SECTION 6

EWT	Emergya Wind Technologies BV
	DIRECTWIND

Category:	Specification	Page 1 / 4
Doc code:	S-1009941.docx	

Created by:	MS	Creation Date:	30-06-10
Checked by:	TY	Checked Date:	30-06-10
Approved by:	AvdB	Approved Date:	30-06-10

Title:

Specification

Power Curve DW 54*500

Revision	Date	Author	Approved	Description of changes
01	24-02-11	GF	TY	Format
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Emergya Wind Technologies BV
Building "Le Soleil" - Computerweg 1 - 3821 AA Amersfoort - The Netherlands
T +31 (0)33 454 0520 - F +31 (0)33 456 3092 - www.ewtinternational.com

EWT	Category:	Specification	Revision: 01
	Title:	Power Curve DW 54*500	Page 2 / 4
	Doc code:	S-1009941.docx	

Contents

1 General information

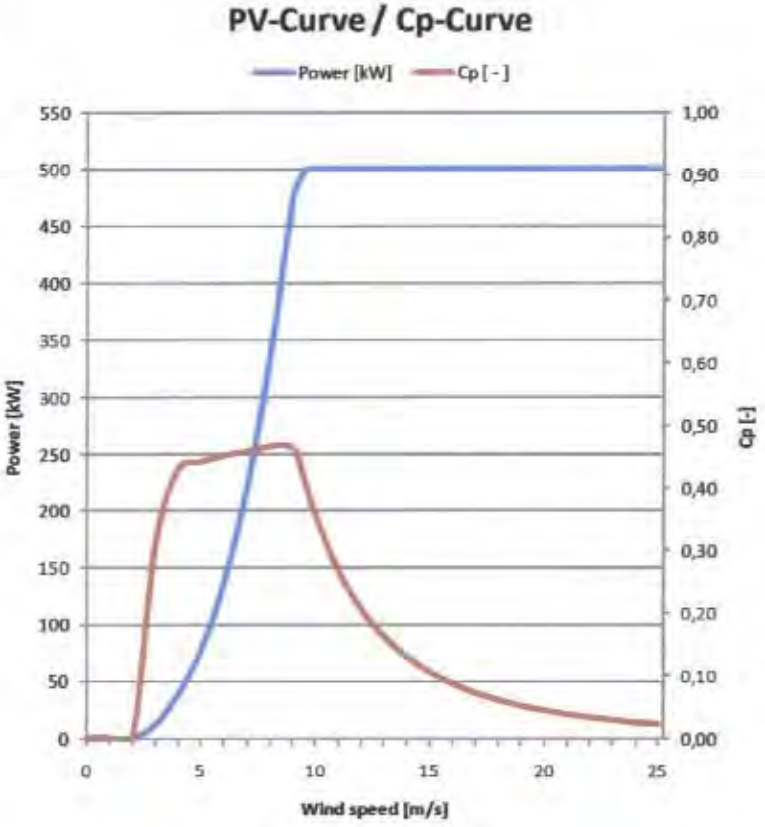
Rotor diameter: 54 m
Rated power: 500 kW
IEC Wind class: IIIA

Cut-in wind speed: 3 m/s
Cut-out wind speed: 25 m/s
Rated wind speed: 10 m/s

Wind speeds based on 10 minute averages

2 Power curve

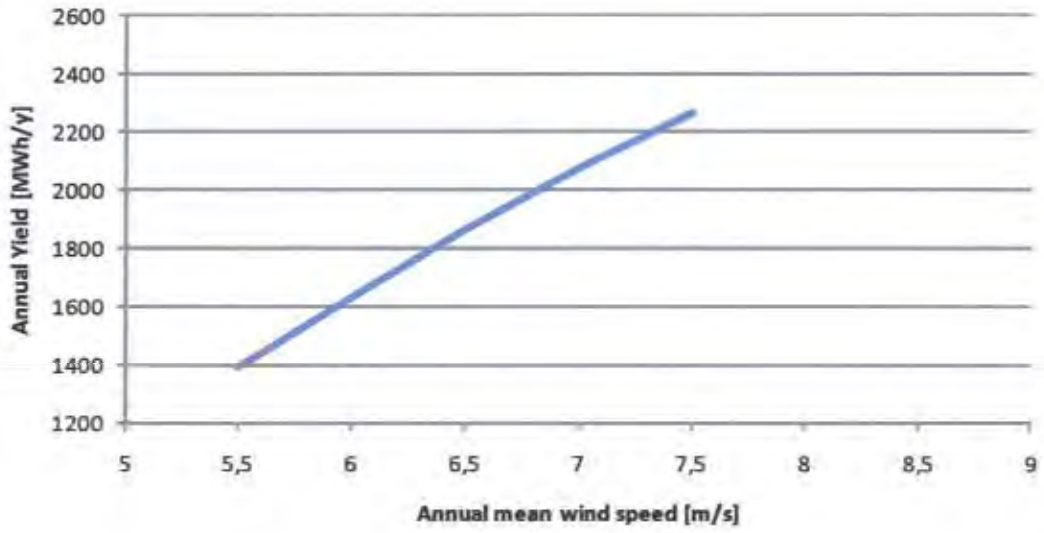
Wind speed [m/s]	Power [kW]	Cp [-]
0	0	0,00
1	0	0,00
2	0	0,00
3	12	0,32
4	39	0,43
5	78	0,44
6	138	0,46
7	222	0,46
8	337	0,47
9	477	0,47
10	500	0,36
11	500	0,27
12	500	0,21
13	500	0,16
14	500	0,13
15	500	0,11
16	500	0,09
17	500	0,07
18	500	0,06
19	500	0,05
20	500	0,04
21	500	0,04
22	500	0,03
23	500	0,03
24	500	0,03
25	500	0,02



The power curve is calculated and valid for the standard atmospheric conditions of temperature 15 °C, an air density of 1,225 kg/m3, vertical wind shear exponent of 1/7, horizontal undisturbed air flow and clean blades with no snow and or ice formation. No misalignment is assumed in the calculation. The power curve is represented with a turbulence intensity of 10% according to IEC 61400-1 and takes into account the effects of blade deformation and the effects of rotation on lift coefficient.

3 Annual yield

The annual energy production for different annual mean wind speeds at hub height are calculated from the above power curve data assuming a Weibull wind speed distribution with a k-factor of 2,0. Furthermore assumed is 100% availability and no reductions due to park losses, grid losses or other external factors effecting the production.



Wind Speed [m/s]	Energy [MWh/y]	Energy_sp [kWh/m2.y]
5,5	1391	607
6,0	1634	714
6,5	1864	814
7,0	2076	906
7,5	2269	991

SECTION 7

EWT	Emergya Wind Technologies BV
	Engineering

Category:	Specification	Page 1 / 2
Doc code:	S-1005020	

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Approved by:	TY	Approved Date:	07-12-11

Title:

Specification

Sound power warranty levels DW52/54 500kW

Revision	Date	Author	Approved	Description of changes
02	14-03-12	AB	TY	Modifications based on new IEC measurements
01	09-12-11	AB	TY	correction
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Emergya Wind Technologies BV
Building "Le Soleil" - Computerweg 1 - 3821 AA Amersfoort - The Netherlands
T +31 (0)33 454 0520 - F +31 (0)33 456 3092 - www.ewtinternational.com

Sound power levels

The warranted sound power levels are presented with reference to IEC 61400-11:2002.

V_{wind} at 10m height	DW52	DW54
5 m/s	96,5 dB(A)	97.0 dB(A)
6 m/s	97.5 dB(A)	98.0 dB(A)
7 m/s	98.5 dB(A)	99.0 dB(A)
8 m/s	99.5 dB(A)	100.0 dB(A)
9 m/s	100.3 dB(A)	100.5 dB(A)
10 m/s	100.5 dB(A)	100.5 dB(A)

Sound power level Lw in dB(A)

The warranted sound power levels are based on actual measurements executed by an independent noise measurement institute according to the preferred methods set out in IEC-61400-11.

Uncertainty levels are included in the warranted sound power levels.

At 5m/s a maximum tonal noise penalty of 2,5dB shall be considered according to ETSU-R-97 guidelines.

The measured third octave sound power levels are available upon request.

The values given in the table are valid for normal operational mode (rotation speed 0-24 RPM)

The calculation of the standardized wind speed at 10m height according to IEC 61400-11 is based on a terrain roughness length Z_0=0,05m.

In case validation measurements have to be performed, they should be executed according to the preferred methods set out in IEC-61400-11 by an independent measurement institute which is accredited to ISO/IEC 17025 to conduct measurements of wind turbine noise emissions.

EWT reserves the right to make modifications or adjust settings in order to comply with the warranted sound power levels.

SECTION 8

REPORT

Forfar Golf Course

Theoretical Noise Study

Dr. Jonathan Ball Bsc.(Hons), PgDip., MSc., PhD.

TO:

Alex Craig

A Craig Architectural Consultants ,
6 Clerk St, Brechin, Angus, DD9 6AE

(15. Aug. 2013)

MappaGnosis Ltd. (Company N°: SC384524) is an independent consultancy providing services relating to all aspects of **Geographical Information Systems (GIS)** with particular experience in bespoke spatial analysis, site identification, 3D landscape modelling, wind farm environmental impact analysis and associated cartography.

MappaGnosis Ltd. • 4 Riverside Drive • Kincardineshire • AB39 2GP • Scotland
Phone: 01569 767390 • E-mail: jonathan.ball@mappagnosis.com

Table of Contents

1 Introduction

MappaGnosis Ltd. Was commissioned by A Craig Architectural Consultants to undertake a desk-based theoretical noise study on the Forfar Golf Course wind farm proposal.

1.1 General UK planning regulations on wind turbine noise

The standard for assessing the effects of noise from wind turbines in the UK is ETSU-R-97[1], as recommended by PPS22 in England and Wales, PAN 45[1] in Scotland and PPS18 in Northern Ireland. ETSU-R-97 recommends a noise limit at the nearest noise-sensitive properties of:

$$X \text{ dB } L_{A90}$$

or 5dB above the prevailing background noise[2], whichever is greater where X varies with the time of day or circumstances as follows:

- Day-time (0700 to 2300): X = 35-40 dB(A)
- Night-time (2300 to 0700): X = 43 dB(A)
- Financially involved properties: X = 45 dB(A)

A simplified noise criterion is also defined, where, if turbine noise is limited to no more than 35 dB(A) at wind speeds of up to 10 ms^{-1} (at 10m above ground level), consideration of background noise levels is unnecessary. This implies a simplified criterion of 45 dB(A) for properties where the occupier has a financial interest.

1.2 IoA guidance for calculations in this study

PAN 45 states:

> *"The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice"*

Institute of Acoustics (IoA) states in their Good Practice Guidance[3] that the ISO 9613-2 standard is the most commonly used and validated method for the prediction of proposed turbine noise levels at the nearest residential receptors.

Therefore, in accordance with the IOA recommendation (and implicit acceptance of it by the Scottish Government), calculations in this desk-based study were conducted in accordance with ISO 9613 guidance.

In the following discussion of the noise calculations for this project the following terms are used as follows:

- Sound power is the amount of sound being produced at source
- Sound pressure is the observed noise level at a given location

1 The Scottish Government, 2013, *Planning Advice Note 45 – Onshore wind turbines* [Revised July 2013]

2 Measured during defined quiet daytime periods (Monday to Friday 1800 to 2300, Saturdays 1300 to 2300 and Sundays 0700 to 2300).

3 Institute of Acoustics, 2013, *A Good Practice Guide To The Application of ETSU-R-97 For The Assessment And Rating of Wind Turbine Noise*, available at the time of writing on-line at http://www.ioa.org.uk/pdf/ioa-gpg-on-wtna-issue-01-05-2013.pdf

2 Turbine Specifications

2.1 The proposal:

The proposed wind farm comprises a single turbine and calculations are based on the following turbine specification for this project:

Make	Wind Energy Solutions
Model	EWT 54 500kW
Hub height (m)	50
Rotor diameter (m)	54
Tip height (m)	77

The turbine coordinates are as follows:

Turbine	Eastings	Northings
1	348524	750248

2.2 Effective sound power level of the proposed turbine:

The proposed turbine has a stated sound power of 100.5 dB(A) at 10ms^{-1} wind speed (see appended EWT Sound Power Warranty). This figure already includes uncertainty levels and a tonal penalty of +2.5dB at 5ms^{-1} rising to +5dB at 10ms^{-1} in accordance with ETSU-R-97.

3 Calculations

The results of the calculations presented here were performed using OpenWind[4], which conforms to ISO 9613. The sound power values can be converted into sound pressure using the following equation:

$$L_n(DW) = L_w + D_c - A$$

where:

$L_n(DW)$ is the downwind sound pressure level at the receiver location;

L_w is the sound power level, in decibels, produced by the point sound source relative to a reference sound power source of one picowatt (1 pW);

D_c is the directivity correction

A is the attenuation that occurs during propagation.

3.1 Standardised wind conditions:

For the purposes of this calculation, a wind speed of 10ms^{-1} with a reference height of 10m and using a roughness length of 0.05.

4 AWS Truepower LLC, 2013, OpenWind wind farm design software, available at the time of writing on-line at http://www.awsopenwind.org/

3.2 Site temperature and humidity:

The density of the air through which sound travels effects its propagation. Therefore, in accordance with the recommendations of ISO 9613 the atmospheric conditions were set to 10°C and 70% humidity for the calculation.

3.3 Atmospheric absorption attenuation:

While the Danish model uses a factor of 0.005 dB/m, ISO 9613 recommends the more conservative value of 0.00193 dB/m for the atmospheric absorption attenuation coefficient at 500hz when using the standard single A-weighted sound power level calculation, which is more appropriate for the air temperature and humidity. This latter value is the one used in these calculations.

3.4 Ground porosity:

ISO 9613 allows for three 'zones' of attenuation; the source, middle and receiver. Each of these regions can be assigned a porosity factor, G, in the range from 0 (hard ground such as paving or trampled ground) to 1 for porous ground (ground covered by grass or trees). A porosity factor of 1 is not recommended and, in accordance with SB20 of the IoA Good Practice Guide porosity was set to G = 0.5 at all locations, except for propagation over large bodies of water where G = 0 will be used.

3.5 Receiver height:

A receiver height of 4m was used in these calculations in accordance with the recommendations of ISO 9613 to represent a two storey residential property, where the bedrooms are assumed to be on the upper floor.

3.6 Tonality and uncertainty:

The Institute of Acoustics states in Section 4.2.7 of their Good Practice Guidance (*op. Cit.*):

> *"It is highly unlikely that any specific information on tonality at representative receptor separation distances in accordance with the ETSU-R-97 methodology will be available at the planning application stage."*

A penalties for tonality and uncertainty have already been applied in the manufacturer's warranted sound power levels so no further penalty was added.

3.7 Background noise and mitigations:

As this is a desk-based study, no assessment of prevailing background noise was made in the field and no account has been taken of mitigating circumstance such as proximity to busy roads or woodlands, where the noise of traffic or the rustle of leaves and sound of the wind in branches. Therefore this is a worst-case scenario.

4 Results

The noise propagation of the proposed development is presented in the map of theoretical noise propagation at the end this report, which shows a noise-contour plot.

4.1 Identification of Neighbouring properties:

The predicted sound pressure contours were projected to the Google Spherical Mercator projection and exported to KML format. The contours were viewed in Google Earth and the nearest point of relevant residential properties was identified with a marker and the markers imported into geographical information systems software to calculate distance to the nearest turbine and the sound pressure at each property.

4.2 Sound Pressure at Neighbouring properties:

Current mapping and aerial photography suggests that there are no residential properties within the 35dB(A) contour (Figure 1) barring one location. These properties and the predicted theoretical noise levels propagated by the proposal at their locations are as follows:

Id	Name	Eastings	Northings	Distance (m)*	Predicted L_{A90} (dB)
1	Lochhead Cottages	348534	750888	640	33.57
2	Lochhead Farm Cottage	348374	750878	647	33.46
3	Mid Dod	349175	749914	732	32.29
4	Tullibardine	348772	749755	552	35.08
5	Auchterforfar	348018	749947	589	34.45

** The value presented here is the straight-line distance to the nearest turbine.*

4.3 Tullibardine:

The residential property at Tullibardine is on the 35dB(A) threshold. The point used for measurement was the closest part of the building to the turbine. The 35dB(A) contour cuts through the building. It may be an acceptable argument that there are a number of factors likely to be of mitigation:

- dense trees to the north of the property, being between it and the turbine,
- the close proximity of the road (also between the property and the turbine,
- the property is to the south of the turbine and the prevailing wind will be approximately from the south-west and therefore predominantly carrying the sound away from the building.

If the these factors are considered insufficient or unacceptable, a simple mitigation may be to move the turbine location a few meters north (taking care not to impact the properties at Lochhead.

Appendix 1: EWT DW52/54 Sound Power Warranty Levels

EWT	Emergya Wind Technologies BV
	Engineering

Category:	Specification	Page 1 / 2
Doc code:	S-1005020	

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Emergya Wind Technologies BV
Building 'Le Soleil' - Computerweg 1 - 3821 AA Amersfoort - The Netherlands
T +31 (0)33 454 6520 - F +31 (0)33 456 3092 - www.ewtinternational.com

EWT	Category:	Specification	Revision: 02
	Title:	Sound power warranty levels DW52/54 500kW	Page 3 / 3
	Doc code:	S-1005020	

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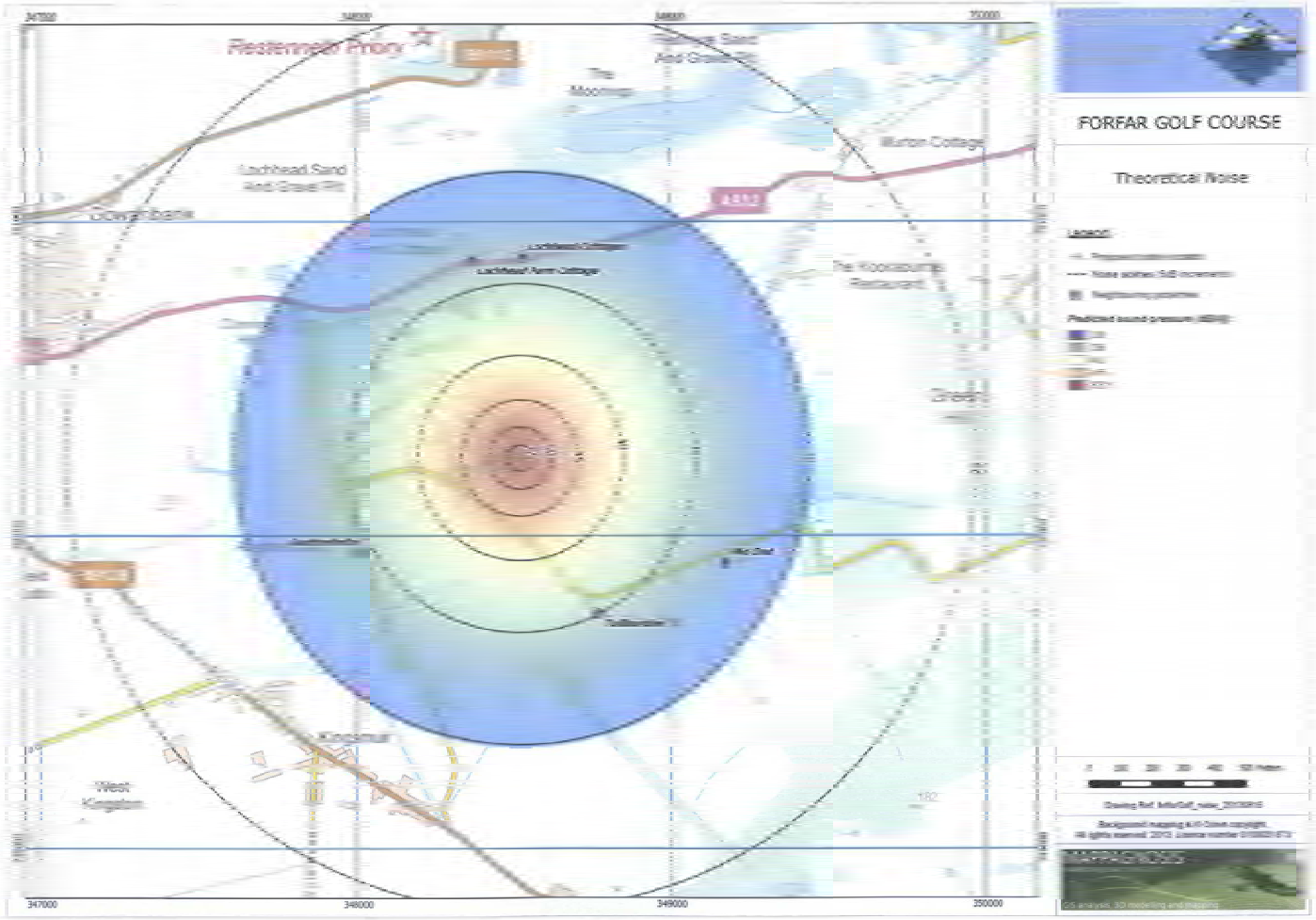


Figure 1: Noise contours

SECTION 9

AC54

Forfar Golf Club

Survey Report

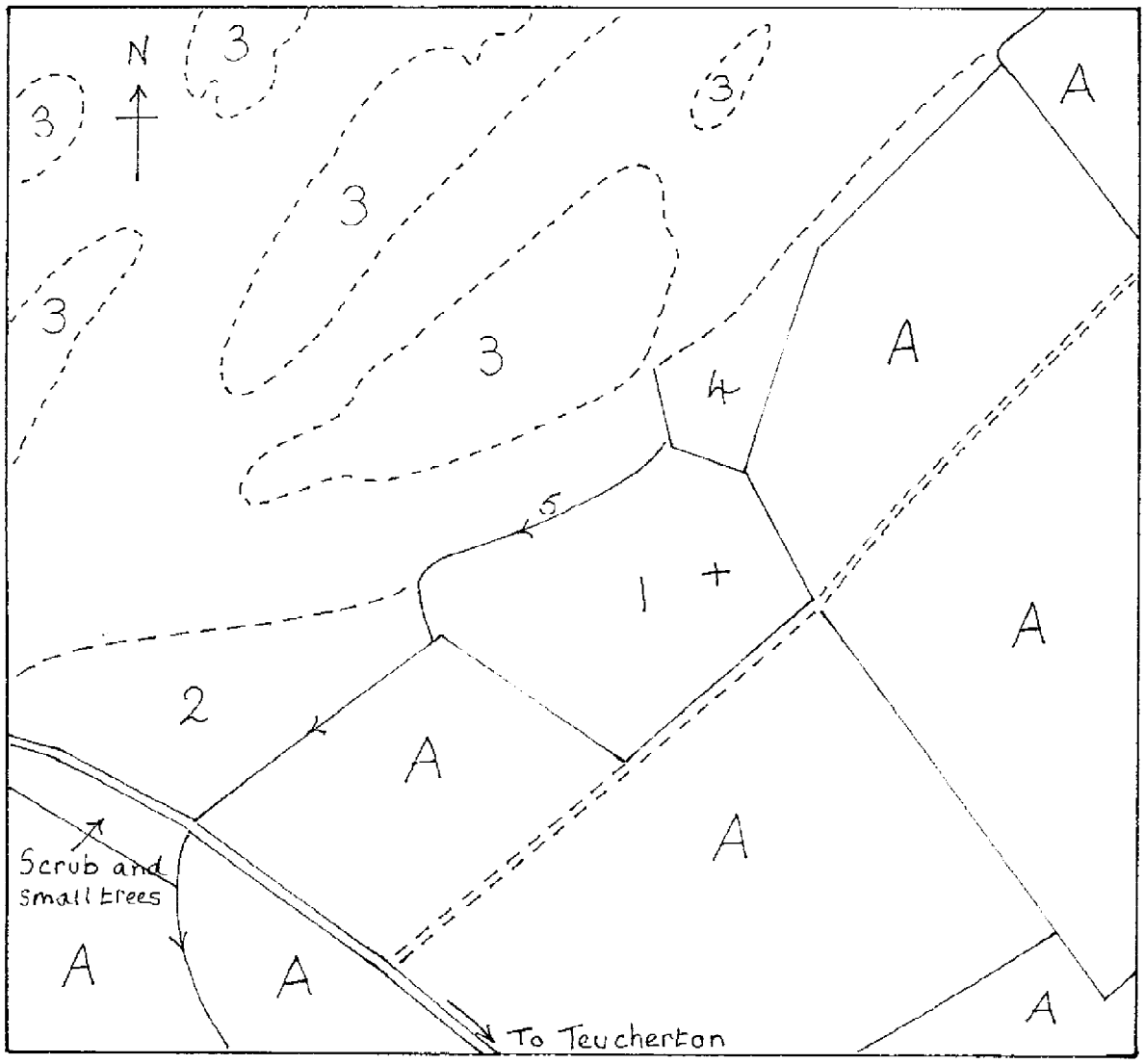
by

Barbara Hogarth

17 July 2013

Forfar Golf Club

Site Map



A	Arable
—+—	Drain
1 – 5	See report
+	Site of proposed wind turbine

Forfar Golf Club

In relation to proposals to erect a single wind turbine at NO 48524 50248 a habitat survey and environmental assessment were carried out at the request of Alex Craig, Architectural Consultant.

The survey was undertaken on 17 July 2013 by Barbara Hogarth.

Site Map

The map of the relevant section of Forfar Golf Course and adjacent land shows the areas described in this report. The numbers relate to those in the description of the site.

Description of site

1 Conifer Plantation

This area comprises an open stand of even-age Scots Pine. There is a sparse under-storey of Rowan and Elder below which the ground is covered by localised patches of Brambke, Stinging Nettle and Creeping Soft-grass. Also present are Broad Buckler-fern, False Oat-grass, Yorkshire-fog, Broom, Hogweed, Ragwort, Creeping Thistle, Foxglove, Creeping Buttercup, Pink Purslane, Bush Vetch, Common Dog-violet and Germander Speedwell.

2 Conifer plantation

The wooded strip between the fairway and neighbouring arable farmland comprises an open stand of even-age Scots Pine with a few Larch trees. Adjacent to the fairway relatively short acid grassland is dominated by Wavy Hair-grass and Heath Bedstraw with occasional Sweet Vernal-grass, Fescue and Bent grasses, Devil's-bit

Scabious, Tormentil, Harebell, Cat's-ear, Common Knapweed. Away from the fairway this grades to a mosaic of tall grasses and tall ruderal species. These include False Oat-grass, Yorkshire-fog, Creeping Soft-grass Stinging Nettle and Rosebay Willowherb with localised patches of Bramble, Raspberry, Gorse and Broom.

3 Conifer plantation

The strips of woodland within the golf course are predominantly even-age Scots Pine with acid grassland.

4 Mixed Woodland

A block of relatively young trees of planted origin with Gean, Rowan, Oak, Guelder-rose and Scots Pine over Stinging Nettle, Creeping Thistle, Rosebay Willowherb and Bramble.

5 Drain

The drain between the playing area of the golf course and Area 1 is kept clean and open although there are signs of fresh growth of Brooklime and Floating Sweet-grass. Vegetation along the drain becomes taller and denser where it runs along the boundary between Area 2 and the neighbouring arable fields. Here the tall herbs and ruderal species present in Area 2 are interspersed with Meadowsweet and Sweet Cicely.

Observations

Ringlet butterflies were seen in the vicinity of the drain but otherwise there were no indications that this site supported any significant wildlife.

Conclusions

The areas of conifer plantation have little or no nature conservation interest but may provide shelter for wildlife.

The present low level of nature conservation interest would not be adversely affected by the proposals for the site.

Barbara Hogarth BSc (Hons) Botany
Botanist/Habitat Surveyor