounts for this difference on the assumption of an even flight distribution within each particular survey height band, and an adjustment can be made to estimate total flight duration at actual rotor blade altitude.

⁵ i.e. the flights were either not within the CRAA and associated viewshed or were only recorded flying above 150m.

2.2 Collision Risk Model Outputs

The bird seconds for target species flights within the CRAA at PCH were then input into a Collision Risk Model (CRM) to calculate the predicted collision rates per season. The CRM calculations for each species can be found in **Annex A. Table 8-3-3** and **Table 8-3-4** provide the estimated collision rates and number of seasons per collision for each species.

Table 8-3-3 Estimated collision rates

Species	2015/2016 non-breeding season	2016 breeding season	2016/2017 non-breeding season	2017 breeding season	2017/2018 non-breeding season	2018 breeding season	2019 breeding season	2019/2020 non-breeding season
Golden eagle	0.0056	0.0124	0.0653	0.0107	0.0012	0.2558	0.0192	-
Golden plover	-	0.0158	-	-	-	0.0080	0.0336	-
Greylag goose	-	-	0.0011	-	0.1144	-	-	-
Hen harrier	0.0015	0.0026	0.0023	-	-	-	-	-
Merlin	-	0.0183	-	-	-	-	-	-
Peregrine falcon	0.0023	0.0085	0.0052	0.0469	0.0101	0.0041	-	0.0021
Pink-footed goose	0.0102	-	-	-	-	-	-	-
Red kite	0.0594	0.1108	0.1122	0.1086	0.0594	0.3053	0.0970	0.0368
White-tailed eagle	0.0047	-	-	0.0935	-	1.1454	-	-
Whooper swan	0.1344	-	-	-	-	-	-	-

Table 8-3-4 Estimated number of seasons per collision

Species	2015/2016 non-breeding season	2016 breeding season	2016/2017 non-breeding season	2017 breeding season	2017/2018 non-breeding season	2018 breeding season	2019 breeding season	2019/2020 non-breeding season
Golden eagle	178	81	15.3	93	865	3.9	52	-
Golden plover	-	63	-	-	-	125	30	-
Greylag goose	-	-	886	-	8.7	-	-	-
Hen harrier	657	387	437	-	-	-	-	-
Merlin	-	55	-	-	-	-	-	-
Peregrine falcon	440	117	192	21.3	99	241	-	478
Pink-footed goose	98	-	-	-	-	-	-	-
Red kite	16.8	9.03	8.9	9.2	16.8	3.3	10.3	27
White-tailed eagle	212	-	-	10.7	-	0.9	-	-
Whooper swan	7.4	-	-	-	-	-	-	-

ANNEX A. COLLISION MODEL OUTPUTS

Delaunay Triangulation⁶ from the proposed turbine locations was used to create a wind farm area⁷ and from this the Collision Risk Analysis Area (CRAA) was created using a 500 metre (m) buffer (**Figure 8.3** and **Figure 8.4**). Using the larger 500 m area around the turbines accounts for possible inaccuracies in the recording of flightlines and ensures the assessment is precautionary.

The ultimate aim is to have 100 % coverage of the turbines and associated CRAA by the viewsheds, however in practice this is often unachievable as a result of the topography of the Site, presence of mature forestry and limited to no access outwith the Site Boundary. For the Development, although two small areas of the CRAA remain ‘invisible’ at 20 m above ground level (**Figure 8.3** and **Figure 8.4**), the habitat within these areas is of sufficient similarity such that the survey data collected and subsequently assessed are considered to be representative of the whole CRAA. In addition, there were no records made during any of the surveys which would suggest that this area was of any particular importance to target species. Furthermore, the flight time at risk height (secsHahr⁻¹) for each species is calculated as a single mean activity rate within the entirety of the CRAA.

Table A-5, **Table A-6** and **Table A-7** present the parameters which apply to each Collision Risk Model (CRM).

Table A-5 Wind farm parameters

Size of wind farm envelope	587.16	hectares (ha)
Number of turbines	16	turbines
Rotor diameter	133	metres (m)
Hub height	83.4	m
Max. rotor depth	1.16	m (at 15° pitch angle)
Max. chord	4	m
Pitch	15	degrees (°)
Rotation period	4.8	seconds (secs)
Turbine operation time	85	percent (%)
Risk height: highest	149.9	m
Risk height: lowest	16.9	m
Flight risk volume	780,921,740	m ³

Table A-6 CRM parameters per species

Species	Length (m)	Wingspan (m)	Assumed flight speed, v (ms ⁻¹)	Avoidance rate	Probability of collision	Bird transit time (secs)
Golden eagle	0.815	2.12	15	0.99	0.0812	0.132
Golden plover	0.28	0.72	17.9	0.98	0.0524	0.0807
Greylag goose	0.825	1.635	17.1	0.998	0.0743	0.1164
Hen harrier	0.48	1.1	12	0.99	0.0723	0.1371

⁶ Delaunay triangulation is a form of mathematical/computational geometry where a given set of points (in this case the turbine locations) are all joined to create discrete triangles. Further information is available here:

<https://uk.mathworks.com/help/matlab/math/delaunay-triangulation.html>

⁷ This was adjusted where appropriate depending on the spatial location of the turbines in relation to other turbines.

Species	Length (m)	Wingspan (m)	Assumed flight speed, v (ms ⁻¹)	Avoidance rate	Probability of collision	Bird transit time (secs)
Merlin	0.28	0.56	13	0.98	0.0583	0.1111
Peregrine falcon	0.48	1.1	12.1	0.98	0.0719	0.1359
Pink-footed goose	0.675	1.525	17.3	0.998	0.0689	0.1063
Red kite	0.66	1.95	12	0.99	0.0842	0.1521
WhitA-tailed eagle	0.9	2.4	13.6	0.95	0.0901	0.1518
Whooper swan	1.525	2.305	17.3	0.995	0.0991	0.1555

Table A-7 Visible area within the CRAA per vantage point

VP	Area (ha)	VP	Area (ha)
1	68.91	5	141.38
2	91.30	6	172.63
3	169.24	7	134.29
4	104.65	8	196.24

Birds are assumed to be active during all the daylight hours and this is estimated by calculating the number of hours per day between sunrise and sunset (adjusting for correct latitude) for the survey seasons as defined in **Table A-8** below.

Table A-8 Season definitions per species/species group

Species	Breeding season			Non-breeding season		
	Start date	End date	Hours presumed present	Start date	End date	Hours presumed present
Golden eagle	1 st February	31 st August	2,814	1 st September	31 st January	1,689
WhitA-tailed eagle	1 st February	31 st August	2,814	1 st September	31 st January	1,689
Geese and swans	15 th May	31 st August	1,830	1 st September	14 th May	2,674
Raptors	15 th March	31 st August	2691	1 st September	14 th March	1813
Waders	1 st April	31 st July	2,008	1 st August	31 st March	2,496

Outputs for the CRM for the following species are presented in the following order below:

- Golden eagle;
- Golden plover;
- Greylag goose;
- Hen harrier;
- Merlin;
- Peregrine falcon;
- Pink-footed goose;
- Red kite;

- White-tailed eagle; and
- Whooper swan.

A.1 Golden eagle

Non-Breeding Season 2015/2016

Table A-9 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
3	29.50	4,569.3556	0.00000053

Table A-10 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.00031	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	0.5295	hrs/season
Bird occupancy of rotor swept volume	1.0741	bird-sec
No. of transits through rotors	8.1385	per season
Estimated collisions	0.6612	per season
Estimated collisions after correction for operation	0.5621	per season
Estimated collisions after avoidance factor	0.0056	per season
Equivalent to 1 bird every	177.92	seasons

Breeding Season 2016

Table A-11 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
2	18.48	3,767.8939	0.00000022
4	13.39	4,447.6606	0.00000016
5	26.74	5,372.4984	0.00000032

Table A-12 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.00042	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	1.1698	hrs/season
Bird occupancy of rotor swept volume	2.3732	bird-sec
No. of transits through rotors	17.9816	per season
Estimated collisions	1.4610	per season
Estimated collisions after correction for operation	1.2418	per season
Estimated collisions after avoidance factor	0.0124	per season
Equivalent to 1 bird every	80.53	seasons

Non-Breeding Season 2016/2017

Table A-13 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	13.11	2,894.2430	0.00000017
3	474.42	7,615.5927	0.0000060
4	3.66	3,453.4776	0.000000046

Table A-14 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.00364	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	6.1541	hrs/season
Bird occupancy of rotor swept volume	12.4844	bird-sec
No. of transits through rotors	94.5936	per season
Estimated collisions	7.6856	per season
Estimated collisions after correction for operation	6.5327	per season
Estimated collisions after avoidance factor	0.0653	per season
Equivalent to 1 bird every	15.31	seasons

Breeding Season 2017

Table A-15 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	0.62	2,274.0481	0.0000000090
2	41.63	3,538.1443	0.00000060

Table A-16 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.00036	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	1.0088	hrs/season
Bird occupancy of rotor swept volume	2.0464	bird-sec
No. of transits through rotors	15.5058	per season
Estimated collisions	1.2598	per season
Estimated collisions after correction for operation	1.0708	per season
Estimated collisions after avoidance factor	0.0107	per season
Equivalent to 1 bird every	93.38	seasons

Non-Breeding Season 2017/2018

Table A-17 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
3	7.03	4,569.3556	0.00000011

Table A-18 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.00006	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	0.1089	hrs/season
Bird occupancy of rotor swept volume	0.2210	bird-sec
No. of transits through rotors	1.6741	per season
Estimated collisions	0.1360	per season
Estimated collisions after correction for operation	0.1156	per season
Estimated collisions after avoidance factor	0.0012	per season
Equivalent to 1 bird every	864.92	seasons

Breeding Season 2018

Table A-19 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	85.58	2,274.0481	0.0000012
3	606.53	6,007.8565	0.0000084
4	343.52	3,715.1047	0.0000047
5	21.73	4,877.6631	0.00000030

Table A-20 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.0086	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	24.1011	hrs/season
Bird occupancy of rotor swept volume	48.8924	bird-sec
No. of transits through rotors	370.4560	per season
Estimated collisions	30.0989	per season
Estimated collisions after correction for operation	25.5840	per season
Estimated collisions after avoidance factor	0.2558	per season
Equivalent to 1 bird every	3.91	seasons

Breeding Season 2019

Table A-21 Golden eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
6	37.06	6,128.2973	0.00000058
7	32.91	4,700.2036	0.00000051

Table A-22 Golden eagle mortality estimates

Mean activity in wind farm at rotor height	0.00064	hr ¹
Total Combined rotor swept volume	440,057	m ³
Bird occupancy	1.8048	hrs/season
Bird occupancy of rotor swept volume	3.6613	bird-sec
No. of transits through rotors	27.7417	per season
Estimated collisions	2.2540	per season
Estimated collisions after correction for operation	1.9159	per season
Estimated collisions after avoidance factor	0.0192	per season
Equivalent to 1 bird every	52.20	seasons

A.2 Golden plover

Breeding Season 2016

Table A-23 Golden plover flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
5	33.44	2,050.0323	0.00000082

Table A-24 Golden plover mortality estimates

Mean activity in wind farm at rotor height	0.00048	hr ¹
Total Combined rotor swept volume	321,134	m ³
Bird occupancy	0.9669	hrs/season
Bird occupancy of rotor swept volume	1.4314	bird-sec
No. of transits through rotors	17.7358	per season
Estimated collisions	0.9296	per season
Estimated collisions after correction for operation	0.7902	per season
Estimated collisions after avoidance factor	0.0158	per season
Equivalent to 1 bird every	63.28	seasons

Breeding Season 2018

Table A-25 Golden plover flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr-1)
3	16.92	3,977.0318	0.00000042

Table A-26 Golden plover mortality estimates

Mean activity in wind farm at rotor height	0.00024	hr ⁻¹
Total Combined rotor swept volume	321,134	m ³
Bird occupancy	0.4914	hrs/season
Bird occupancy of rotor swept volume	0.7275	bird-sec
No. of transits through rotors	9.0137	per season
Estimated collisions	0.4725	per season
Estimated collisions after correction for operation	0.4016	per season
Estimated collisions after avoidance factor	0.0080	per season
Equivalent to 1 bird every	124.50	seasons

Breeding Season 2019

Table A-27 Golden plover flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr-1)
6	28.97	5,178.8428	0.00000054
7	64.18	3,894.4545	0.0000012

Table A-28 Golden plover mortality estimates

Mean activity in wind farm at rotor height	0.00102	hr ⁻¹
Total Combined rotor swept volume	321,134	m ³
Bird occupancy	2.0527	hrs/season
Bird occupancy of rotor swept volume	3.0389	bird-sec
No. of transits through rotors	37.6521	per season
Estimated collisions	1.9736	per season
Estimated collisions after correction for operation	1.6775	per season
Estimated collisions after avoidance factor	0.0336	per season
Equivalent to 1 bird every	29.81	Seasons

A.3 Greylag goose

Non-Breeding Season 2016/2017

Table A-29 Greylag goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
3	34.52	9,477.1821	0.00000032

Table A-30 Greylag goose mortality estimates

Mean activity in wind farm at rotor height	0.00019	hr ⁻¹
Total Combined rotor swept volume	442,280	m ³
Bird occupancy	0.5100	hrs/season
Bird occupancy of rotor swept volume	1.0399	bird-sec
No. of transits through rotors	8.9369	per season
Estimated collisions	0.6638	per season
Estimated collisions after correction for operation	0.5643	per season
Estimated collisions after avoidance factor	0.0011	per season
Equivalent to 1 bird every	886.11	seasons

Breeding Season 2017/2018

Table A-31 Greylag goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
5	3,126.279627	5,867.3338	0.00003

Table A-32 Greylag goose mortality estimates

Mean activity in wind farm at rotor height	0.01934	hr ¹
Total Combined rotor swept volume	442,280	m ³
Bird occupancy	51.7153	hrs/season
Bird occupancy of rotor swept volume	105.4415	bird-sec
No. of transits through rotors	906.1985	per season
Estimated collisions	67.3133	per season
Estimated collisions after correction for operation	57.2163	per season
Estimated collisions after avoidance factor	0.1144	per season
Equivalent to 1 bird every	8.74	seasons

A.4 Hen harrier

Non-Breeding Season 2015/2016

Table A-33 Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
3	14.26	6,092.4742	0.00000019

Table A-34 Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.00011	hr ¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.2014	hrs/season
Bird occupancy of rotor swept volume	0.3394	bird-sec
No. of transits through rotors	2.4766	per season
Estimated collisions	0.1790	per season
Estimated collisions after correction for operation	0.1521	per season
Estimated collisions after avoidance factor	0.0015	per season
Equivalent to 1 bird every	657.38	seasons

Breeding Season 2016

Table A-35 Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
5	13.58	4,170.7554	0.00000022

Table A-36 Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.00013	hr ¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.3423	hrs/season
Bird occupancy of rotor swept volume	0.5768	bird-sec
No. of transits through rotors	4.2087	per season
Estimated collisions	0.3041	per season
Estimated collisions after correction for operation	0.2585	per season
Estimated collisions after avoidance factor	0.0026	per season
Equivalent to 1 bird every	386.83	seasons

Non-Breeding Season 2016/2017

Table A-37 Hen harrier flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	26.06	3,514.4379	0.00000028

Table A-38 Hen harrier mortality estimates

Mean activity in wind farm at rotor height	0.00017	hr ¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.3030	hrs/season
Bird occupancy of rotor swept volume	0.5107	bird-sec
No. of transits through rotors	3.7260	per season
Estimated collisions	0.2692	per season
Estimated collisions after correction for operation	0.2289	per season
Estimated collisions after avoidance factor	0.0023	per season
Equivalent to 1 bird every	436.95	seasons

A.5 Merlin

Breeding Season 2016

Table A-39 Merlin flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
5	54.90	4,170.7554	0.00000088

Table A-40 Merlin mortality estimates

Mean activity in wind farm at rotor height	0.00051	hr ¹
Total Combined rotor swept volume	321,134	m ³
Bird occupancy	1.3835	hrs/season
Bird occupancy of rotor swept volume	2.0481	bird-sec
No. of transits through rotors	18.4300	per season
Estimated collisions	1.0748	per season
Estimated collisions after correction for operation	0.9136	per season
Estimated collisions after avoidance factor	0.0183	per season
Equivalent to 1 bird every	54.73	seasons

A.6 Peregrine falcon

Non-Breeding Season 2015/2016

Table A-41 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHaHr ⁻¹)
1	1.01	2,825.3324	0.000000013
2	2.37	3,446.2445	0.000000031
5	7.24	4,594.9000	0.000000096

Table A-42 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00008	hr ⁻¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.1500	hrs/season
Bird occupancy of rotor swept volume	0.2528	bird-sec
No. of transits through rotors	1.8599	per season
Estimated collisions	0.1337	per season
Estimated collisions after correction for operation	0.1137	per season
Estimated collisions after avoidance factor	0.0023	per season
Equivalent to 1 bird every	439.88	seasons

Breeding Season 2016

Table A-43 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHaHr ⁻¹)
1	1.23	2,067.3164	0.000000020
2	19.50	2,940.7953	0.000000031
5	1.63	4,170.7554	0.000000026

Table A-44 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00021	hr ⁻¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.5636	hrs/season
Bird occupancy of rotor swept volume	0.9498	bird-sec
No. of transits through rotors	6.9879	per season
Estimated collisions	0.5024	per season
Estimated collisions after correction for operation	0.4271	per season
Estimated collisions after avoidance factor	0.0085	per season
Equivalent to 1 bird every	117.08	seasons

Non-Breeding Season 2016/2017

Table A-45 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
3	27.27	8,123.2989	0.00000030
5	2.25	5,938.0246	0.000000025

Table A-46 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00019	hr ¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.3433	hrs/season
Bird occupancy of rotor swept volume	0.5786	bird-sec
No. of transits through rotors	4.2568	per season
Estimated collisions	0.3061	per season
Estimated collisions after correction for operation	0.2601	per season
Estimated collisions after avoidance factor	0.0052	per season
Equivalent to 1 bird every	192.20	seasons

Breeding Season 2017

Table A-47 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	62.95	1,653.8531	0.0000011
3	48.49	4,907.8264	0.00000085

Table A-48 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00115	hr ¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	3.0969	hrs/season
Bird occupancy of rotor swept volume	5.2193	bird-sec
No. of transits through rotors	38.3985	per season
Estimated collisions	2.7608	per season
Estimated collisions after correction for operation	2.3467	per season
Estimated collisions after avoidance factor	0.0469	per season
Equivalent to 1 bird every	21.31	seasons

Non-Breeding Season 2017/2018

Table A-49 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	29.09	3,721.1696	0.00000042
5	14.69	4,170.7554	0.00000021

Table A-50 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00037	hr ⁻¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.6654	hrs/season
Bird occupancy of rotor swept volume	1.1214	bird-sec
No. of transits through rotors	8.2502	per season
Estimated collisions	0.5932	per season
Estimated collisions after correction for operation	0.5042	per season
Estimated collisions after avoidance factor	0.0101	per season
Equivalent to 1 bird every	99.17	seasons

Breeding Season 2018

Table A-51 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
5	11.52	4,877.6631	0.00000017

Table A-52 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.00010	hr ⁻¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.2738	hrs/season
Bird occupancy of rotor swept volume	0.4614	bird-sec
No. of transits through rotors	3.3945	per season
Estimated collisions	0.2441	per season
Estimated collisions after correction for operation	0.2075	per season
Estimated collisions after avoidance factor	0.0041	per season
Equivalent to 1 bird every	241.02	seasons

Non-Breeding Season 2019/2020

Table A-53 Peregrine falcon flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ⁻¹)
1	0.46	2,790.8772	0.0000000072
5	7.89	4,382.8277	0.00000012

Table A-54 Peregrine falcon mortality estimates

Mean activity in wind farm at rotor height	0.0001	hr ⁻¹
Total Combined rotor swept volume	365,591	m ³
Bird occupancy	0.1381	hrs/season
Bird occupancy of rotor swept volume	0.2328	bird-sec
No. of transits through rotors	1.7129	per season
Estimated collisions	0.1232	per season
Estimated collisions after correction for operation	0.1047	per season
Estimated collisions after avoidance factor	0.0021	per season
Equivalent to 1 bird every	477.65	seasons

A.7 Pink-footed goose

Non-Breeding Season 2015/2016

Table A-55 Pink-footed goose flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHaHr ⁻¹)
3	307.34	8,123.2989	0.0000031

Table A-56 Pink-footed goose mortality estimates

Mean activity in wind farm at rotor height	0.00184	hr ⁻¹
Total Combined rotor swept volume	408,937	m ³
Bird occupancy	4.9127	hrs/season
Bird occupancy of rotor swept volume	9.2613	bird-sec
No. of transits through rotors	87.0908	per season
Estimated collisions	5.9973	per season
Estimated collisions after correction for operation	5.0977	per season
Estimated collisions after avoidance factor	0.0102	per season
Equivalent to 1 bird every	98.08	seasons

A.8 Red kite

Non-Breeding Season 2015/2016

Table A-57 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHaHr ⁻¹)
1	48.40	2,825.3324	0.00000064
2	145.06	3,446.2445	0.0000019
3	127.79	6,092.4742	0.0000017
5	156.62	4,594.9000	0.0000021

Table A-58 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00372	hr ⁻¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	6.7488	hrs/season
Bird occupancy of rotor swept volume	12.6189	bird-sec
No. of transits through rotors	82.9882	per season
Estimated collisions	6.9908	per season
Estimated collisions after correction for operation	5.9422	per season
Estimated collisions after avoidance factor	0.0594	per season
Equivalent to 1 bird every	16.83	seasons

Breeding Season 2016

Table A-59 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	100.12	2,067.3164	0.0000016
2	178.21	2,940.7953	0.0000028
3	136.20	4,992.4441	0.0000022
5	84.75	4,170.7554	0.0000014

Table A-60 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00468	hr ¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	12.5825	hrs/season
Bird occupancy of rotor swept volume	23.5267	bird-sec
No. of transits through rotors	154.7231	per season
Estimated collisions	13.0337	per season
Estimated collisions after correction for operation	11.0786	per season
Estimated collisions after avoidance factor	0.1108	per season
Equivalent to 1 bird every	9.03	seasons

Non-Breeding Season 2016/2017

Table A-61 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	218.01	3,514.4379	0.0000024
2	246.16	3,767.8939	0.0000027
3	170.47	8,123.2989	0.0000019
4	29.15	4,081.3826	0.00000032
5	431.73	5,938.0246	0.0000047

Table A-62 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00703	hr ¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	12.7397	hrs/season
Bird occupancy of rotor swept volume	23.8207	bird-sec
No. of transits through rotors	156.6565	per season
Estimated collisions	13.1965	per season
Estimated collisions after correction for operation	11.2170	per season
Estimated collisions after avoidance factor	0.1122	per season
Equivalent to 1 bird every	8.92	seasons

Breeding Season 2017

Table A-63 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	19.0623	1,653.8531	0.00000034
2	12.6130	2,711.0456	0.00000022
3	171.3960	4,907.8264	0.0000030
5	240.8672	3,746.6108	0.0000042

Table A-64 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00458	hr ¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	12.3376	hrs/season
Bird occupancy of rotor swept volume	23.0689	bird-sec
No. of transits through rotors	151.7118	per season
Estimated collisions	12.7800	per season
Estimated collisions after correction for operation	10.8630	per season
Estimated collisions after avoidance factor	0.1086	per season
Equivalent to 1 bird every	9.21	seasons

Non-Breeding Season 2017/2018

Table A-65 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	194.71	3,721.1696	0.0000028
2	34.38	2,021.7967	0.00000049
3	52.78	4,569.3556	0.00000075
4	30.28	4,970.9147	0.00000043
5	132.02	4,170.7554	0.0000019

Table A-66 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00372	hr ¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	6.7503	hrs/season
Bird occupancy of rotor swept volume	12.6218	bird-sec
No. of transits through rotors	83.0069	per season
Estimated collisions	6.9924	per season
Estimated collisions after correction for operation	5.9435	per season
Estimated collisions after avoidance factor	0.0594	per season
Equivalent to 1 bird every	16.83	seasons

Breeding Season 2018

Table A-67 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	130.00	1,240.3899	0.0000020
2	83.66	3,262.4448	0.0000013
3	353.42	6,007.8565	0.0000053
4	284.56	3,087.1997	0.0000043
5	608.23	4,877.6631	0.0000091

Table A-68 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.01289	hr ⁻¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	34.6799	hrs/season
Bird occupancy of rotor swept volume	64.8447	bird-sec
No. of transits through rotors	426.4494	per season
Estimated collisions	35.9235	per season
Estimated collisions after correction for operation	30.5350	per season
Estimated collisions after avoidance factor	0.3053	per season
Equivalent to 1 bird every	3.27	seasons

Breeding Season 2019

Table A-69 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
6	223.32	6,128.2973	0.0000035
7	37.70	4,700.2036	0.00000059
8	185.65	6,966.4368	0.0000029

Table A-70 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00409	hr ⁻¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	11.0168	hrs/season
Bird occupancy of rotor swept volume	20.5992	bird-sec
No. of transits through rotors	135.4701	per season
Estimated collisions	11.4118	per season
Estimated collisions after correction for operation	9.7000	per season
Estimated collisions after avoidance factor	0.0970	per season
Equivalent to 1 bird every	10.31	seasons

Non-Breeding Season 2019/2020

Table A-71 Red kite flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	144.33	2,790.8772	0.0000022
2	75.95	2,596.1708	0.0000012
3	6.46	5,077.0618	0.00000010
4	9.65	3,034.8743	0.00000015
5	16.56	4,382.8277	0.00000026

Table A-72 Red kite mortality estimates

Mean activity in wind farm at rotor height	0.00231	hr ⁻¹
Total Combined rotor swept volume	405,603	m ³
Bird occupancy	4.1823	hrs/season
Bird occupancy of rotor swept volume	7.8200	bird-sec
No. of transits through rotors	51.4281	per season
Estimated collisions	4.3322	per season
Estimated collisions after correction for operation	3.6824	per season
Estimated collisions after avoidance factor	0.0368	per season
Equivalent to 1 bird every	27.16	seasons

A.9 White-tailed eagle

Non-Breeding Season 2015/2016

Table A-73 White-tailed eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
3	4.93	4,569.3556	0.000000089

Table A-74 White-tailed eagle mortality estimates

Mean activity in wind farm at rotor height	0.00005	hr ⁻¹
Total Combined rotor swept volume	458,952	m ³
Bird occupancy	0.0886	hrs/season
Bird occupancy of rotor swept volume	0.1874	bird-sec
No. of transits through rotors	1.2343	per season
Estimated collisions	0.1112	per season
Estimated collisions after correction for operation	0.0945	per season
Estimated collisions after avoidance factor	0.0047	per season
Equivalent to 1 bird every	211.55	seasons

Breeding Season 2017

Table A-75 White-tailed eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
1	49.97	2,274.0481	0.00000072
5	23.42	4,594.9000	0.00000034

Table A-76 White-tailed eagle mortality estimates

Mean activity in wind farm at rotor height	0.00062	hr ¹
Total Combined rotor swept volume	458,952	m ³
Bird occupancy	1.7523	hrs/season
Bird occupancy of rotor swept volume	3.7074	bird-sec
No. of transits through rotors	24.4203	per season
Estimated collisions	2.2006	per season
Estimated collisions after correction for operation	1.8706	per season
Estimated collisions after avoidance factor	0.0935	per season
Equivalent to 1 bird every	10.69	seasons

Breeding Season 2018

Table A-77 White-tailed eagle flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
4	941.49	3,715.1047	0.000013

Table A-78 White-tailed eagle mortality estimates

Mean activity in wind farm at rotor height	0.00763	hr ¹
Total Combined rotor swept volume	458,952	m ³
Bird occupancy	21.4600	hrs/season
Bird occupancy of rotor swept volume	45.4038	bird-sec
No. of transits through rotors	299.0731	per season
Estimated collisions	26.9512	per season
Estimated collisions after correction for operation	22.9085	per season
Estimated collisions after avoidance factor	1.1454	per season
Equivalent to 1 bird every	0.87	seasons

A.10 Whooper swan

Non-Breeding Season 2015/2016

Table A-79 Whooper swan flight activity

VP	Seconds at risk height	Observation effort (HaHr)	Flying time at risk height (secsHahr ¹)
5	1126.73	5,867.3338	0.000011

Table A-80 Whooper swan mortality estimates

Mean activity in wind farm at rotor height	0.00674	hr ¹
Total Combined rotor swept volume	597,881	m ³
Bird occupancy	18.0099	hrs/season
Bird occupancy of rotor swept volume	49.6388	bird-sec
No. of transits through rotors	319.2757	per season
Estimated collisions	31.6292	per season
Estimated collisions after correction for operation	26.8848	per season
Estimated collisions after avoidance factor	0.1344	per season
Equivalent to 1 bird every	7.44	seasons

Corriegarth 2 Wind Farm

Appendix A8.4

Golden Eagle Population Modelling

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A.1 Introduction

Population modelling has been used to assess potential impacts for some Scottish wind farm projects where golden eagle has been identified as a sensitive receptor, and has commonly been based on the golden eagle population modelling (GEPM) methods used in Whitfield et al. (2006¹; 2008²); Fielding and Haworth (2010³) and Haworth (2014⁴). The GEPM procedure has been used for assessing the potential effects of the proposed Corriegarth 2 Wind Farm (“the Development”). The model uses a deterministic matrix formulation and can be used to explore how additional eagle mortality may affect predicted growth rates of the Natural Heritage Zone (NHZ) 10: Central Highlands’ golden eagle population.

There are four key parameters in the model:

- Number of occupied ranges;
- Mean number of young fledged per pair per year;
- Annual survival rate of young birds; and
- Annual survival rate of adult, range-holding birds.

Estimates for the first two are available with a reasonably high degree of confidence at an NHZ 10 level. The latter two are more difficult to estimate at the level of individual NHZ populations and therefore the values for these have been informed by studies conducted on other populations, in combination with regional information, such as trends in the number of occupied ranges, which can be used to modify their values (Haworth, 2014).

Only the female half of the population is modelled. Therefore, calculated collision rates were halved, assuming a 1:1 sex ratio, equal activity and equal risk of collision.

Fielding and Haworth (2010) describe how alternative scenarios can be modelled to obtain predicted rates of population growth over a duration of 25 years, with or without a proposed wind farm and with varying rates of additional mortality on adults and/or sub-adults. The predicted population growth rate, the expected number of occupied territories after a period of 25 years and the time to reach a notional population target (e.g. the level associated with the wider concept of “Favourable Conservation Status” outlined below) can be reviewed whilst varying levels of additional mortality.

The parameter ranges considered in the GEPM for assessing the potential impacts of the Development and other wind farms cumulatively are outlined in turn in Table 1 and detailed in the text below.

¹ Whitfield, D. P., Fielding, A. H., McLeod, D. R. A., Haworth, P. F. & Watson, J. 2006. A conservation framework for the golden eagle in Scotland: refining condition targets and assessment of constraint influences. *Biological Conservation*, 130(4), 465-480.

² Whitfield, D P, Fielding, A H, McLeod, D R A and Haworth, P F (2008). A conservation framework for golden eagles: implications for their conservation and management in Scotland. Scottish Natural Heritage.

³ Fielding, A. and Haworth, P. (2010). Golden eagles and wind farms: A report created under an SNH Call-of-Contract Arrangement. Haworth Conservation.

⁴ Haworth, P. (2014). The Dunmaglass Wind Farm Regional Eagle Conservation Management Plan. Haworth Conservation.

Table 1 Parameters used in the GEPM.

Parameter	Golden Eagle Conservation Framework Report 2008	Values to be used in Corriegarth 2 GEPM	Rationale
Number of pairs within NHZ 10	12	25	Highland Raptor Study Group data estimated 25 pairs within NHZ 10 in 2019; up from 12 pairs from the national census in 2003.
Total number of ranges within NHZ 10	26	37	Highland Raptor Study Group in 2020 estimated that there are up to 37 ranges available within NHZ 10; up from an estimated 26 ranges estimated for the national census in 2003.
Favourable Conservation Status of NHZ 10: Occupancy	17	25	66% occupancy rate of total available ranges within NHZ 10
S1 – survival rate from fledging to age 4 (note this is not the annual rate but the product of 4 annual rates)	0.400	0.250 – 0.400	0.279 for ages 0-4 combined (annual survival of 0.727 ⁴) is the value extrapolated from the model, based on the best fit of observed population growth from 2003 (12 pairs) to 2019 (25 pairs), using the predicted adult survival (0.9512) and mean productivity (0.737) rates for this period. It is thought that sub-adult survival has historically been the main factor in keeping the population low within this NHZ (see results of satellite tag study by Whitfield & Fielding (2017) for example). 0.400 was used by Whitfield <i>et al.</i> (2008) and Haworth (2014). This equates to a 40% survival from fledging to adulthood (annual survival of 0.795 ⁴). This was considered to be the minimal sub-adult survival rate which would predict stability or expansion for any credible measure of productivity which has been identified.
S2 – adult survival (note this is the annual rate)	0.9512	0.9512	0.9512 was used by Whitfield <i>et al.</i> (2006; 2008) and Haworth (2014). This is a precautionary estimate which equates to a minimal adult survival rate (20 years of occupation) which predicts stability or expansion for any credible measure of productivity which has been identified. No NHZ-specific information is available.
Mean fledging rate per pair within NHZ 10 (both sexes)	0.83 (2003 census) and 0.47 (mean 1982, 1992,	0.47	Mean productivity from 1982, 1992 and 2003 national censuses, as outlined in the Golden Eagle Conservation Framework. NHZ 10 mean productivity in 1982 and 1992 was low at 0.24 and 0.29 respectively, but higher in 2003 at 0.83.
		0.619	Mean of all available results for NHZ population. From 1982, 1992, 2003, 2015-19 monitoring.

Parameter	Golden Eagle Conservation Framework Report 2008	Values to be used in Corriegarth 2 GEPM	Rationale
	2003 censuses)	0.718	From Highland Raptor Study Group data. Mean of 2015-19 counts: <i>In 2015, all ranges were checked and 11 were considered vacant. 14 chicks fledged from 17 territorial pairs (0.824 chicks/ terr pr)</i> <i>In 2016, all ranges were checked and 9 were considered vacant. 12 chicks fledged from 19 territorial pairs (0.632 chicks/terr pr)</i> <i>In 2017, 26 ranges were checked and 5 were considered vacant. 15 chicks fledged from 21 territorial pairs (0.714 chicks/terr pr)</i> <i>In 2018, 24 territorial pairs with average productivity of 0.61 chicks/territorial pair.</i> <i>In 2019, 25 territorial pairs with average productivity of 0.81 chicks/territorial pair.</i>
		0.737	Mean of all available results for NHZ 10 population in recent times. From 2003 and 2015-19 monitoring.
		0.83	NHZ10 productivity in 2003 national census. This was the highest fledging rate of all NHZs assessed in this year.

A.2 Conservation Status of NHZ 10: Central Highlands

Whitfield et al. (2008) devised three tests that should be applied to a golden eagle population to assess its conservation status. All three tests must be passed to achieve a favourable status.

1. Regionally, at least 66% of known territories should be occupied by pairs.
2. Demographic parameter values should allow the maintenance of a stable or expanding population. With limited information available on survival rates, an annual adult survival of 95.12% was adopted as the lower limit for a favourable conservation status classification. This equates to an expected 20 years of territory occupation by an adult. A minimum acceptable rate for sub-adult survival of 40% (across the first four years of life which equates to an annual survival rate of 79.5%) was used. Under these survival rates an average reproductive rate of about 0.28 fledglings per pair per year is the minimum required to maintain a stable population (i.e. a growth rate of 1). It follows, however, that if these parameter values varied regionally then lower rates in one parameter could be compensated for, to a degree, by higher rates in another parameter.
3. Compare the predicted population projections from the population model against the observed trends in the number of occupied territories from previous censuses. If the observed population trend failed to match predictions then the survival rates applied in the Level 2 test were probably too high (for example, if stability or increase was predicted but decline was observed). Under these circumstances it would be assumed that survival was below the lower limit for favourable status and the population would be deemed to have failed the Level 3 test.

The NHZ 10: Central Highlands' golden eagle population was determined by Whitfield et al. (2008) to be in unfavourable conservation status.

The population failed the Level 1 test because, in 2003, only 12 ranges out of 25 known at that time were occupied, meaning that another five needed to be reoccupied for the NHZ to pass the Level 1 test.

For the Level 2 test, Whitfield et al. (2008) ran a population model for the NHZ with a starting population set at the 2003 level, and with a capped population set at the number of known territories. The output was the mean predicted number of occupied territories after 21-30 years averaged over 100 simulated runs using randomly generated parameter values. NHZ 10 passed both Level 2 tests with observed fledging rates of 0.47 (mean for the 1982, 1992 and 2003 national surveys) and 0.83 for the 2003 national survey (i.e. above the minimum mean reproductive rate of 0.28).

The Level 3 test was failed because the relatively high productivity rates (0.83 per pair in 2003, and a long-term mean of 0.47 per pair) would have been expected to permit population expansion, but the trend was for stability.

The two main factors believed to be restricting growth of the NHZ 10 population were identified as persecution and over-grazing by red deer *Cervus elaphus*, which have also been identified as the primary constraining factors in all NHZs in the wider area.

As the level 1 and level 3 tests were failed, the NHZ 10 population was considered to be in Unfavourable Conservation Status in 2008.

A.3 GEPM Input Parameters

3.1 Level 1 Test: Number of Currently Occupied Ranges

In Whitfield et al. (2008) a target of 66% occupation of known territories was prescribed before each NHZ population could be considered to be in favourable condition. For the NHZ 10 population, this would be 25 out of a possible 37 known territories. It is therefore considered that currently the Level 1 Favourable Conservation Status threshold is met as most recent evidence in 2019 suggests that 25 territories are occupied.

3.2 Level 2 Test: Survival Rates

Survival rates specific to the NHZ 10 population are unknown and so precautionary values for S1 (sub-adult) and S2 (adult) survival rates were used in the model, taken from the following sources:

- **S2 survival: 0.9512** was used in Whitfield et al. (2008) for various NHZs and for the NHZ 10 population in Haworth (2014). This was defined as the lowest rate for attaining favourable conservation status used in Whitfield et al. (2006).
- **S1 survival:** a four-year survival rate of **0.279** for survival from ages 0-4 (equating to annual survival of 0.727) was derived using the model to match the observed increased population growth from 2003 to 2019, with conservative adult survival (0.9512) and the long-term mean observed productivity rates this period (0.737). This is lower than the national mean survival rate of 0.400 used in the Golden Eagle Conservation Framework model, which was defined as the lowest rate for attaining favourable conservation status used in Whitfield et al. (2006), in combination with the S2 survival rate above.

Using the S1 survival rate = 0.400 in the model, the current NHZ population would be expected to reach a carrying capacity of 37 pairs by year 8 (around 2028), whereafter, all excess individuals would have to be recruited to neighbouring NHZ populations to breed. To simulate this in the GEPM a cap of 37 was placed on the number of pairs. Once this population size was achieved in the model the growth rate becomes 1 (i.e. stable). Consequently, the rates of growth provided below refer to the period of growth prior to this limit being attained. These were calculated as the average of the annual rates, but omitted the first 3 annual values as these reflect starting conditions in the model and not the stable growth rate (Caswell 2001⁵).

3.3 Level 2 Test: Mean Fledging Rate

The mean fledging rate of 0.718 was based on values provided in the most recent five years of monitoring within NHZ 10 (2015 to 2019), as per Table 1.

A.4 RESULTS OF THE GEPM

4.1 Baseline Scenario

With the more recent data now available, an updated evaluation of the current conservation status of the NHZ 10 population can be made, within the context of the three tests described above.

⁵ Caswell, H. (2001) Matrix Population Models. Sinauer Associates, Inc., Sunderland, MA.

1. Occupancy: based on results of the most recent census, 25 out of a possible 37 territories are likely to be currently occupied within NHZ 10, resulting in an occupancy rate of 67%, thereby meeting the minimum 66% occupancy rate: **Favourable Conservation Status achieved.**

The mean productivity per pair is currently around 0.718 (0.359 females per pair). Using the precautionary survival rates ($S_1 = 0.279$; $s_2 = 0.9512$) population growth would be around 3.3% per year (A growth rate above 1.00 indicates population increase, a rate below 1.00 indicates decline. A rate of 1.05 indicates 5% annual growth. Note that the mean growth rate only applies until the population attains the carrying capacity (37 pairs).

2. Table 2), leading to 100% territory occupancy within 13 years. Using more realistic mean survival rates described above ($S_1 = 0.400$; $S_2 = 0.9512$), based on the trend of continued expansion in recent years, an annual growth rate of around 5.7% was predicted, leading to 100% territory occupancy within 8 years: **Favourable Conservation Status achieved.**
3. The predicted growth rates correspond to the steady growth between the 2003 and 2015 censuses, and the recent further population estimate provided by the Highland Raptor Study Group (e.g. an increase in the NHZ 10 population from 21 to 25 pairs in the last three years): **Favourable Conservation Status achieved.**

This means that despite any ongoing limiting factors on the population (identified as persecution and grazing by Whitfield et al. 2008, on the basis of the most recent data, the NHZ 10 population is in **Favourable Conservation Status**.

Under the baseline scenario (without additional mortality due to predicted collisions at the Development alone or cumulatively) this population growth would theoretically permit the carrying capacity of the NHZ 10 (37 pairs) to be reached within 8 to 13 years. Once all available territories are occupied it is reasonable to suppose that individuals unable to acquire territories would emigrate to other NHZs.

A growth rate above 1.00 indicates population increase, a rate below 1.00 indicates decline. A rate of 1.05 indicates 5% annual growth. Note that the mean growth rate only applies until the population attains the carrying capacity (37 pairs).

Table 2 Predicted mean annual growth rate of NHZ 10 Golden Eagle Population under Baseline Scenario (excluding any effects associated with the Development).

		Mean fledging rate				
S1 survival rate		0.470	0.619	0.718	0.737	0.830
	0.250	1.006	1.019	1.027	1.029	1.035
	0.279	1.011	1.025	1.033	1.034	1.042
	0.300	1.014	1.029	1.037	1.040	1.047
	0.350	1.023	1.038	1.046	1.050	1.054
	0.400	1.031	1.048	1.057	1.058	1.062

A.5 With Additional Mortality due to Predicted Collisions at the Development

The collision modelling mean annual mortality prediction of 0.093 birds per year due to the Development was included in the GEPM as an additional source of mortality to the NHZ 10

population (note this was halved to account for female only collisions). Using the mean fledging rate of 0.718, and a precautionary S1 survival rate of 0.279, the population growth rate declined slightly from 3.3% to 3.1%, and there was an extension to the period taken for the population limit of 37 pairs to be attained from 13 to 14 years. Using an S1 survival rate of 0.400 the growth rate and time to reach the population limit was unchanged.

Table 3 Predicted mean annual growth rate of NHZ 10 Golden Eagle Population with a mean annual collision rate of 0.093 associated with the Development.

Mean fledging rate						
S1 survival rate		0.470	0.619	0.718	0.737	0.830
	0.250	1.004	1.018	1.025	1.027	1.035
	0.279	1.010	1.024	1.031	1.034	1.042
	0.300	1.013	1.028	1.037	1.037	1.047
	0.350	1.021	1.038	1.046	1.046	1.054
	0.400	1.029	1.044	1.057	1.058	1.062

This demonstrates that the NHZ 10 golden eagle population would be expected to continue to expand at a similar rate despite the additional mortality predicted to be associated with collisions with turbines at the Development.

A.6 With NHZ 10 Cumulative Annual Collision Rate

A worst-case cumulative annual collision rate for both sexes combined for all other installed, constructed, consented or application stage wind farm projects, including the Development, within NHZ 10 was estimated to be 1.277 collisions per year (assuming all collisions are attributable to NHZ 10 adult birds; note for the female only GEPM this equates to mortality of 0.638 females).

Using this value, the annual population growth rate was reduced from 3.3% to 1.8% based on an S1 survival rate of 0.279 (Table 4). At this rate of growth, the carrying capacity of 37 pairs would be achieved by year 25 (an increase of 11-12 years compared to the baseline and Development only scenarios described above). Using the more realistic S1 survival rate of 0.4, the growth rate would reduce from 5.7% (Table 2: S1 survival 0.4, fledging rate 0.718) to 4.3% (Table 4: S1 survival 0.4, fledging rate 0.718), with the carrying capacity reached in year 11 (an increase of 3 years compared to the baseline and Development only scenarios).

Table 4 Predicted mean annual growth rate of NHZ 10 Golden Eagle Population with a mean annual cumulative collision rate of 1.277 associated with all NHZ 10 projects.

Mean fledging rate						
S1 survival rate		0.470	0.619	0.718	0.737	0.830
	0.250	0.981	0.999	1.009	1.011	1.020
	0.279	0.988	1.007	1.018	1.019	1.027
	0.300	0.993	1.013	1.022	1.024	1.032
	0.350	1.004	1.023	1.033	1.034	1.042
	0.400	1.014	1.032	1.043	1.044	1.052

The model predicts continued growth in the majority of modelled scenarios, with the exception of the most precautionary fledging and S1 survival rates. This suggests that the NHZ 10 golden eagle population is likely to continue to increase, despite the additional mortality predicted to be associated with collisions with turbines at the Development and other projects within NHZ 10.

A.7 SUMMARY AND CONCLUSIONS

Based on the increase in number of occupied territories between 2003 and 2019, the NHZ 10 golden eagle population is currently considered to be in favourable conservation status. Modelling of the potential effects of collisions on the population suggest that:

- Under a baseline scenario (zero collisions) growth would continue until the NHZ's carrying capacity of 37 pairs is reached (within 8 to 13 years).
- With additional mortality due to predicted collisions with turbines at the Development (0.093 per year) taken into consideration, population growth would be predicted to decline slightly from 3.3% to 3.1%. This would not prevent carrying capacity being reached but would be expected to delay reaching this target slightly (by c. 1 year).
- With additional collision mortality from the Development and all other wind farm projects within NHZ 10 (1.277 per year), population growth would be reduced but remain positive, resulting in a delay until the NHZ carrying capacity would be attained of 11-12 years under a precautionary S1 survival rate, and 3 years under a more realistic rate,.
- With stable or continued growth predicted over the long-term, despite additional mortality associated with collisions due to the Development and other projects, it is predicted that Favourable Conservation Status would be maintained, and there would be no significant effects on the NHZ 10 population as a result of additional mortality associated with collisions.