APPENDIX 3.1

SCREENING REQUEST

Alan Keir
Marine Scotland
Marine Policy and Planning
Scottish Government
Marine Laboratory
375 Victoria Road
Aberdeen
AB11 9DB

26 January 2017

Our Reference: 2652/Screening
Your Reference:

Dear Mr Keir,

The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as modified by the Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations 2013) and the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2007 – Request for a Screening Opinion for an Variation to Condition 1 of the Levenmouth Demonstration Turbine Consent

On behalf of Offshore Renewable Energy Catapult (ORE Catapult), Arcus Consultancy Services Ltd (Arcus) hereby request an Environmental Impact Assessment (EIA) Screening Opinion from Marine Scotland Licensing Operations Team (MS-LOT) regarding the variation to Condition 1 of the consent for the Levenmouth Demonstration Turbine (the LDT) (previously known as the Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT)). The variation is for an extension in the operational life of the LDT, from five years to 15 years; i.e. an extension of 10 years. There will be no change to any built or physical aspects of the 'as built' LDT.

In line with the requirements of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (the Electricity Works EIA Regulations) and the Marine Works (Environmental Impact Assessment) Regulations 2007 (the Marine Works EIA Regulations) (both as modified by regulation 5 of the Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations 2013), this letter includes:

- A plan which depicts the location of the LDT;
- A description of the nature and purpose of the LDT;
- A statement of working activities (required by the Marine Works EIA Regulations only);
- A description of the sensitivities of the site and the surrounding area; and
- A description of the potential effects.

It is only expected that changes to the original EIA will be experienced where the increase in operational duration leads to an increase in magnitude of effects and/or where the baseline has changed.

The Levenmouth Demonstration Turbine

On 03 May 2013 consent was granted by the Scottish Ministers under Section 36 of the Electricity Act 1989 (as amended) for the construction and operation of a single 7 megawatt (MW) demonstration wind turbine off the East Fife coast at the Fife Energy Park, Methil. The turbine is now operational and measures 196 metres (m) from sea level to blade tip with a rotor diameter of 171 m. The LDT Specification Sheet and a plan showing the location of the LDT are enclosed within this letter for further infromation.

Consent for the LDT was originally granted to Scottish Enterprise, with ownership of the consent being first assigned to Samsung Heavy Industries UK on 22 July 2013 and subsequently assigned to ORE Catapult on 24 November 2015. In conjunction with the Section 36 consent, two Marine Licences were also obtained; one for a 'Marine Renewable Energy Project in the Territorial Sea and UK Controlled Waters adjacent to Scotland' and one for 'Dredging and Deposit of Solid Waste in the Territorial Sea and UK Controlled Waters adjacent to Scotland' as required by the Marine (Scotland) Act 2010.

Variation Sought

A number of conditions were attached to the consent of which, Condition 1 specified the following:

> *"The consent is for a period from the date the consent is granted until the date occurring **5 years** after the Final Commissioning of the turbine. Written confirmation of the date of the Final Commissioning of the turbine must be provided by the Company to the Scottish Ministers, the Planning Authority and Scottish Natural Heritage no later than one calendar month after the Final Commissioning of the Development."*

This application for a variation in regards to the operational lifetime of the turbine proposed the following variation to Condition 1:

> *"The consent is for a period from the date the consent is granted until the date occurring **15 years** after the Final Commissioning of the turbine. Written confirmation of the date of the Final Commissioning of the turbine must be provided by the Company to the Scottish Ministers, the Planning Authority and Scottish Natural Heritage no later than one calendar month after the Final Commissioning of the Development."*

Environmental Impact Assessment

Given that the consented LDT was considered to be a Schedule II EIA Development in terms of the Electricity Works EIA Regulations and the Marine Works EIA Regulations, it can be concluded that by association this variation to the consent will, in turn, require an EIA to be undertaken.

It is proposed that the Environmental Statement (ES) required to support this variation application will take the form of an ES Addendum to the original ES (Arcus, 2012) which supported the Section 36 application. This ES Addendum will provide details of the environmental effects resulting from the variation being sought, it is expected that this will cover the following topics:

- Landscape and visual;
- Noise;
- Ecology (including biodiversity);
- Ornithology;
- Water resources and coastal hydrology;
- Cultural heritage;
- Socio-economics, tourism, land use and commercial fishing;
- Navigation;
- Telecommunications and existing infrastructure;
- Shadow flicker; and

- Miscellaneous issues, including access and transport, climate and carbon balance, and health and safety.

A scoping exercise will be undertaken with MS-LOT, statutory consultees and interested parties to determine which of the aforementioned topics are likely to result in significant environmental effects and will require a full assessment under within the ES Addendum. A Scoping Report will be submitted in due course presenting details of the proposed assessment.

Arcus on behalf of ORE Catapult are therefore seeking formal confirmation from MS-LOT that an EIA is required and that this approach is acceptable.

Your response to this formal request for an EIA Screening Opinion is welcomed within the three week statutory period which will end on 16 February 2017. Should you have any questions, or require any further information, please do get in touch.

Yours sincerely,

Kirsty McGuigan

Senior Environmental Consultant

Enclosed:

- Site Location Plan
- Levenmouth 7MW demonstration offshore wind turbine – Specification sheet

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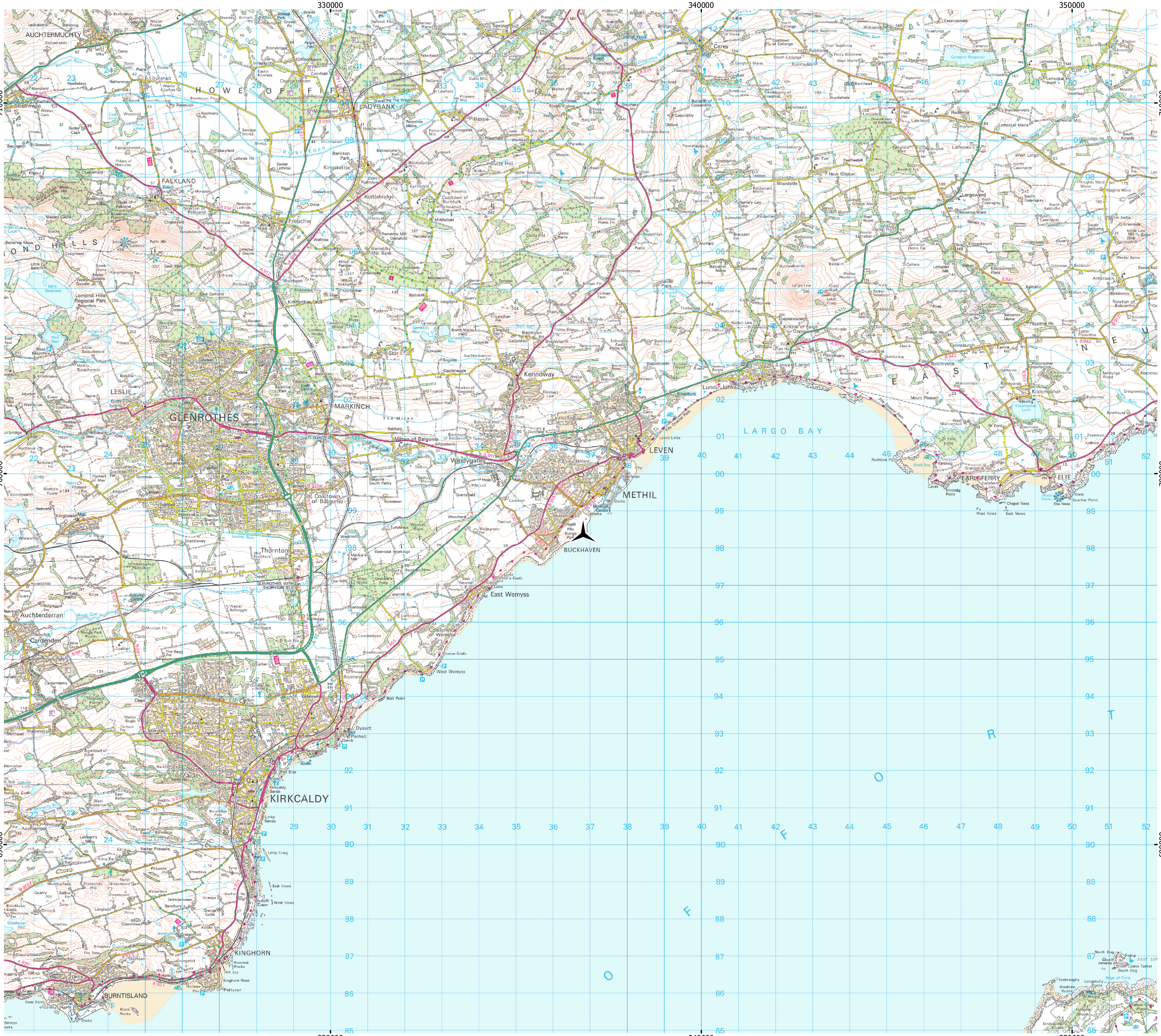


CATAPULT Offshore Renewable Energy

ARCUS

Turbine Location

1:100,000 Scale @ A3

0 | 2.5 | 5 km

N

Produced: LHu
Reviewed: SC
Approved: KMcG

Ref: 2652/REP/001	Revision: A
Date: 20/01/2017	

Site Location

Levenmouth Demonstration Turbine

P:\Projects\2652 Levenmouth Turbine Variation\GIS\Document Files\Reports\Screening Letter\2652_Levenmouth_Site_Location.mxd

Levenmouth 7MW demonstration offshore wind turbine

Specification sheet

ORE Catapult's 7MW demonstration offshore wind turbine, located at Levenmouth in Fife, is the world's most advanced open access offshore wind turbine dedicated to research and product validation. It also offers complementary opportunities for training and development of skills vital for the future of the offshore wind industry.

Features

Wind class
IEC Class I_A/ S_B

Rotor dia.
171.2m

Capacity
7MW at grid side

Hub height
110.6m

Blade length
83.5m

Total height
196m blade tip to sea level

Generator
Medium voltage PMG (3.3kV)

Converter
Full power conversion

Drive train
Medium speed (400rpm)

Rated frequency
50Hz

Rotor speed
5.9 ~ 10.6rpm

Wind speed
3.5 ~ 25m/s

Temp. range
Survival
-20°C to +50°C
Operating
-10°C to +25°C

Lightning protection level
Level 1 (IEC 62305-1)

Corrosion category (ISO 12944-5)
Inside : C4
Outside : C5-M

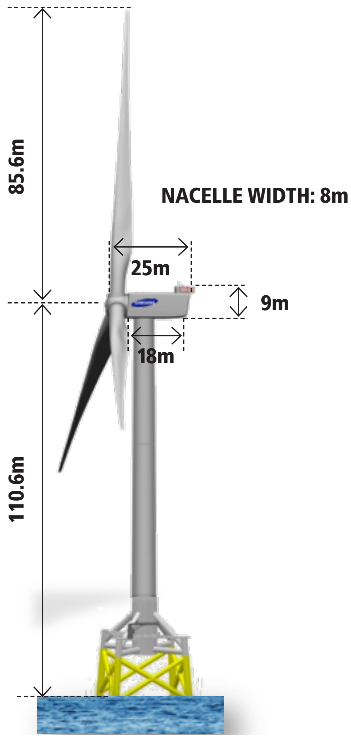
Design life
25 years

Control system features

- Independent and collective pitch control modes
- Active drivetrain damping
- Active load control
- Blade load monitoring

Complementary measurement opportunities

- Access hatches on roof
- Land-side flat locations for lidar installation (including 1 pad with electrical connections)
- On-site IEC met mast with cup anemometry currently installed
- Deck space on transition piece for small instruments



ORE Catapult
Fife Renewables Innovation Centre
Ajax Way, Leven, KY8 3RS

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info@ore.catapult.org.uk
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Service summary

The turbine also provides a broad spectrum of other opportunities to:

- Evaluate environmental conditions, data and/or impact
- Conduct training
- Practice operation & maintenance (O&M) procedures
- Demonstrate remote inspection methods and technologies

The turbine and its onshore met mast offers researchers, developers and manufacturers an excellent opportunity to conduct research and development, introduce new concepts, and carry out product and component validation.

It enables vital testing, verification and validation of remote sensing and other innovative technologies in order to prove reliability, data availability and performance in a next generation offshore wind turbine.

The turbine also provides the opportunity to evaluate real operating conditions against a controlled test programme using the Catapult's 15MW wind turbine nacelle test facility. This will help to improve the quality of tests and better replicate real-life events.

R&D offer

- Product validation of new concepts and technology (including power performance measurements)
- Improve wind resource estimation and standardisation
- Holistic control system development, including control algorithm optimisation
- Prognostic condition monitoring system (CMS) development
- Measurement system development (DAQ, sensors)
- Measure and compare real-life data against a controlled test programme
- Structural mechanics
- Aeroelastic modelling
- Aerodynamic modelling
- Design and analysis tool evaluation

For R&D enquiries email:
research@ore.catapult.org.uk

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APPENDIX 3.2

SCREENING OPINION

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The Scottish Government
Riaghaltas na h-Alba

Kirsty McGuigan
Senior Environmental Consultant
Arcus Consultancy Services Ltd
7th Floor
145 St Vincent Street
Glasgow
G2 5JF

Date: 16th March 2017

Dear Ms McGuigan,

Electricity Act 1989

THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000 (AS AMENDED) (AS MODIFIED BY THE ELECTRICITY GENERATING STATIONS (APPLICATIONS FOR VARIATION OF CONSENT) (SCOTLAND) REGULATIONS 2013)

SCREENING OPINION ON THE REQUEST FOR A VARIATION TO CONDITION 1 OF THE LEVENMOUTH DEMONSTRATION TURBINE SECTION 36 CONSENT

With regard to your letter dated 21st January 2017 relating to your request for a Screening Opinion on the proposed variation to Condition 1 of the Levenmouth Demonstration Turbine section 36 Consent, Marine Scotland Licensing Operations Team (MS-LOT) advises that the screening process is used to determine whether a project requires an EIA. The original application for the Levenmouth Demonstration Turbine fell under the description of an Annex II project, 3(i) as an installation for the harnessing of wind power for energy production (wind farms) as laid down in the codified Directive 2011/92/EU (as amended by Directive 2014/52/EU) on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive'), and an EIA was required. The request for a variation does not change that and the project is still considered to be an EIA project as suggested in your letter. MS-LOT are interpreting this request for a "screening opinion" also as a request whether it is appropriate to consider the proposed changes to the project as a variation under The Electricity Generating Stations (Applications For Variation Of Consent) (Scotland) Regulations 2013, or as a new application.

MS-LOT consider that it is appropriate to consider the application as a variation. In reaching this decision the Scottish Government Energy Consents and Deployment Unit (ECDU) guidance on the variation of Section 36 consent under the Electricity Act 1989 has been used. MS-LOT do not consider that the proposed changes will be fundamentally different in terms of character, scale or environmental impacts from what is authorised by the existing consent. The guidance also states that "*It should generally be possible to consider authorising changes which only affect the operation of an existing station and do not involve construction of a new generating station or extension of an existing one under the section 36 consent variation procedure. This might include changes to the conditions attached to the consent.*"

The Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations came into force on 1 December 2013. These regulations provide a predictable, consistent and transparent process for making, publicising and considering applications to vary section 36 consents. In particular, they provide for the procedure which ensures that the relevant provisions of EIA Directive will be implemented as necessary in relation to applications to vary a section 36 consent in the same way as they are in relation to an application for a section 36 consent.

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The Scottish Government
Riaghaltas na h-Alba

The 2013 Regulations provide (in regulation 5) that the 2000 EIA Regulations apply to applications to vary section 36 consents as they apply to original applications for consent under section 36, with certain modifications. Since most, if not all, developments consented under section 36 are likely to have significant effects on the environment, it is expected that applications to vary section 36 consents will invariably need to be accompanied by some form of environmental statement. The scoping process may be used to identify the scope of the environmental information required to be submitted with the application to vary the section 36 consent.

The application to vary the section 36 consent must describe the whole of the development that it proposes is built and operated once the section 36 consent which the applicant is seeking to vary has been varied. In many cases, subject to any need to update information about environmental impacts, it may be possible for the application to do this by resubmitting documents prepared in support of the original section 36 application which it is now proposed to vary and describing the changes in construction, operation or impacts which are proposed, but it is essential that the application documents give a clear and complete picture of what development would result if the varied consent is implemented.

You may be aware of the forthcoming changes to the EIA regulations, implementing the 2014 amendments to the EIA Directive, due to come into force on the 16th May 2017. The 2014 Directive allows projects where a scoping request is received before 16th May 2017 to be considered under the current regulations (although the exact transitional arrangements will not be known until the regulations are finalised). The new EIA regulations will apply to applications for variations as they apply to new applications for section 36 consents.

Further discussion with MS-LOT will be required regarding a marine licence.

Yours sincerely,

[redacted]

Alan Keir
Marine Scotland Licensing Operations Team

APPENDIX 3.3

SCOPING REPORT

LEVENMOUTH DEMONSTRATION TURBINE
EIA SCOPING REPORT

APRIL 2017

Prepared By:

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TABLE OF CONTENTS

1 INTRODUCTION

This Scoping Report has been prepared by Arcus Consultancy Services Ltd (Arcus) on behalf of Offshore Renewable Energy Catapult (the Applicant). The Applicant is proposing to submit an application for a variation to Condition 1 of the consent for the Levenmouth Demonstration Turbine (the LDT) (previously known as the Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT)). The variation is for an extension in the operational life of the LDT, from five years to 15 years; i.e. an extension of 10 years (the Variation). There will be no change to any built or physical aspects of the 'as built' LDT.

The purpose of this Scoping Report is to outline the potential environmental effects resulting from the Variation. An Environmental Impact Assessment (EIA) was undertaken for the LDT to determine the effects during construction, operation and decommissioning, with the results presented in an Environmental Statement[1] (ES). Further to this, post consent monitoring of the LTD has been undertaken to provide a reference of the realised effects of the LDT. This Scoping Report will therefore make use of the previously undertaken assessment work and post consent monitoring to identify:

- Where the baseline conditions have changed;
- Where impacts may potentially increase the magnitude as a result of the proposed time extension and/or;
- Where elements of the Variation could introduce new effects.

1.1 ORE Catapult

ORE Catapult is the UK's flagship technology innovation and research centre for advancing wind, wave and tidal energy. ORE Catapult operates the largest concentration of open access renewable energy test and demonstration facilities anywhere in the world, with the LDT complementing its existing open access testing facilities in Blyth, Northumberland.

ORE Catapult completed the acquisition of the LDT from Samsung Heavy Industries UK in November 2015. The LDT is the world's most advanced, open access, offshore wind turbine dedicated to research, and offers complementary opportunities for economic growth, training and development of skills vital for the future of the offshore wind industry in Scotland. ORE Catapult is working closely with key academic and industry stakeholders to align the LDT research programme with industry priorities to continue driving down the cost of offshore wind whilst maximising UK Supply Chain opportunities and growing the economic benefits arising from a vibrant Offshore Wind Sector.

2 LEVENMOUTH DEMONSTRATION TURBINE

2.1 Project Background

An ES was submitted to the Scottish Ministers in July 2012 under Section 36 of the Electricity Act 1989[2] (as amended) for the construction and operation of a single 7 megawatt (MW) demonstration wind turbine off the East Fife coast at the Fife Energy Park, Methil. Subsequently, an addendum was submitted to the Scottish Ministers on 03 March 2013 which detailed an increase in the size of boreholes required for the turbine foundation.

Consent was granted by the Scottish Ministers on 03 May 2013 and the turbine is now operational and measures 196 metres (m) from mean sea level to blade tip with a rotor diameter of 171 m.

In addition to the turbine itself, the LTD also comprises of the following elements:

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[1] Arcus (2012) Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT) Environmental Statement

[2] Electricity Act 1989. Available online at: http://www.legislation.gov.uk/ukpga/1989/29/data.pdf [Accessed 09/02/2017]

- A personnel bridge connection between the Fife Energy Park and the turbine tower;
- An onshore crane pad on the Fife Energy Park; and
- An onshore Control compound.

The location and aerial photography of the LDT are shown on Figures 1 and 2 respectively.

Subsequently, an application to vary the operational noise limits as detailed in Condition 13 and Annex 3 of the consent was made to Scottish Ministers on 03 October 2014 and subsequently approved on 23 March 2016.

2.2 Variation Sought

Consent for the LDT was originally granted to Scottish Enterprise, with ownership of the consent being first assigned to Samsung Heavy Industries UK on 22 July 2013 and subsequently assigned to ORE Catapult on 24 November 2015. In conjunction with the Section 36 consent, two Marine Licences were also obtained; one for a 'Marine Renewable Energy Project in the Territorial Sea and UK Controlled Waters adjacent to Scotland' and one for 'Dredging and Deposit of Solid Waste in the Territorial Sea and UK Controlled Waters adjacent to Scotland' as required by the Marine (Scotland) Act 2010[3].

A number of conditions were attached to the consent of which, Condition 1 specified the following:

*"The consent is for a period from the date the consent is granted until the date occurring **5 years** after the Final Commissioning of the turbine. Written confirmation of the date of the Final Commissioning of the turbine must be provided by the Company to the Scottish Ministers, the Planning Authority and Scottish Natural Heritage no later than one calendar month after the Final Commissioning of the Development."*

This application for a variation in regards to the operational lifetime of the turbine proposed the following variation to Condition 1:

*"The consent is for a period from the date the consent is granted until the date occurring **15 years** after the Final Commissioning of the turbine. Written confirmation of the date of the Final Commissioning of the turbine must be provided by the Company to the Scottish Ministers, the Planning Authority and Scottish Natural Heritage no later than one calendar month after the Final Commissioning of the Development."*

3 ENVIRONMENTAL IMPACT ASSESSMENT

The 2011 EIA Directive (2011/92/EU)[4] was transposed into Scottish law through a number of different regulations. In relation to the LDT, the EIA Directive is applied through the following regulations:

- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000[5], as amended by the Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2008[6]; and
- The Marine Works (Environmental Impact Assessment) Regulations 2007[7], as amended by the Marine Works (Environmental Impact Assessment) (Amendment)

[3] The Marine (Scotland) Act 2010. Available online: http://www.legislation.gov.uk/asp/2010/5/contents [online]. Available at: http://www.legislation.gov.uk/asp/2010/5/contents (Accessed on 09/02/2017)

[4] European Parliament and the Council of the European Union (2011) Directive 2011/92/EU [online]. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0092&from=EN (Accessed on 09/02/2017)

[5] The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 [online]. Available at: http://www.legislation.gov.uk/ssi/2000/320/contents/made (Accessed on 09/02/2017)

[6] The Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2008 [online]. Available at: http://www.legislation.gov.uk/ssi/2008/246/contents/made (Accessed on 09/02/2017)

[7] The Marine Works (Environmental Impact Assessment) Regulations 2007 [online]. Available at: http://www.legislation.gov.uk/uksi/2007/1518/made (Accessed 09/02/2017)

Regulations 2011[8] and the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2015[9].

Collectively these regulations are referred to as the 'EIA Regulations' throughout this Scoping Report.

In addition, new regulations came into force on 01 December 2013 which provide for variation applications for Section 36 consents:

- Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations 2013[10].

Given that the consented LDT was considered to be a Schedule II EIA Development in terms of the EIA Regulations, it can be concluded that by association this variation to the consent will, in turn, require an EIA to be undertaken. A screening opinion was issued by Marine Scotland Licencing Operation Team (MS-LOT) on 16 March 2017 formally confirming that an EIA is required and that it is appropriate for the application to be considered as a variation under the 2013 regulations as stated above. MS-LOT also confirmed that whilst updated information regarding the environmental effects must be provided, documents submitted in support of the original application (i.e. the Original ES) can be resubmitted.

This scoping exercise is being undertaken with MS-LOT, statutory consultees and interested parties to determine the scope of the ES Addendum, refining which environmental topics are likely to result in significant environmental effects and will therefore require a full assessment within the ES Addendum.

3.1 2014 EIA Directive

On 12 March 2014, the European Parliament voted to adopt substantive amendments to the 2011 EIA Directive (2011/92/EU), thereby superseding this directive. The United Kingdom (UK) has until the 16 May 2017 to transpose the amendments made by the 2014 EIA Directive (2014/52/EU)[11] (the new EIA Directive) into UK legislation.

It is Arcus' understanding that there is no formal need to incorporate the new EIA Directive requirements if key aspects of the EIA have been commenced prior to the issuance of the new EIA Regulations; i.e. screening and scoping. However, consideration has been given to additional environmental topics noted within the new EIA Directive to ensure that a fully robust analysis of the LTD is undertaken.

3.2 ES Addendum

In line with the MS-LOT scoping opinion, it is proposed that an ES Addendum to the Original ES will be produced to support the variation application. The ES Addendum will provide details of the environmental effects resulting from the variation being sought.

3.2.1 Structure and Content

The structure of the ES Addendum will follow the specifications detailed within Schedule 4 of the EIA Regulations. The ES Addendum will consist of a single report with a non-technical summary and will be supported by figures and further technical reports as required.

[8] The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011 [online]. Available at: http://www.legislation.gov.uk/uksi/2011/735/made (Accessed 09/02/2017)

[9] The Marine Works (Environmental Impact Assessment (Amendment) Regulations 2015 [online]. Available at: http://www.legislation.gov.uk/uksi/2015/446/pdfs/uksi_20150446_en.pdf (Accessed 09/02/2017)

[10] The Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations 2013 [online]. Available at: http://www.legislation.gov.uk/ssi/2013/304/contents/made (Accessed 09/02/2017)

[11] European Parliament and the Council of the European Union (2014) Directive 2014/52/EU) [online]. Available at: http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0052 (Accessed on 15/02/2017)

The front end of the ES Addendum will include:

- An introduction, including a summary of the EIA process and methodology;
- Description of the site and its surroundings; and
- A summary of the relevant planning policy and environmental context.

The technical chapters of the ES Addendum will present details of the assessments undertaken, including any cumulative effects, required mitigation and residual effects.

4 POLICY AND LEGISLATIVE CONTEXT

The ES Addendum will provide a review of the policy and legislation identified within the Original ES and, where necessary, update and assess the local, regional and national policies relevant to renewable energy projects in Scotland. This section of the Scoping Report provides an overview of the previous considerations and any identified changes in the policy and legislative context since the Original ES was submitted.

4.1 Assessment Summary

The Original ES assessed the planning and legislative framework relevant to the Development at the time of writing, and consisted of several key elements surmised in the sections below.

4.1.1 Statutory Development Plan

When the Original ES was submitted in July 2012 the statutory Development Plan consisted of:

- Fife Structure Plan (2006 - 2026)[12]; and
- Mid Fife Local Plan[13] (adopted 23 January 2012).

The Development Plan assessed within the Original ES outlined a range of policies considered supportive to renewable energy developments, including Structure Plan **Policy R1: Wind Turbines**, and Mid Fife Local Plan **Policies MET14: Energy Park, Fife**, **I1: Renewable Energy**, and **E3: Development Quality - Environmental Impact**.

The Fife Structure Plan has since been superseded by SESPlan[14] (Section 4.2.1.1) whist the Mid Fife Local Plan is due to be superseded by FIFEplan[15] imminently.

4.1.2 Fife Supplementary Planning Guidance: Wind Energy (June 2011 Revision)

Fife Supplementary Planning Guidance Wind Energy[16], **Policy R3: Offshore Activities** outlined the Councils support of offshore renewable wind energy developments, provided that the proposed development would have no significant adverse effect on a range of activities.

4.1.3 Material Considerations

In addition to the Development Plan and key supplementary planning guidance, a range of material considerations were evaluated within the Original ES to assess the national and

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[12] Fife Council (2009). Fife Structure Plan 2006 - 2026. Available online: http://www.communityplanningtoolkit.org/sites/default/files/AlignmentR18.pdf [Accessed 07/02/2017]

[13] Fife Council (2012). Mid Fife Local Plan [online]. Available at: http://fife-consult.objective.co.uk/portal/local_view_fusion/mid_fife_local_plan/mflp (Accessed 07/02/2017)

[14] SES Plan Strategic Development Plan (2013) [online]. Available at: http://www.sesplan.gov.uk/about-sesplan.php (Accessed on 14/02/2017)

[15] Fife Council (2014). Fife Local Development Plan – Proposed Plan (FIFEplan) [online]. Available at: https://www.fifedirect.org.uk/topics/index.cfm?fuseaction=page.display&p2sid=D61AC1F5-DD4B-CE6A-51E3BDDED79D5ABC&themeid=2B482E89-1CC4-E06A-52FBA69F838F4D24 (Accessed on 14/02/2017)

[16] Fife Council (2011). Wind Energy Supplementary Planning Guidance: Wind Energy [online]. Available at: http://admin.1fife.org.uk/uploadfiles/publications/c64_Item08-combined6.pdf (Accessed on 14/02/2017)

regional considerations pursuant to renewable energy developments. Material considerations included the 2020 Routemap for Renewable Energy in Scotland[17], A Low Carbon Economic Strategy for Scotland[18], the Climate Change (Scotland) Act 2009[19], the Marine (Scotland) Act 2010[3], Scottish Planning Policy[20], and the Blue Seas - Green Energy Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters[21].

4.2 Changes since 2012

The sections below identify and summarise the key policy framework expected to be fully assessed within the forthcoming ES Addendum.

4.2.1 Statutory Development Plan

The Statutory Development Plan at present consists of:

- SESplan Strategic Development Plan (adopted 27 June 2013); and
- Mid Fife Local Plan (adopted 23 January 2012).

The Development Plan is described in further detail below.

4.2.1.1 Strategic Development Plan (SESPlan)

SESPlan[14] is a Strategic Development Plan prepared by six member authorities to set parameters for Local Development Plans and provide an overarching vision to guide development within the region. SESPlan was approved on the 27 of June 2013 and covers a city-region area that includes southern Fife.

Of particular relevance to the LDT is **Policy 10: Sustainable Energy Technologies** which sets out a requirement for Local Authorities to set frameworks encouraging the development of renewable energy proposals that contribute to achieving national targets.

SESPlan will be fully considered within the ES Addendum.

4.2.1.2 Mid Fife Local Plan

At the time of publication the aim of the Mid Fife Local Plan was to complement the Mid Fife Structure Plan and provide detailed policies and proposals which guide development up until 2021. At the time of writing the Mid Fife Local Plan is due to be superseded by FIFEplan[15] when it is adopted in 2017, and further information regarding FIFEplan is provided in Section 4.2.3.1 of this submission.

The Mid Fife Local Plan was fully assessed within the Original ES, however it is likely that the ES Addendum will instead assess FIFEplan on the basis that this Local Development Plan is due to be adopted imminently and will replace the Mid Fife Local Plan.

4.2.2 Wind Energy Planning Supplementary Guidance[16] (June 2013 Revision)

Published in June 2013, this revised spatial framework sets out planning policy and guidance to inform renewable energy development proposals within Fife. The guidance sets out the wind turbine constraints within Fife, broad areas of search for onshore wind, and the key environmental constraints. This document also sets out the importance of the

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[17] The Scottish Government (2015). 2020 Routemap for Renewable Energy in Scotland – Update 2015 [online]. Available at: http://www.gov.scot/Resource/0048/00485407.pdf (Accessed on 14/02/2017)

[18] The Scottish Government (2010). A Low Carbon Economic Strategy for Scotland [online]. Available at: http://www.gov.scot/resource/doc/331364/0107855.pdf (Accessed on 14/02/2017)

[19] The Scottish Government (2009). Climate Change (Scotland) Act 2009 [online]. Available at: http://www.gov.scot/Topics/Environment/climatechange/scotlands-action/climatechangeact (Accessed on 14/02/2017)

[20] The Scottish Government (2014) Scottish Planning Policy [online]. Available at: http://www.gov.scot/Publications/2014/06/5823 (Accessed on 08/02/2017)

[21] The Scottish Government (2011). Blue Seas – Green Energy. A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters [online]. Available at: http://www.gov.scot/resource/doc/346375/0115264.pdf (Accessed on 14/02/2017)

Fife region with regards to demonstrator offshore wind turbines. This document will be fully assessed within the ES Addendum.

4.2.3 Emerging Guidance

4.2.3.1 FIFEplan Local Development Plan

FIFEplan is a new single Local Development Plan (LDP) which, once adopted, will replace the three existing Local Plans for the Fife region (superseding the Mid Fife Local Plan). An examination report[22] has been published by the Scottish Government's Planning and Environmental Appeals Division, and following consideration this is due to be reported to the Fife Council Executive Committee meeting on 28 February 2017. Adoption of FIFEplan is expected to occur shortly afterwards, and the document will be considered in preparation of the ES Addendum.

The policies and guidance contained within FIFEplan will shape development within Fife over the next 10 years, and a range of policies outlined within the draft LDP are considered relevant to the Development. These may include (however are not limited to) draft **Policy 1: Development Principles** (in particular respect of site specific designation of a safeguarded employment area), draft **Policy 5: Employment Land and Property**, and draft **Policy 11 Low Carbon Fife**.

Consideration is also expected to be provided to the spatial framework for wind turbines and the landscape capacity and cumulative thresholds for wind turbines, as indicated within FIFEplan.

4.2.3.2 Proposed SESplan

Consultation on the SESplan's Proposed Strategic Development Plan closed on the 24 November 2016, with a report outlining consultation responses expected in 2017 before approval of the plan in 2018.

4.2.4 Material Considerations

Many of the material considerations defined within Section 4.1.3 were assessed within the Original ES are still considered relevant to the ES Addendum, and will be assessed in full during the analysis and preparation of this document. As well as providing an overview of national planning policy, legislative guidance supporting the LDT will also be assessed, to provide an overview on the national planning policy context and ongoing support for renewable energy developments. National and international guidance outlining support for reductions in carbon emissions, support for climate change agendas, and energy diversification will also be assessed within the ES Addendum.

4.3 Supporting Statement

Arcus will produce a Supporting Statement which will accompany the ES Addendum. This document will assess the Variation against the relevant policies and material considerations outlined within the ES Addendum. The Supporting Statement will present details of the Variation and a case for why it is required.

4.4 Summary

In summary, there have been several changes to the planning and legislative policy assessed within the Original ES, notably a new Strategic Development Plan and a forthcoming Local Development Plan.

[22] Fife Council (2016). FIFEplan Examination Report [online]. Available at: https://fifedirect.org.uk/publications/index.cfm?fuseaction=publication.pop&pubid=A3587022-A880-0B10-E0587384F4F201F8 (Accessed on 14/02/2017)

The ES Addendum will be assessed against relevant planning policies contained within the statutory Development Plan and associated guidance at the time of submission, with detailed descriptions of relevant policy included within the ES Addendum. Arcus will continue to monitor the progress of the emerging LDP and SESPlan, and the ES Addendum will be written in-line with the appropriate up-to-date policy considerations.

5 TOPICS TO BE SCOPED OUT

The purpose of the Scoping Report is to ensure that the EIA focuses on those issues which are likely to give rise to significant environmental effects and to scope out those aspects that will not. As there is no physical change proposed to LDT, which is already operational, there are limited technical areas where the extension to the operational life of the LDT are likely to introduce new impacts.

Arcus undertook all of the technical assessments for the Original ES with the exception of Landscape and Visual which was undertaken by RV Design. Based on our detailed knowledge of the LDT and a review of previous work, it is expected that the topics which can be scoped out will include:

- Noise;
- Water resources and coastal hydrology;
- Cultural heritage;
- Tourism, land use and commercial fisheries;
- Navigation;
- Telecommunications and existing infrastructure;
- Shadow flicker;
- Access and traffic;
- Human health; and
- Health and safety.

Further details on each of these technical areas are given below and include a brief summary of the assessment contained within the Original ES and details any work carried out post consent.

5.1 Noise

Sources of noise during operation of a wind turbine are mechanical (from machinery housed within the turbine nacelle) and aerodynamic (from the movement of the blades through the air). Modern turbines are designed to minimise mechanical noise emissions from the nacelle through isolation of mechanical components and acoustic insulation of the nacelle. Aerodynamic noise is controlled through the design of the blade tips and edges. In most modern wind turbines, aerodynamic noise is also restricted by control systems which actively regulate the pitch of the blades.

Whilst noise from wind turbines does increase with wind speed, at the same time ambient background noise (for example wind in trees) usually increases at a greater rate. Planning conditions are used to enforce compliance with specified noise limits.

5.1.1 Assessment Summary

Baseline background noise levels at three representative noise-sensitive receptors located closest to the LDT were measured as part of the Original ES. Based upon the noise limits derived in accordance with ETSU-R-97[23], maximum permissible turbine noise emissions levels which would ensure compliance with the requirements of ETSU-R-97 were established (see Table 1).

[23] ETSU for the DTI (1996) ETSU-R-97: The Assessment and Rating of Noise from Wind Farms.

Table 1: Derived Noise Limits

Location	Period	1	2	3	4	5	6	7	8	9	10	11	12
		Standardised 10 m Wind Speed, metres per second (ms^{-1})											
		Noise Limit, dB, $L_{A90,10min}$											
1	Day	44.0	44.0	44.0	44.0	44.1	44.8	46.3	48.8	48.8	48.8	48.8	48.8
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.5	47.2	49.9	51.6	51.2	51.2
2	Day	40.5	41.4	41.5	41.3	41.5	42.7	45.1	47.9	47.9	47.9	47.9	47.9
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.7	49.1	49.9	49.9
3	Day	38.9	38.9	38.9	38.9	38.9	38.9	41.2	44.1	44.1	44.1	44.1	44.1
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	46.0	46.0	46.0

Whilst the turbine noise emissions could not be confirmed at the time of writing of the Original ES, compliance with the maximum permissible noise emission levels would be achieved with a range of commercially available offshore wind turbines of a scale similar to that proposed.

In the event that noise emissions from the turbine results in a breach of noise limits or constitutes a statutory nuisance, the Applicant is committed to complying with any noise requirements imposed on the LDT. Therefore, based upon the noise limits derived in accordance with ETSU-R-97 and the control measures identified in order to ensure compliance, the effects of noise from operation of the turbine were considered to be not significant.

5.1.2 Changes since 2012

Since the Original ES, the following guidance and information sources have been updated:

- The Scottish Government's web-based planning information on onshore wind turbines was revised in December 2013[24]; and
- Bowdler et al. (2009) 'Prediction and Assessment of Wind Turbine Noise' has been replaced by 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'[25].

These changes in guidance will not affect the assessment detailed in the Original ES.

5.1.3 Post Consent Work

In October 2014, an application to vary the consent under Section 36C of the Electricity Act 1989 was submitted to MS-LOT. The variation proposed to revise the maximum permissible noise limits set out in Condition 13 and Annex 3 of the Section 36 consent. Following the production of the Operational Noise Assessment in May 2014 to enable the discharge of Condition 13, it was found that under certain conditions noise from the operation of the turbine, was greater than the limits detailed within Annex 3 of Condition 13. It was also found that background noise levels recorded in 2014 were significantly higher than those recorded as part of the Original ES. It was therefore proposed to remove the tabulated noise limits as set out in Annex 3 so that revised noise limits which relate directly to background noise levels at the time of any noise compliance monitoring are

[24] The Scottish Government (2013) [online] Onshore Wind Turbines http://www.gov.scot/Resource/0044/00440315.pdf (Accessed on 07/02/2017)

[25] Institute of Acoustics (2013) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise.

utilised. This variation set out the following requirements in relation to operational noise from the LDT:

'At standardised 10 m wind speeds not exceeding 12 ms^{-1}, the rating level of noise emissions (measured as LA90,10 min) from the wind turbine, when measured at any dwelling in existence prior to the installation of the Development or at any dwelling which has been given planning permission prior to such installation, shall not exceed:

• The greater of 35 dB(A) or 5 dB above the prevailing background noise (LA90,10 min) between the hours of 07:00-23:00; and

• The greater of 43 dB(A) or 5 dB above the prevailing background noise (LA90,10 min) between the hours of 23:00-07:00.

Noise monitoring for compliance purposes must be undertaken by the Company in the event of a reasonable complaint of noise due to the operation of the wind turbine either from a member of the public, or in the event of the Local Authority having reasonable and justifiable grounds for believing that the wind turbine is likely to be in breach of noise limits.'

This application was subsequently approved in March 2016.

As part of the discharge of condition process, a Project Environmental Monitoring Programme (PEMP) was required detailing the requirements for monitoring and, where appropriate, agreed mitigation of the potential noise effects. Under the PEMP, the Applicant is required to undertake operational monitoring to ensure the turbine does not exceed the limits set out in the Original ES. Since 2014, noise monitoring during the operation of the turbine has been carried out and reported to MS-LOT. Based on the data recorded during the operational noise monitoring carried out to date, the turbine is shut down under wind speeds and wind directions when measurements suggest turbine noise levels may exceed consented noise limits.

5.1.4 Conclusion

As there are no physical changes proposed to the LDT, no significant effects are predicted and thus it is proposed that this topic will not be considered further. Under the requirements of the PEMP, the Applicant will continue to monitor operational noise from the LDT and operate within the agreed noise limits. In order to ensure compliance with these limits, the LDT is shut down under certain wind speeds and directions.

5.2 Ecology

Detailed baseline ecology studies, for both the marine and terrestrial environment, were undertaken to inform the application for the original consent. These included both desk studies and field surveys, with baseline data feeding into ecological impact assessment (EcIA) undertaken as part of the wider EIA.

During previous consultation (June, 2013), SNH did not provide detailed comment on terrestrial or marine ecology aspects, with provision of a general statement confirming that the post-consent documentation is well-presented and demonstrates that most previous (SNH) advice has been understood and adopted[26].

Marine Scotland Science (MSS) provided comment on the marine ecology aspects, particularly the pre-construction benthic habitat survey[27]. MSS noted that no conclusions or recommendations were presented with regards to the possible impacts on the benthos

[26] SNH, 2013. Consultation response 'Fife Energy Park Offshore Demonstrator Wind Turbine (FEPODWT). Post-consent documentation', 19th June 2013. Dr Chris Leakey, Marine Renewable Energy Casework Adviser. SNH Ref: CNS REN OSWF DS Methil CLC123612

[27] Marine Scotland Science, 2013. Consultation response 'Scottish Enterprise and Arcus: Offshore Wind Turbine - Fife Energy Park Decommissioning Plan - Marine Scotland Science Comments, 20th June 2014. Paul Stainer, Marine Scotland Science

present in the area and suggested that post development/decommissioning surveys might be useful. On the basis of the pre-construction benthic ecology survey results from 2012, these comments are addressed below in Section 5.2.1.1.

5.2.1 Assessment Summary

5.2.1.1 Designated Sites

The LDT is located within the Firth of Forth Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar site, however no notified ecology features (i.e. terrestrial or marine habitats) of the designated sites are located within the footprint or surrounding environment of the LDT. As a result of this, no direct effects on these designated sites were predicted as a result of the construction, operation or decommissioning of the LDT.

5.2.1.2 Terrestrial Ecology

Construction of the LDT resulted in the direct loss of approximately 3 ha of terrestrial habitat comprising bare ground. Due to the negligible ecological value of this habitat and negligible value of habitat loss, this impact was assessed as not significant.

No operational impacts on terrestrial habitats were predicted from the operational phase of the LDT.

Construction of the LDT was considered to have effects of localised disturbance and habitats loss to otters present in the wider area. As the value of affected habitats to otters was considered negligible, effects of habitat disturbance and loss to otter were assessed as not significant.

No effects on otter were predicted as a result of the operational phase of the LDT.

5.2.1.3 Marine Ecology

Construction of the LDT required the drilling of supporting piles within rocky intertidal habitats (comprising bare rock) to support the access bridge, resulting in localised habitat loss. Due to the negligible ecological value of the intertidal habitats and negligible value of the habitat loss, this impact was assessed as not significant.

Removal of 850 square metres (m^2) subtidal habitats (comprising cobbles and boulders) was required as part of the seabed preparation for installation of the turbine foundation. Removal of this habitat was considered to have a temporary effect on the local subtidal ecology, with full recovery of subtidal habitats and associated benthic fauna expected over time. Permanent loss of approximately 12 m^2 of subtidal habitat resulted from construction of the turbine foundation. Due to the negligible ecological value of the subtidal habitats and negligible value of the habitat losses (both temporary and permanent), this impact was assessed as not significant.

Construction of the LDT was predicted to result in low levels of noise emissions, particularly for the drilling and grouting of supporting piles in both intertidal and subtidal habitats. The potential for disturbance to marine mammals through increased underwater noise (should they be present at the time of works) was predicted as negative, unlikely and temporary. Due to the high level of legal protection and sensitivity of marine mammal species to underwater noise, embedded mitigation to minimise the risk of accidental disturbance to marine mammals was required during the construction phase (as a commitment of the Original ES). Due to the low likelihood, localised and temporary effects of disturbance to marine mammal species from noise, this construction phase impact was assessed as not significant.

During operation of the LDT, the potential for accidental disturbance to marine mammals from operational noise and vibration associated with turbine rotation was identified. This effect was considered to be negative, unlikely and long-term. Due to the low magnitude and low likelihood of this effect, the impact of operational disturbance to marine mammals was assessed as not significant.

Overall the potential effects of the LDT on ecological interests, both terrestrial and marine, were assessed as not significant. Similarly no significant cumulative effects were identified.

5.2.2 Changes since 2012

5.2.2.1 Changes in the Ecological Baseline

No changes to the terrestrial ecology baseline are expected.

Following construction of the LDT foundation and supporting piles within the subtidal and intertidal environments, it is considered likely that localised changes in marine ecology, particularly the benthic habitats and communities, may have taken place. This is considered likely due to the availability of new intertidal and subtidal structures, offering opportunities for new and ecologically beneficial establishment (and in disturbed areas, recovery) of marine benthos. The presence of new structures in the intertidal zone may have also resulted in localised changes in coastal processes, with the potential for creation of a limited area of shelter, resulting in aggregation of marine biota. Such changes are anticipated to be of a minor magnitude, positive and very localised in nature, due to the size, scale and location of the LDT.

Localised changes in marine benthic communities may also have indirect effects to associated marine species, including fish and sea birds (also likely to be of a minor magnitude and localised scale). These effects may be of an extremely localised and minor magnitude and therefore unmeasurable.

5.2.2.2 Changes in Guidance

Since the assessment was undertaken in 2012, there have been changes to the guidelines for EcIA, with new guidance from the Chartered Institute of Ecology and Environmental Management (CIEEM) issued in 2016[28]. Should these updated guidelines be applied to the assessment, the EcIA methodology would change, however the outcome of the impact assessment and significance of predicted impacts would likely remain the same; due to the negligible ecological value of habitats, negligible magnitude of effects, and low likelihood of impact to protected species, including otter and marine mammals.

5.2.3 Post Consent Work

During construction a Marine Mammal Observer undertook visual watches for marine mammals during the installation of the turbine base. During the nine week construction period 44 marine mammal sightings were recorded within the 500 m mitigation zone. This included 15 bottlenose dolphins (three sighting events), 40 pinnipeds (each an individual sighting event) which were likely grey seals, and one record of an individual dolphin sighted on 27th June 2013 (identification to species level was not possible as the sighting was brief).

Based on observations of behavioural responses, grey seals did not seem to be affected by any source activity whereas bottlenose dolphins appeared to have moved to a different location after the first sightings, during the construction period.

No other post consent or operational surveys have been carried out for either terrestrial or marine ecology.

[28] CIEEM, 2016. Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd Edition. Chartered Institute of Ecology and Environmental Management, Winchester.

5.2.4 Conclusion

Continued operation of the LDT is not anticipated to have any effects to designated sites or terrestrial ecology aspects (i.e. terrestrial habitats and (non-avian) species). No significant effects are predicted and therefore these elements can be scoped out.

As highlighted above in Section 5.2.2.1, it is considered likely that localised changes in marine ecology may have occurred as a result of the construction and presence of the LDT structures in intertidal and subtidal environments. The precise nature of changes to marine habitats and benthos is unknown; however it is considered that any changes in the baseline are likely to be of a minor magnitude and localised scale, potentially with beneficial effects for marine epifauna and associated species. Therefore it is proposed to scope ecology out of the ES Addendum.

5.3 Ornithology

The aim of ornithological assessments is to consider the likely use of the development site by sensitive bird species and evaluate the potential for habitat loss, disturbance, displacement and collision with the LDT.

5.3.1 Previous Assessment Summary

An assessment of the potential effects from the LDT on ornithological resources was undertaken by Arcus in 2012 as part of the Original ES. Bird species associated with the Firth of Forth SPA, SSSI and Ramsar site were identified as valuable ecological receptors and thus subject to assessment following discussions with SNH and MSS. As a result of this, the Original ES considered the following effects:

- Disturbance and displacement caused by the presence of the LDT and turbine maintenance;
- Obstruction to bird flight paths through the area, increasing energy expenditure or disturbance through avoidance behaviour; and
- Collision risk resulting in injury or death as a result of birds coming into contact with the operational turbine.

The assessment concluded that effects on birds during construction, operation and decommissioning would be not significant.

5.3.2 Changes since 2012

SNH guidance to inform the impact assessment of onshore windfarms[29] has been updated since the original baseline surveys were completed. These changes included a greater emphasis on consultation during the survey work, and the likely requirement for two years of survey.

In addition, since the original assessment was undertaken in 2012, there have been changes to the guidelines for EcIA, with new guidance from the Chartered Institute of Ecology and Environmental Management (CIEEM) issued in 2016[30].

Whilst application of these updated guidelines would alter the EcIA methodology and terminology used, the outcome of the assessment and significance of predicted impacts would likely remain the same.

[29] Prevailing guidance as of February 2017: SNH (2014) Recommended bird survey methods to inform impact assessment of onshore wind farms. Scottish Natural Heritage, 2014.

[30] CIEEM, 2016. Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd Edition. Chartered Institute of Ecology and Environmental Management, Winchester.

5.3.3 Post-consent Work

Following a review of the bird survey methodology used during the pre-construction and construction surveys (July 2013–October 2013) updates were made to the format of data to be collected during subsequent operational bird monitoring surveys to better assess birds interactions with the LDT. The bird survey methods were altered in agreement with SNH and MSS via Marine Scotland Licensing Operations Team (MS-LOT). All three years of operational monitoring data have been collected using the same methods and it is also noted that changes to the methodology should not affect the ability to draw comparisons between the baseline and operational monitoring data.

A PEMP[31] was produced in November 2013 to comply with the requirements set out in Condition 11 of the consent. The PEMP detailed the methodology for monitoring and a protocol for mitigation measures associated with various environmental and ecological aspects, including birds, during Years 1–3 and Year 5 of operation. In accordance with Condition 12 of the consent, the PEMP[32] was subsequently updated in June 2016 to include the findings of survey results.

In line with the requirements of the PEMP, operational monitoring began, following commissioning of the turbine in April 2014. Surveys have been completed in Year 1 (2014/15) and Year 2 (2015/16) of operation; Year 3 (2016/17) is currently underway (due for completion in March 2017) and Year 5 surveys are currently proposed to take place in 2018/19; no surveys are required in Year 4. The monitoring surveys consist of:

- Flight Activity Surveys: consisting of 12 hours of observations per month from a single Vantage Point (VP) location; and,
- Hourly Activity Summary Surveys: consisting of an hourly census of all perched birds and those on the water within the survey area.

A summary of Year 1 and 2 results is presented below:

- No collisions with the LDT have been observed.
- During both years of survey, few flights were recorded within the nearshore area or distance band including the LDT. Most flights were observed beyond the LDT and below rotor-swept height (RSH).
- Avoidance behaviour was observed in a small number of recorded flights (1.8 % of flights in Year 1 and 1.6 % in Year 2).
- During both years of survey, 18 species were recorded during the hourly activity summaries. Species diversity was broadly similar across the years although numbers of observations and flock sizes varied.

These results indicate that no significant effects have resulted from the presence and operation of the LDT.

5.3.4 Conclusion

As no physical changes are proposed to the LDT as built, the construction and decommissioning effects remain unchanged and therefore will not be considered in the ES Addendum.

Based on the previous assessment and preliminary analysis of the operational monitoring results, it is anticipated that operational impacts on ornithological resources will not be significant and therefore it is also proposed to scope out an assessment of the operational effects.

This approach will be confirmed following detailed analysis of the monitoring data undertaken at the LDT. Should the detailed analysis identify any significant effects, an

[31] Arcus (2013) Fife Energy Park Offshore Demonstration Wind Turbine: Project Environmental Monitoring Programme

[32] Arcus (2016) Fife Energy Park Offshore Demonstration Wind Turbine: Project Environmental Monitoring Programme. v6.2

assessment of the operational effect of the LDT will be included in the ES Addendum, the approach of which would be agreed in advance with MSS and SNH.

5.4 Water Resources and Coastal Hydrology

The development of an offshore turbine has the potential to impact water resources and coastal hydrology, including altering sedimentation, erosion and current flow processes and the accidental release of chemical pollutants.

5.4.1 Assessment Summary

An assessment of potential effects from the LDT on water resources and coastal hydrology resources was undertaken by Arcus in 2012. All potential effects were assessed as being of minor or negligible significance and are therefore not significant in terms of the EIA Regulations.

5.4.2 Changes since 2012

Since the submission of the Original ES in 2012, the following changes to guidance and legislation have occurred:

- Scottish Planning Policy (SPP)[20] was published in 2014, and replaces the previous SPP (published in 2010). Paragraphs 255 to 268 of the SPP set out guidance for development within areas of flood risk (including areas at risk from sea level rises), including the responsibilities of planning authorities in regulating and controlling development in such areas, in order to prevent increased risk of flooding in the future and to ensure that the development can operate without being affected by flooding. The SPP emphasises the need to apply sustainability principles to the prevention of flooding and the control of future development. Whilst SPP 2010 has been superseded the content of SPP 2014 does not change how the LDT is assessed.
- Pollution Prevention Guidance (PPG) 14: Marinas and Craft has been revoked by the Scottish Environment Protection Agency (SEPA). This guidance document was primarily used to inform the construction phase of the LDT. As such, the revocation does not impact upon the Variation to extend the operational phase of the LDT.
- Planning Advice Note (PAN) 69: Planning and Building Standards Advice on Flooding has been superseded by the Scottish Government Online Planning Advice on Flood Risk[33]. The information within the Online Planning Advice on Flood Risk does not change the requirements for the assessment of flood risk or the assessment undertaken in 2012.
- The Construction Industry Research and Information Association (CIRIA) Environmental Good Practice on Site (C692) (2010) has been superseded by Environmental Good Practice on Site (C741) (2015)[34]. This guidance document was primarily used to inform the construction phase of the LDT. As such, the revocation does not impact upon the Variation to extend the operational phase of the LDT.

Since the submission of the Original ES in 2012, the following baseline conditions changed:

- The Highest Astronomical Tide (HAT)[35] for Leith (nearest monitored port to the LDT), has increased by 0.04 m Above Ordnance datum (AOD) compared to the value reported in the Original ES. Given that no electrically sensitive equipment is located under 3.34 m AOD, it is considered that the minimal increase in HAT will not change the conclusion of the Original ES and that reassessment is not required.

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33 The Scottish Government (2015) Online Planning Advice on Flood Risk [online]. Available at: http://www.gov.scot/Resource/0047/00479774.pdf (Accessed on 14/02/2017)

34 Edwards, C.P (eds) (2015). Environmental Good Practice on Site Guide (Fourth Edition) (C741).

35 Highest Astronomical Tide: National Oceanography Centre (2017). Highest and Lowest Predicted Tides at Leith [online]. Available at: http://www.ntslf.org/tides/hilo?port=Leith (Accessed on 14/02/2017)

- The SEPA Flood maps[36] have been updated since the submission of the Original ES. The Original ES identified areas adjacent the LDT as being at risk of flooding from coastal sources. The areas of flood risk identified in the Original ES are representative of the areas identified on the updated SEPA Flood map published in 2014. As such, it is considered that these changes would not impact upon the conclusions reached within the Original ES.

As the baseline conditions have not significantly changed since the submission of the Original ES, it is considered that the Variation will have no significant effects on water resources and coastal hydrology and therefore there is no requirement for further assessment. Thus it is proposed that this topic is scoped out of the ES Addendum.

5.4.3 Post Consent Work

Water quality monitoring was undertaken by the Contractor to ensure that the hydrological environment was safeguarded during the construction phase of the LDT. The results of this monitoring was detailed in Surface and Coastal Water Management Plan (SCWMP).

5.4.4 Conclusion

As the LDT will not involve physical alterations to the existing infrastructure, there will be no changes to the assessment of effects undertaken in 2012. All potential effects were assessed as being of minor or negligible significance and are therefore not significant in terms of the EIA Regulations.

As such, it is considered that water resources and coastal hydrology resources can be scoped out of the ES Addendum.

5.5 Cultural Heritage

Cultural heritage, in this context means the above and below ground archaeological resource, built heritage, the historic landscape and any other elements which may contribute to the historical and cultural heritage of the area.

5.5.1 Assessment Summary

No significant direct effects were predicted as part of the previous assessment for the Original ES as there are no known archaeological features within the site, nor was there considered to be any potential for any unknown remains to exist and therefore no mitigation was proposed.

In addition, no significant effects were predicted to occur to the setting of any cultural heritage assets arising from the construction, operation or decommissioning of the LDT. Although a number of not significant effects (i.e. of minor or negligible significance) were identified, these were considered temporary and fully reversible upon the decommissioning of the LDT.

5.5.2 Changes since 2012

Since the Original ES, the following legislation have been introduced or updated:

- SPP[20] was updated in 2014 and sets out how nationally important land use planning matters should be addressed. Paragraphs 135 - 151 sets out the process for dealing with all types of historic environment assets within the planning framework.

[36] SEPA (2014) Flood Maps. [online]. Available at: https://www.sepa.org.uk/environment/water/flooding/flood-maps/ (Accessed on 14/02/2017)

- The Historic Environment Scotland Act 2014[37] sets out Historic Environment Scotland's (formerly Historic Scotland) role and legal status, including changes in processes for the designation of monuments and buildings. This Act establishes Historic Environment Scotland (HES) as a new Non-Department Public Body which will take over the functions of Historic Scotland (HS) and the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS).
- The Town and Country Planning (Historic Environment Scotland) Amendment Regulations 2015 amends legislation on EIA, development planning and development procedures to reflect the formation of HES. This amendment will not impact the original assessment.

In addition, the HES Policy Statement was updated in 2016[38] and which replaces the Scottish Historic Environmental Policy[39]. This policy statement sets out how HES fulfils its regulatory and advisory roles and how it expects others to interpret and implement SPP.

Furthermore, a review of publicly available datasets indicates that, since 2012, there is one new listed building located approximately 1.9 km to north of the LDT:

- Former Innerleven East Church, Den Walk, Methil (excluding later hall addition to rear), designated as Category B on the 19 March 2013 (LB52337)[40].

The Former Innerleven East Church is an example of a transitional, proto-modern church of the inter-war period in Scotland and was one of the first commissions by renowned Scottish architect, Alexander Esmé Gordon. Although this building is predicted to lie within the Zone of Theoretical Visibility (ZTV), it is considered that there will not be significant intervisibility of the LDT due to screening provided by the surrounding buildings and trees. The setting of the Former Innerleven East Church is considered to be street side and urban in character, with residential streets to the north and west and a bus depot immediately south of the Church. Therefore the setting of this Listed Building is not considered to be affected by the LDT.

No additional Scheduled Ancient Monuments, Garden and Designed Landscapes or Conservation Areas have been designated within 15 km of the LDT since the submission of the Original ES in 2012.

5.5.3 Conclusion

As the Original ES did not predict any significant direct or indirect effects on cultural heritage assets, and due to the fact that there are no physical changes proposed to the LDT, it is considered that cultural heritage can be scoped out of the ES Addendum as there will be no significant effects.

5.6 Tourism, Land Use and Commercial Fisheries

Potential impacts on tourism and recreational resources relate strongly to the attitudes of the individuals experiencing the LDT. Studies undertaken by professional bodies across the UK have suggested that the public is generally in favour of generating energy from

[37] The Scottish Government (2014) The Historic Environment Scotland 2014 [online]. Available at: http://www.legislation.gov.uk/asp/2014/19/pdfs/asp_20140019_en.pdf (Accessed on 09/02/2017)
[38] Historic Environment Scotland Policy Statement [online]. Available at: https://www.historicenvironment.scot/advice-and-support/planning-and-guidance/legislation-and-guidance/historic-environment-scotland-policy-statement/ (Accessed on 08/02/2017)
[39]
[40] Historic Environment Scotland (undated) Designations List [online]. Available at: http://portal.historicenvironment.scot/designation/LB52337 (Accessed on 09/02/2017)

renewable resources and that the majority of those surveyed do not have a negative attitude towards wind farms[41].

The establishment of offshore wind farms may have the potential to cause disruption to commercial activities, including through the loss of access to some fishing grounds for the operational life of the LDT.

5.6.1 Assessment Summary

5.6.1.1 Tourism Effects

The assessment in the Original ES found that the construction of the LDT was not predicted to have any indirect or direct effects on any land-based or marine-based recreational and tourist facilities.

Although the operation of the LDT was deemed to have significant effects on local views up to 6 km along the Fife Coastal Path, it is relevant to note that the LDT is located within a heavily industrialised area and effects will be fully reversible once the LDT is decommissioned.

5.6.1.2 Land Use

The LDT is located within the Fife Energy Park (FEP) which comprises of approximately 55 hectares (ha) of semi-derelict industrial land in Methil. The FEP is a joint venture between Scottish Enterprise and Fife Council and is a world leading engineering and research zone within the energy sector. The FEP encompasses an engineering site, Methil Docks, Methil Docks Business Park and Low Carbon Investment Park.

The LDT is installed 48.3 m from the FEP boundary and is connected to FEP by a bridging structure. Site offices and a construction workshop are also located within FEP close to LDT.

5.6.1.3 Commercial Fisheries Effects

Following consultation with the Scottish Fishermen's Federation and local fishing associations, it was identified that there was very limited use of the area surrounding the LDT for fishing due to its near shore location and the shallow water depths; therefore no concerns were raised.

For health and safety reasons, a temporary 500 m exclusion zone area surrounding the turbine was implemented for fishing vessels during construction of the LDT.

5.6.2 Changes since 2012

A review of publicly available information indicates that no new recreational routes, tourism receptors or land use changes have been identified since the submission of the Original ES. Furthermore, there have been no significant changes to policy or guidance documents.

Consultation with the Royal Yachting Association Scotland in February 2017 has confirmed that they have no objection to the Variation. A request for comment was issued to the Scottish Fishermen’s Federation, however no response has been received. Given that no issues were raised during the original application, it is not expected that the variation would give rise to an objection.

[41] Ipsos MORI (2012) Public Attitudes to Wind Power [online]. Available at: https://www.ipsosmori.com/researchpublications/researcharchive/2946/RenewableUK-Wind-Power.aspx (Accessed on 02/02/2017)

5.6.3 Conclusion

As the Original ES did not predict any significant effects on land or marine based tourism, land use, or commercial fisheries, and due to the fact that the LDT is operational and thus no further temporary exclusion zones are required for construction activities, it is unlikely that the Variation to extend of the operational life of the LDT will have significant effects on these topics. It is therefore considered that tourism, land use and commercial fishery resources can be scoped out of the ES Addendum

5.7 Navigation

Navigational safety is of paramount importance when considering the development of an offshore wind farm. The Original ES for the LDT considered the effects on shipping navigation, fishing vessel movements, recreational vessel movements and other navigational issues.

5.7.1 Assessment Summary

The previous assessment predicted no significant effects on shipping and fishing activities due to the following factors:

- The near shore intertidal location of the LDT;
- The shallow water depth at the LDT location;
- The LDT is located within an area of very low density for shipping and limited fishing activity;
- The LDT will be connected to the shore by a bridge; and
- No significant concerns were raised during consultations with recreational sailing groups or fishing associations.

To ensure navigational safety at all times during the operation of the LDT, the following mitigation measures have been implemented:

- Navigational lights and markings have been installed following Northern Lighthouse Board recommendations and in agreement with Forth Ports and Methil Docks (FPMD) Harbour Master;
- The exact location of the turbine as constructed was provided to FPMD and communicated to mariners via 'notices to mariners', radio navigational warnings and marking on admiralty charts; and
- A temporary 500 m exclusion zone was set up during the construction of the LDT for fishing vessels and recreational craft for health and safety reasons.

5.7.2 Changes since 2012

Since the Original ES, the Marine Coastguard Agency (MCA) has released updated guidance on issues to be considered when assessing the impact on navigational safety and emergency response, caused by offshore renewable energy installation developments[42]. This guidance supersedes Marine Guidance Note 371 'Offshore Renewable Energy Installations (OREIs) – Guidance on the UK Navigation Practice, Safety and Emergency Response Issues'[43].

Furthermore, in 2013 the Department of Trade and Industry (DTI), in co-operation with the Department for Transport and the MCA, updated the 2005 guidelines: 'Methodology for

[42] Marine Coastguard Agency (2016) Safety of Navigation: Offshore Renewable Energy Installations - Guidance on UK Navigational Practice, Safety and Emergency Response. [online], Available at: https://www.gov.uk/government/publications/mgn-543-mf-safety-of-navigation-offshore-renewable-energy-installations-oreis-uk-navigational-practice-safety-and-emergency-response (Accessed on 02/02/2017)

[43] Marine Coastguard Agency (MCA), (2008), Marine Guidance Note 371 'Offshore Renewable Energy Installations (OREIs) – Guidance on the UK Navigation Practice, Safety and Emergency Response Issues'. [online] Available at: http://www.mcga.gov.uk/c4mca/mgn371.pdf (Accessed on 09/02/2017)

Assessing the Marine Navigational Safety Risks of Offshore Wind Farms'[44]. This updated guidance was prepared to include data gained through operational knowledge since 2005.

In addition, funding from the Government for the Department of Energy and Climate Change (DECC) Maritime Data/DTI online GIS Shipping database ceased in 2010 and was officially closed down in 2014.

None of the above changes will result in any changes to the original assessment.

5.7.3 Post Consent Work

To enable discharge of Condition 9 of the consent, the Applicant which, at that time, was Samsung Heavy Industries, had to ensure that they took account of and addressed all MCA recommendations in the current Marine Guidance Note 'Offshore Renewable Energy Installations - Guidance on UK Navigational Practice Safety and Emergency Response - Issues'[42].

5.7.4 Conclusion

As the Original ES did not predict any significant effects on navigational safety and given that no complaints regarding any limitations to shipping, fishing or recreational activities in the vicinity of the LDT have been received to date, it is unlikely that the Variation to extend of the operational phase of the LDT will have significant effects on navigational safety and thus this topic will not be considered in the ES Addendum.

5.8 Telecommunications and Existing Infrastructure

Due to the size and nature of wind turbines, they have the potential to interfere with electromagnetic signals passing above ground during operation, or existing infrastructure buried below ground during construction. Infrastructure can include telecommunication links, microwave links, television reception, and civil and military aviation operations, including impacts on radar and utilities.

5.8.1 Assessment Summary

The previous assessment determined that the LDT would have no significant effects on existing telecommunications and microwave links or aviation and defence receptors.

Potential radio and television reception interference were considered unlikely due to the location of the two identified television receptors (Black Hill and Craigkelly) and the fact that the digital switch over was completed in this area between April and June 2011.

Condition 15 attached to the consent detailed that within 12 months of the final commissioning of the turbine, any claim regarding television picture loss or interference which is attributable to the operation of the LDT must be investigated. To date, no complaints of television and radio interference have been reported.

5.8.2 Changes since 2012

Since the Original ES, the Civil Aviation Authority (CAA) has released the sixth edition of 'CAA Policy and Guidelines on Wind Turbines - CAP 764[45]' which updates and replaces all previous versions. This updated guidance does not affect the original assessment.

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[44] Department of Trade and Industry (2013) Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations [online], Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/372597/NRA_Methodology_2013.pdf (Accessed on 02/02/2017)

[45] The Air Navigation Order 2009 has since been superseded by the Air Navigation Order 2016 (CAP 393).

5.8.3 Post Consent Work

To enable the discharge of Condition 18, the CAA were provided with the following information:

- Precise location of the turbine;
- Maximum blade tip height;
- Construction start and end dates;
- Confirmation that the turbine is lit in accordance with Article 220 of the CAA Air Navigation Order 2009; and
- Confirmation that the colour of the turbine is as directed.

As part of the ongoing work to assess the effects of the Variation, Arcus have re-consulted with aviation and telecommunication consultees to state the Applicant's intention to extend the consent period for the LDT.

To date, responses have been received from the following consultees, with responses outstanding from Arquiva, Spectrum Licencing and Vodafone:

- Joint Radio Company – no objection;
- Atkins Global – no objection; and
- NATS Safeguarding Office - no objection.

Given that the Original ES did not identify any significant effects on existing aviation and telecommunication infrastructure, it is not anticipated that consultees who have not yet responded will have any objections to the extension of the consent period.

5.8.4 Conclusion

As the Original ES did not predict any significant effects on existing infrastructure and due to the fact that no complaints regarding radio and television interference have been received to date, it is unlikely that the extension of the operational phase of the LDT will have significant effects on existing infrastructure.

As no further construction activities are required as part of the Variation, potential effects on below ground infrastructure will not be considered further.

5.9 Shadow Flicker

Shadow flicker is an effect that can occur when the shadow of a moving wind turbine blade passes over a small opening (e.g. a window), briefly reducing the intensity of light within the room, and causing a flickering effect to be perceived. The likelihood and duration of this effect occurring depends upon certain combinations of relative sun, turbine and window locations, turbine orientation, times of day, days of the year and weather conditions.

In the UK, the shadow flicker effect is known to occur within 130 degrees either side of north relative to the turbine positions, as turbines do not cast long shadows on their southern side. It is also known that the effect is likely to occur within 10 rotor diameters and so, in this instance, the Shadow Flicker Study Area was set at 1,720 m around the turbine.

5.9.1 Assessment Summary

The Original ES identified a number of properties which had the potential to be affected by shadow flicker, however it was not practical or considered necessary to assess the effects of shadow flicker on all potential receptors. Ordnance Survey Master Map Address Layer 2 data[46], site visits and photographs were used to refine the potential receptors to a number

[46] For more information, please refer to OS website
http://www.ordnancesurvey.co.uk/oswebsite/products/osmastermap/layers/addresslayer2/

of representative assessment locations. From the potential receptors, a total of 15 assessment locations were chosen to best represent the predicted shadow flicker hours per annum.

Under the worst case assumptions, there was a potential for shadow flicker effects, which exceed 30 hours per annum, at five residential properties within the Shadow Flicker Study Area. However it was noted that all of these five locations are located out with the minimum separation distance of 500 m from the turbine as per the recommended guidance[47]. As a result, the Original ES concluded a low magnitude of likely significant effects and hence no mitigation was proposed.

5.9.2 Changes since 2012

A search for additional residential and commercial properties using Ordnance Survey Address Layer data within the Shadow Flicker Study Area was undertaken. Since 2012, 24 residential and 18 commercial properties have been registered within this Shadow Flicker Study Area. Of the new residential receptors, nine are located within a new build development, located approximately 1.5 km north east of the LDT on Durie Street. The remaining properties are located within established residential areas of Methil. It is considered that the original assessment locations continue to provide a representative sample of the receptors located within the Shadow Flicker Study Area and therefore it is considered that a further shadow flicker assessment is not required.

5.9.3 Post Consent Work

As stated in the Original ES, should shadow flicker complaints be raised and are proven to constitute a statutory nuisance, then mitigation measures would be introduced. These measures would comply with the terms of any notice that may be issued under the terms of the Environmental Protection Act 1990[48] (as amended).

The PEMP, produced to discharge Condition 11 of the consent, details the requirements for monitoring and, where appropriate, agreed mitigation of the potential shadow flicker effects. The Applicant have implemented a manual flicker control procedure which involves manually switching the turbine on/off when a shadow is cast over the local houses. This is monitored by site personnel or Closed Circuit Television (CCTV) via the control centre.

5.9.4 Conclusion

As there are no physical changes proposed to the LDT as built, and that newly identified receptors are located within the assessment locations considered in the Original ES, no significant effects are predicted and thus this topic will not be considered further. As stated in the PEMP, the Applicant will continue to monitor potential shadow flicker effects and follow the manual shut down procedure should effects occur.

5.10 Access and Traffic

The FEP has two commercial port facilities operated by Forth Ports Ltd and suitable access for Heavy Goods Vehicles (HGVs). The Original ES considered the effects of the LDT on the road network and traffic volumes.

[47] Department of Environment, Northern Ireland - Best Practice Guidance to Planning Policy 18 'Renewable Energy' (2009) [online]. Available at: http://www.planningni.gov.uk/index/policy/planning_statements/planning_policy_statement_18__renewable_energy__best_practice_guidance.pdf (Accessed on 06/02/2017)

[48] The Environmental Protection Act 1990. Available at: http://www.legislation.gov.uk/ukpga/1990/43/pdfs/ukpga_19900043_en.pdf (Accessed on 06/02/2017)

5.10.1 Assessment Summary

As the majority of the turbine components were either manufactured on site or delivered by sea, the traffic generated on the surrounding trunk road network during the construction and operation of the LDT was predicted to be minimal. Vehicular access to the site was proposed to be via the entrance to the FEP which as noted is suitable for HGV movements and, as such, it was not proposed to construct any additional tracks.

During decommissioning, the turbine will be removed from the site along with the jacket. Once removed, the turbine components will be transported from the site via sea to a suitable disposal facility.

5.10.2 Changes since 2012

There have been no significant changes to legislation, guidance or baseline conditions since the Original ES.

5.10.3 Conclusion

The Variation to extend the operational period of the LDT is not predicted to have any significant access and traffic effects and therefore this topic can be scoped out of further assessment. As required under Condition 3, the Decommissioning Plan will be updated and submitted to the relevant authorities no later than one year prior to the commencement of decommissioning activities. This Decommissioning Plan will set out the methodology and programme for decommissioning of the turbine, including traffic movements.

5.11 Human Health

The new EIA Directive (2014/52/EU)[11] aims to achieve high levels of protection of human health and the environment. One of the key changes in the revised directive is that direct and indirect significant effects of a project on population and human health should be identified, described and assessed.

Assessment of the effects on human health requires the consideration of the accumulation of a number of effects assessed elsewhere in an EIA. It is considered that the key elements associated with wind energy developments which can affect human health include noise, shadow flicker and visual amenity[49,50].

As detailed in the PEMP, the LDT is shut down under wind speeds and wind directions when measurements suggest turbine noise levels may exceed the consented noise limits and when significant shadow flicker effects could occur. The Applicant will continue to monitor potential noise and shadow flicker effects and will follow the manual flicker control procedure should shadow flicker effects occur or undertake noise measurements should a valid noise complaint be lodged.

As there are no physical changes proposed to the LDT as built, and due to these commitments in the PEMP, effects on human health will not be significant and therefore are not considered further in the ES Addendum.

5.12 Health and Safety

Health and safety concerns include the potential for interaction between construction and operational works and the public. This is therefore not a physical receptor which presents a constraint to the development, but instead is a factor which can be controlled through the construction and operational activity associated with the LDT.

[49] Knopper, L.D *et al.* (2014) Wind Turbines and Human Health. *Frontiers in Public Health,* 2:63.

[50] Knopper, L.D. & Ollson, C.A. (2011) Health Effects and Wind Turbines: A Review of the Literature. *Environmental Health,* 10:78.

5.12.1Assessment Summary

No significant health and safety effects were predicted as part of the previous assessment for the LDT and to date, no reportable health and safety incidents have occurred at the site.

As no physical changes are required to the LDT, there will be no requirement to consider the potential interactions between construction works and the public. The LDT will continue to be managed in accordance with the Health and Safety at Work Act (1974)[51] and Management of Health and Safety at Work Regulations (1999)[52] and will comply with the current health and safety regulations.

Health and safety during the decommissioning phase of the LDT will be controlled by the Decommissioning Plan. This will detail the methods which will be implemented onsite to ensure the safety of those involved in the decommissioning activities, and any members of the public which may be affected by the works at the site during these times. The Decommissioning Plan will be subject to production by the selected contractors in advance of these activities occurring (at least one year prior to decommissioning occurring), and will be subject to agreement with relevant authorities or consultees, in line with Condition 18. An initial draft Decommissioning Plan has been submitted in line with the requirements of this condition.

5.12.2Changes since 2012

Since the previous assessment, the Construction (Design and Management) Regulations 2015[53] supersede the previous 2007[54] version.

Furthermore, the following new health and safety guidelines have been published:

- Onshore Wind Health and Safety Guidelines (2015)[55]; and
- Offshore Wind and Marine Energy Health and Safety Guidelines[56].

This additional guidance does not significantly affect the outcomes of the original assessment.

5.12.3Post Consent Work

Condition 6 of the consent stated that if any health and safety incident were to occur on the site which requires reporting the Health and Safety Executive, then Scottish Ministers must also be notified of the incident within 24 hours of it occurring.

It is noted that, to date, there has been no health and safety incidents that have required reporting to the Health and Safety Executive. The Applicant will continue to comply with this Condition should the Variation to extend the operational life of the LDT be approved.

Furthermore, the PEMP considers the potential for ice build up to occur on the turbine blades which could pose a potential health and safety risk. The LDT is several hundred metres from the nearest residential dwelling and does not oversail any public roads or

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51 Health and Safety at Work Act (1974) [online]. Available at: http://www.legislation.gov.uk/ukpga/1974/37 (Accessed on 15/02/2017)

52 Management of Health and Safety at Work Regulations (1999) [online]. Available at: http://www.legislation.gov.uk/uksi/1999/3242/contents/made (Accessed on 15/02/2017)

53 The UK Government (2015) Construction (Design and Management) Regulations 2015 [online]. Available at: http://www.legislation.gov.uk/uksi/2015/51/contents/made (Accessed on 15/02/2017)

54 The UK Government (2007) Construction (Design and Management) Regulations 2007 [online]. Available at: http://www.legislation.gov.uk/uksi/2007/320/contents/made (Accessed on 15/02/2017)

55 RenewableUK (2015) Onshore Wind Health and Safety Guidelines [online]. Available at: http://www.sgurrenergy.com/download/renewableuk-onshore-wind-health-and-safety-guidelines/ (Accessed on 14/02/2017)

56 RenewableUK (2014) Offshore Wind and Marine Energy Health and Safety Guidelines [online]. (Available at: http://c.ymcdn.com/sites/www.renewableuk.com/resource/collection/AE19ECA8-5B2B-4AB5-96C7-ECF3F0462F75/OnshoreWind_HealthSafety_Guidelines.pdf (Accessed on 14/02/2017)

recreational routes, mitigating the risk from ice fall. The low risk of ice throw is further minimised by the turbine's vibration sensors (or other ice detection measures) which detect any imbalance which might be caused by icing. Should icing occur the turbine would be temporarily shut down until normal balance is restored.

Operational procedures are also established to ensure the safety of both workers and the public in relation to ice throw and ice fall. Procedures would include turbine shutdown and warning signage.

5.12.4 Conclusion

As no physical changes are required to the LDT, there will be no requirement to consider the potential interactions between construction works and the public and therefore this topic can be scoped out of further assessment. The LDT will continue to be managed in accordance with the Health and Safety at Work Act (1974) and Management of Health and Safety at Work Regulations (1999) and will comply with the current health and safety regulations.

Prior to decommissioning, the Decommissioning Plan, produced to enable the discharge of Condition 18, will be updated and agreed with the relevant authorities.

6 TOPICS TO BE SCOPED IN

Following consideration of those topics which could result in significant effects it was noted that each of the below technical areas will be considered within the ES Addendum:

- Landscape and visual;
- Socio-economics; and
- Climate change and carbon balance.

Further details on each of these technical areas are given below and include a brief summary of the assessment contained within the Original ES, changes to the baseline, details any work carried out post consent and the proposed methodology for elements being scoped in.

6.1 Landscape and Visual

A Seascape, Landscape and Visual Impact Assessment (SLVIA) will be undertaken by Chartered Landscape Architects using Guidelines for Landscape and Visual Impact Assessment, 3rd Edition, 2013 (GLVIA3)[57].

6.1.1 Assessment Summary

The 2012 Landscape and Visual Impact Assessment (LVIA) was undertaken by Chartered Landscape Architects in accordance with prevailing published guidance. It identified significant effects on the following:

- Parts of three landscape character types extending from the coastal edge to 5 km inland;
- Houses on the edge of Buckhaven, Methil, East Wemyss, Kennoway and Lower Largo;
- A section of the Fife Coastal Path between West Wemyss and Lower Largo for a distance of 12 km; and
- Local views from a small number of individual houses and farms within 5 km of the LDT.

[57] Landscape Institute and Institute of Environmental Management and Assessment (IEMA) (2013). Guidelines for Landscape and Visual Impact Assessment, 3rd Edition (GLVIA).

6.1.2 Changes since 2012

Since the Original ES the cumulative baseline has changed with a new operational wind farm at Earlseat, 3.5 km to the west of the LDT, and other single wind turbine developments within 15 km of the LDT. In addition, an application was submitted by Forthwind, and has recently been approved by Scottish Ministers, for two No. 2-bladed lattice tower wind turbines each 198 m to blade tip located approximately 1.5 km off the coast of Methil. Further to this Forthwind plan to submit an application for a further nine turbines extending into the Firth of Forth.

Since the Original ES the following new guidance has been produced or come into force:

- Landscape Institute and Institute of Environmental Management and Assessment, (2013), GLVIA3[57];
- Scottish Natural Heritage (SNH), (2014), Visual Representation of Wind Farms[58];
- SNH, (2012), Assessing the Cumulative Impact of Onshore Wind Energy Developments[59];
- SNH, (2012), Offshore Renewables – Guidance on Assessing the Impact on Coastal Landscape and Seascape[60]; and
- SNH, (2016), Guidance on Coastal Character Assessment, Consultation Draft[61].

GLVIA3 2013

GLVIA3 advocates a proportionate approach to SLVIA and in this case, where the operational LDT will not physically change, such guidance is particularly relevant in defining the scope of the SLVIA.

Visual Representation of Wind Farms 2014

The Original ES preceded publication of this guidance. The visualisations prepared for the Original ES do not comply with current guidance and new photography and visualisations will be required for the LDT.

Assessing the Cumulative Impact of Onshore Wind Energy Developments

Although there is no specific guidance in relation to assessing the cumulative impacts of offshore wind energy developments, this SNH guidance remains applicable to this form of development. This guidance sets out how the cumulative effects of onshore wind energy development should be assessed. The main difference from the methodology used in the Original ES is the use of two cumulative baseline scenarios:

- Scenario 1 whereby the effects of the addition of the LDT to all operational and consented wind energy development within the Study Area are assessed. Scenario 1 assumes that all consented wind energy development will be built; and
- Scenario 2 whereby the effects of the addition of the LDT to all operational, consented wind energy development and wind energy development for which there is a valid planning application within the Study Area are assessed. Scenario 2 assumes that all consented wind energy development will be built and all wind energy development in planning will be consented and built.

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[58] SNH (2014). Visual Representation of Wind Farms [online]. Available at: http://www.snh.gov.uk/docs/A1355553.pdf (Accessed on 14/02/2017)
[59] SNH (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments [online]. Available at: http://www.snh.gov.uk/docs/A675503.pdf (Accessed on 14/02/2017)
[60] SNH (2012). Offshore Renewables – Guidance on Assessing the Impact on Coastal Landscape and Seascape [online]. Available at: http://www.snh.gov.uk/docs/A702206.pdf (Accessed on 14/02/2017)
[61] SNH (2016). Guidance on Coastal Character Assessment, Consultation Draft [online]. Available at: http://scotland.landscapeinstitute.org/wp-content/uploads/2016/03/SNH-Coastal-Character-Guidance-consultation-draft-February-2016.pdf (Accessed on 14/02/2017)

In addition the guidance requires preparation of a 60 km radius ZTV showing all cumulative wind farms sites to inform scope of the cumulative assessment.

The cumulative assessment for the SLVIA will follow the two scenario approach in assessing cumulative effects.

Offshore Renewables – Guidance on Assessing the Impact on Coastal Landscape and Seascape

This guidance describes the factors that should be taken into account when assessing the effects of offshore wind energy development on coastal locations. In line with the agreed methodology, the Original ES did not assess impacts on seascape. However Arcus note that during preparation of the Forthwind SLVIA, SNH requested that the guidance was followed when assessing impacts upon seascape and therefore the ES Addendum will utilise this guidance.

6.1.3 Post Consent Work

No monitoring or discharge of conditions work was required in relation to landscape and visual effects.

6.1.4 Proposed Approach

The focus of the SLVIA will be upon effects on seascape resources and cumulative effects only. The presence of the operational wind turbine at the site provides an understanding of the visual effects of the LDT in the context of the current baseline. The Original ES identified significant effects upon visual amenity and landscape occurring primarily within a 5 km radius.

The assessment of landscape and visual effects as reported in the Original ES will be reviewed through desk and fieldwork. A summary of the effects as reported in the Original ES will be provided and if there are any noticeable discrepancies between the effects assessed in 2012 and the effects 'as built' these will be described.

It is anticipated that the SLVIA will focus upon the following receptors:

- Coastal Landscape Character Types (LCT);
- Coastal Special Landscape Areas (SLA);
- Seascape character;
- Settlements including Methil, Buckhaven, Leven, East Wemyss, West Wemyss, Coaltown of Wemyss, Lundin Links, Lower Largo, Upper Largo, Windygates and Kennoway; and
- Fife Coastal Path.

The scope of the assessment will focus upon cumulative effects on those receptors within a 25 km radius of the Development. The cumulative baseline map shown in Figure 3 will be updated during the LVIA and no new cumulative sites will be added to the assessment within eight weeks of the proposed submission date of the application.

Arcus propose that the SLVIA uses viewpoints from 10 of the locations used in the Original ES. These viewpoints are selected primarily to allow an assessment of cumulative effects with operational development at Earlseat and the offshore developments proposed by Forthwind which lie 1.5 km from Methil. All viewpoints used in the Original ES are listed in Table 2, with the proposed 10 viewpoints to inform the ES Addendum highlighted. The proposed format of the visualisations for viewpoints that will be used in the SLVIA is shown in Table 3. New photography will be undertaken and visualisations prepared only for those 10 viewpoints with the other 14 viewpoints being scoped out of the SLVIA.

Table 2: Original ES Viewpoints and Proposed Viewpoints

VP Ref	Location	Grid Ref	Distance to Turbine	To be used in SLVIA
1	**B931/Fife Coastal Path, Buckhaven**	**E336546 N698829**	**500 m**	**Yes**
2	Shore Street, Buckhaven	E335933 N697836	900 m	No
3	A955, Buckhaven	E335901 N699281	1.5 km	No
4	Fife Coastal Path, East Wemyss	E334387 N697192	2.5 km	No
5	**Fife Coastal Path, Leven**	**E338521 N700655**	**3.0 km**	**Yes**
6	**Kennoway**	**E335618 N701941**	**4.0 km**	**Yes**
7	**Fife Coastal Path, Wemyss Castle**	**E332945 N695079**	**5.0 km**	**Yes**
8	Local road west of Kennoway	E333214 N702644	5.5 km	No
9	**Fife Coastal Path, Lower Largo**	**E340759 N702543**	**6.0 km**	**Yes**
10	Minor road east of Coaltown of Balgonie	E330570 N699768	6.5 km	No
11	A916, north-east of Kennoway	E336994 N704771	6.5 km	No
12	**Largo Law**	**E342674 N704970**	**9.0 km**	**Yes**
13	**Fife Coastal Path, Kincraig Point**	**E346176 N699827**	**9.5 km**	**Yes**
14	Local road east of Montrave	E340324 N707256	9.5 km	No
15	A917	E345522 N702896	10.0 km	No
16	**A921/Fife Coastal Path, Kirkcaldy**	**E327955 N690297**	**12.0 km**	**Yes**
17	Local road north of Kinglassie	E323564 N699742	13.5 km	No
18	**Fife Coastal Path, Kinghorn**	**E327614 N687573**	**14.0 km**	**Yes**
19	East Lomond Hill (Lomond Hills)	E324446 N706174	14.5 km	No
20	Local road north-west of Kinghorn	E326111 N687867	15.0 km	No

VP Ref	Location	Grid Ref	Distance to Turbine	To be used in SLVIA
21	**Gullane**	**E347899 N683064**	**19.0 km**	**Yes**
22	A198, at Gosford Bay	E344908 N678873	21.0 km	No
23	North Berwick	E355116 N685343	22.5 km	No
24	Calton Hill, Edinburgh	E326281 N674253	26.0 km	No

Table 3: Proposed format of visualisations

VP Ref	Location	90º baseline panorama and wireline cylindrical projection - A1 sheets	53.5º existing view and photomontage planar projection – A1 sheets	27º single frame photomontage for viewpoint pack – A3 sheet
1	B931/Fife Coastal Path, Buckhaven	1 No. A1 sheets	2 No. A1 sheets	1 No. A3 sheet
5	Fife Coastal Path, Leven	1 No. A1 sheets	2 No. A1 sheets	1 No. A3 sheet
6	Kennoway	1 No. A1 sheets	2 No. A1 sheets	1 No. A3 sheet
7	Fife Coastal Path, Wemyss Castle	1 No. A1 sheets	2 No. A1 sheets	1 No. A3 sheet
9	Fife Coastal Path, Lower Largo	1 No. A1 sheets	2 No. A1 sheets	1 No. A3 sheet
12	Largo Law	1 No. A1 sheets	2 No. A1 sheets	n/a
13	Fife Coastal Path, Kincraig Point	1 No. A1 sheets	2 No. A1 sheets	n/a
16	A921/Fife Coastal Path, Kirkcaldy	1 No. A1 sheets	2 No. A1 sheets	n/a
18	Fife Coastal Path, Kinghorn	1 No. A1 sheets	2 No. A1 sheets	n/a
21	Gullane	1 No. A1 sheets	2 No. A1 sheets	n/a
Total number of Figure sheets		**30 No. A1 sheets**		**5 No. A3 sheets**

6.1.4.1 Methodology

The SLVIA will be undertaken in accordance with GLVIA3. In summary it will consist of the following key stages:

- Desk study including review of the Original ES;
- Consultation;
- Baseline and verification fieldwork;
- Viewpoint photography;
- Preparation of visualisations;
- Assessment fieldwork; and
- Assessment reporting.

The SLVIA methodology will evaluate the sensitivity or nature of receptors through analysis of susceptibility and value. In the case of seascape receptors sensitivity will be evaluated during the assessment stage of the SLVIA using defined criteria. The nature or magnitude of change to receptors will be evaluated using defined criteria. Significance of effects will be assessed through a combination of sensitivity and magnitude to establish which are significant.

GLVIA3 advises a narrative approach rather than reliance on tables or matrices to evaluate effects. The SLVIA will provide narrative regarding the judgements made when evaluating sensitivity, magnitude and significance.

The assessment stage of the SLVIA will be undertaken using a future baseline that consist of the known baseline including all cumulative wind energy sites agreed during consultation minus the operational LDT. The proposed date of the future baseline will be March 2019, as this is the date when consent for the operation development expires.

6.1.5 Conclusion

The LDT will not physically change nor will its location. The cumulative baseline environment has changed since the LDT was consented in 2012. This means that the cumulative effects of the LDT are likely to be different to those assessed in 2012.

LVIA practice and guidance has changed since the 2012 LVIA was prepared. This means that effects will be presented differently and may be assessed in different ways.

While these changes to baseline and guidance are important, the effects of the operational LDT are well understood and the geographical extent of significant effects can be qualified.

6.2 Socio-Economics

This section of ES Addendum will assess the effect of the LDT on the local and national economy. Socio-economic effects can be divided into direct and indirect effects. Direct effects refer to opportunities that can be created immediately as a result of a development, for example job opportunities throughout all stages of the development. Indirect effects refer to opportunities that will be created by the development further down the supply chain, for example companies providing services to the development during construction and operation.

6.2.1 Assessment Summary

The construction of the LDT was deemed to create five full time office-based job opportunities within the local area as well as generating opportunities for approximately 60 local workers to establish site facilities, office, workshop and grid connection cabling and buildings. Once operational, the LDT was predicted to create six full time maintenance and administrative jobs.

In addition to the direct and indirect job impacts, it was considered that the successful delivery of the LDT would help to:

- Remove barriers in the UK industrialisation of offshore wind;
- Increase local industry and academic collaboration, thereby building knowledge capacity in the local area;
- Make significant progress in integrated system technology for offshore wind;
- Facilitate the growth and development of the industry, develop industry process, workforce skills and industry culture in the Fife area; and
- Raise the profile of Fife at an international level.

6.2.2 Changes since 2012

No significant changes to the socio-economic baseline scenario, guidance or assessment methodology have been identified since 2012.

The LDT was originally assessed for the pre-commercial demonstration of the Samsung 7MW WTG concept. The purpose of the site and as such the consent was to enable the 0 series turbine to be proven in a quazi offshore situation. With ORE Catapult taking over control of the LDT, its purpose has changed from demonstration of the WTG concept to a platform on which other Research and Development (R&D) projects can be facilitated. The R&D programme will initially focus on demonstration of products, services and solutions in the following technological areas;

- Structural mechanics;
- Aeroelastic modelling;
- Wind turbine control systems;
- Operations and maintenance;
- Condition monitoring; and
- Aerodynamic modelling.

ORE Catapult work closely with key academic and industry stakeholders to align the R&D programme with industry priorities to drive cost reduction in offshore wind. ORE Catapult are also supporting the local communities through educational and training programmes to support local young adults through the delivery of employment focused, in-demand skills.

6.2.3 Methodology

The socio-economic assessment will examine quantifiable aspects through two key metrics:

- Gross Value Added (GVA); and
- Employment (headcount jobs).

In addition to the direct economic activities supported by the LDT, this assessment will also consider the indirect and induced effects associated with the direct activities by applying the relevant economic multipliers to each of the impacts.

The study will consider the economic impacts in the local and national economies; namely Fife and Scotland.

Consideration will also be given to skill development provided by the LDT as a training facility and the benefits of this skill set within the Scottish labour force.

Impacts to Date

The initial phase of the study will be to set out the economic benefits that the LDT has provided to date, both nationally and locally. This will cover impacts of the onsite activity and the implications for the sector from the start of the development phase to the present day.

The core impacts to be considered will include:

- Direct economic activity - including GVA and employment levels of those employed directly on the site;
- Supplier effects – purchases of goods and services;
- Income effects – expenditure of employees; and
- Impacts on the construction sector – during the capital investment phase of the LDT.

The economic impacts associated with each of these activities will be estimated based on figures provided by ORE Catapult (and possibly others such as the turbine supplier) and national statistics.

In addition to these economic impacts, other quantifiable impacts will include:

- Educational impacts, including training for turbine technicians at Fife College and working to promote STEM subjects (science, technology, engineering and maths) in schools;
- Fiscal contributions to Fife Council through payment of Non-Domestic rates; and
- SME (small and medium enterprises) growth through use of the LDT.

Assessing Non-Quantifiable Benefits

In addition to the quantifiable benefits described above, it is anticipated that the facility will have an economic impact on the local and national economies in ways that cannot be quantified. Although these factors cannot be summed with the quantifiable impacts, experience has found that including such benefits contribute to the narrative around the quantifiable impacts and enable value and meaning to be added to the numbers produced in any analysis.

For example, one such non-quantifiable benefits is the role that the LDT plays in delivering the national and local economic aspirations and strategies. The study will consider the role that the LDT plays in meeting aspirations and strategies including, but not limited to:

- Skills development within Fife;
- Role in establishing Fife as offshore wind energy location;
- Wider contribution to development of Scottish & UK offshore wind sector; and
- Promoting Scotland's international reputation.

Future Impacts

The secondary stage of the study will be to consider the implications of extending the operational life of the LDT. This will cover the same impacts as detailed above.

6.2.4 Conclusion

An economic appraisal will be submitted with the planning application which will summarise the economic impacts of the LDT to date and assess the potential direct and indirect effects of extending the consent period by a further 10 years.

6.3 Climate Change and Carbon Balance

The operation of the LDT has the potential to displace electricity generated from fossil fuels and consequently prevent CO_2 from being released from other forms of energy generation. As the LDT is a test turbine, it is highly likely that its electricity production will vary significantly over its operational lifetime as parameters are altered to facilitate testing.

Recent figures indicate that between 2016 and 2017, the LDT has generated sufficient low carbon electricity to power over 2,000 homes[62].

6.3.1 Assessment Summary

The previous ES indicated that the LDT will have a positive benefit on CO_2 emission savings however, as it is a test facility, it was not possible to quantify the exact CO_2 savings.

6.3.2 Changes since 2012

Climate Change Impact Assessment (CCIA) is a new form of environmental assessment required by the new EIA Directive 2014/52/EU. This assessment will consider how the LDT are that could influence climate change, and also how vulnerable the LDT is to changes in the future baseline environment as a result of climate change.

6.3.3 Methodology

Currently only provisional guidelines exist to standardise the CCIA process in the UK. The Institute of Environmental Management (IEMA) published 'Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation'[63] in November 2015 with the intention of providing an updated and finalised version when the EC Directive is transposed into UK law.

Climatic changes are likely to occur during the lifespan of the LDT and are predicted to become more apparent over the coming decades. Future climate projections are published by the Met Office through the UK Climate Projections (UKCP09) website[64]. For this assessment it is proposed that the medium emissions scenario (A1B) will be utilised as the future baseline. This scenario is based on a future world of rapid economic growth and the rapid introduction of new and more efficient technologies with a balance of non-fossil and fossil intensive energy technologies. The worst case emissions scenario (A1F1), which is based on fossil fuel intensive energy technologies only, would be an extremely unlikely future scenario and therefore the medium emissions scenario is considered the most appropriate for this assessment.

The projected change to a range of climatic conditions at the time of writing the ES Addendum will be used to predict the future baseline for the lifetime of the LDT. It is proposed that projected climatic changes at the 50% probability level (central estimate) will be utilised in the CCIA.

The IEMA guidelines[63] have been used in order to develop an assessment methodology which will cover the following:

- The LDT's vulnerabilities and resilience in the context of climate change; and
- A summary of the LDT's potentially significant impacts upon identified environmental receptors in the context of climate change.

6.3.4 Conclusion

As required under the new EIA Directive, we propose to undertake a CCIA which will determine how the LDT is likely to interact with a changing climate and whether any significant effects could arise. As the LDT is a test facility and electricity production will

[62] ORE Catapult (2017) Levenmouth Demonstration Turbine – Community Update January 2017. [online]. Available at: https://ore.catapult.org.uk/our-services/test-demonstration-assets/demonstration/levenmouth-turbine/ (Accessed on 09/02/2017)
[63] IEMA (2015) Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation [online]. Available at: http://oldsite.iema.net/eia-climate-change (Accessed on 27/01/2017)
[64] UKCP09 (2016). UK Climate Projections [online]. Available at: http://ukclimateprojections.metoffice.gov.uk/ (Accessed on 27/01/2017)

vary significantly over its operational lifetime, it is not proposed to calculate the carbon savings of the LDT.

7 CONCLUSIONS

This Scoping Report has been produced to outline the potential environmental effects resulting from the extension to the operational phase of the LDT. It is noted that no physical changes are proposed to the 'as-built' LDT.

This Scoping Report makes use of information from the previously undertaken assessment works and post consent monitoring to identify where the baseline conditions have changed; where impacts may have increased as a result of the proposed time extension; and/or where the time extension could introduce new effects. This Scoping Report has demonstrated that the effects of the Variation will be limited and therefore to ensure that the ES Addendum focuses only on potential significant effects as per EIA Regulations the following number of technical elements are proposed to be scoped out:

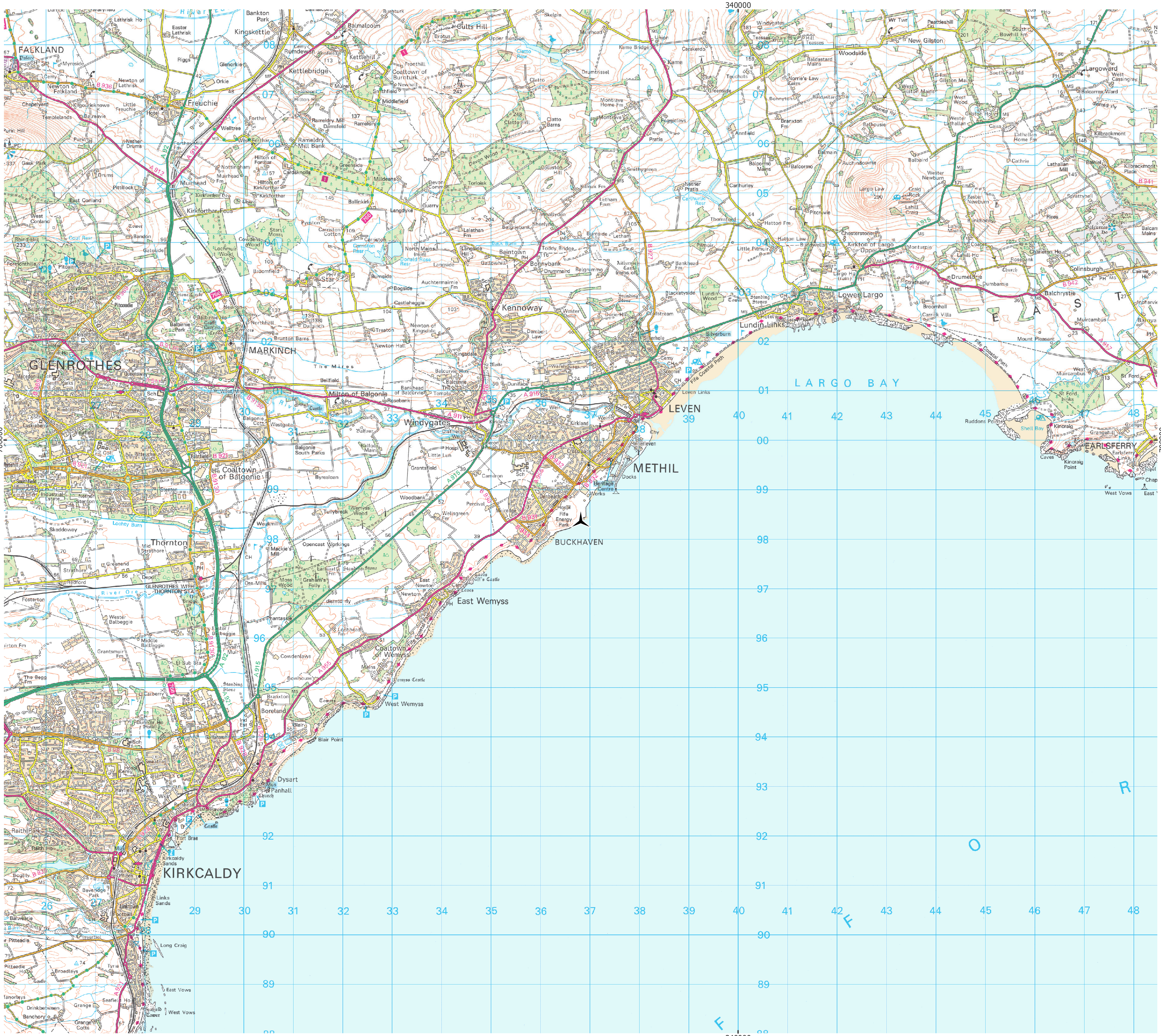
- Noise;
- Ecology;
- Ornithology;
- Water resources and coastal hydrology;
- Cultural heritage;
- Tourism, land use and commercial fisheries;
- Navigation;
- Telecommunications and existing infrastructure;
- Shadow flicker;
- Access and traffic;
- Human health; and
- Health and safety.

No further assessment will be undertaken on these topics.

It is proposed to assess within the following elements within the ES Addendum:

- Landscape and visual;
- Socio-economics; and
- Climate change and carbon balance.

This Scoping Report has presented methodologies for the assessment of these topics and any comment from consultees are welcomed at this stage.



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P:\Projects\2652 Levenmouth Turbine Variation\GIS\Document Files\Reports\Scoping Report\2652 Fig01 Site Location.mxd

CATAPULT Offshore Renewable Energy

ARCUS

Levenmouth Turbine Location

1:75,000 Scale @ A3

0 2 4 km

N

Produced: SC Approved: KM	Ref: 2652/REP/002 Date: 09/02/2017

Site Location
Figure 1

Levenmouth Demonstration Turbine Scoping Report

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CATAPULT Offshore Renewable Energy

ARCUS

Aerial Imagery flown on 10-06-2015.

1:2,500 Scale @ A3

0 50 100 m

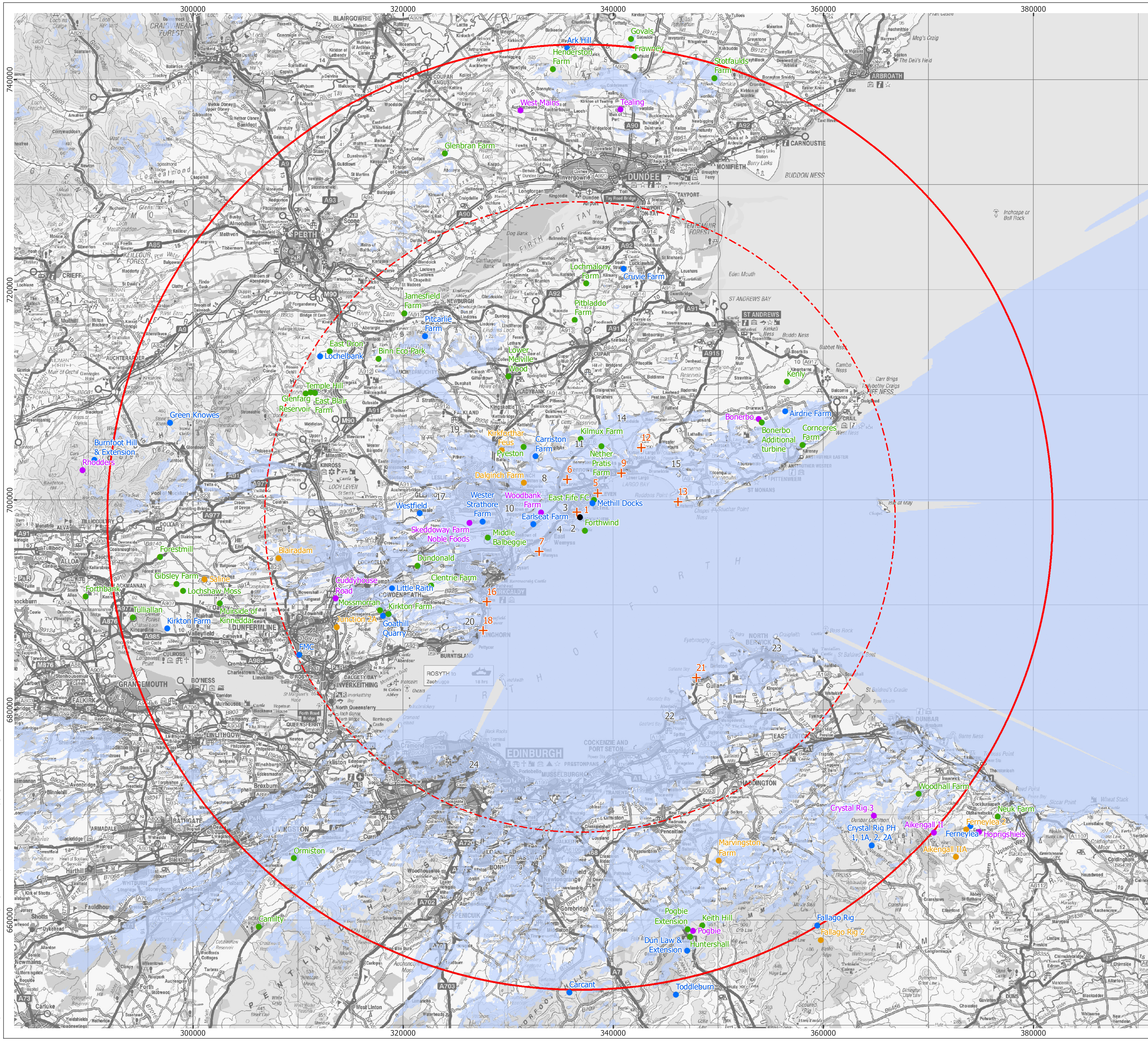
N

Produced: SC Approved: KM	Ref: 2652/REP/003 Date: 10/04/2017

Aerial Photography of Site
Figure 2

Levenmouth Demonstration Turbine Scoping Report

P:\Projects\2652 Levenmouth Turbine Variation\GIS\Document Files\Reports\Scoping Report\2652 Fig02 Aerial Photography.mxd



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CATAPULT Offshore Renewable Energy

ARCUS

- Levenmouth Turbine Location

Cumulative Developments

- Application
- Consented
- Operational
- Under Construction

Viewpoints

- To be used in the SLVIA
- 30 km Study Area
- 45 km Study Area
- Zone of Theoretical Visibility

1:350,000 Scale @ A3

0 9.5 19 km

N

Produced: SC
Approved: RA

Ref: 2652/REP/004
Date: 10/04/2017

Landscape Assessment
Figure 3

Levenmouth Demonstration Turbine Scoping Report

P:\Projects\2652 Levenmouth Turbine Variation\GIS\Document Files\Reports\Scoping Report\2652 Fig03 Landscape Assessment.mxd

APPENDIX 3.4

SCOPING OPINION

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E: MS.MarineRenewables@gov.scot

OFFSHORE RENEWABLE ENERGY CATAPULT (OREC), LEVENMOUTH DEMONSTRATION TURBINE (PREVIOUSLY KNOWN AS THE FIFE ENERGY PARK OFFSHORE DEMONSTRATION WIND TURBINE (FEPODWT)).

Marine Scotland - Licensing Operations Team Scoping Opinion

THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2017 (AS AMENDED)

SCOPING OPINION FOR THE PROPOSED SECTION 36 VARIATION FOR OPERATION OF A DEMONSTRATION OFFSHORE WIND TURBINE

TABLE OF CONTENTS

List of Figures

1 Executive Summary

This is Marine Scotland Licensing Operations Team ("MS LOT")'s Scoping Opinion in respect of the proposed section 36 variation, to extend the operational life from 5 to 15 years, of the Offshore Renewable Energy Catapult ("OREC") Levenmouth Demonstration Turbine (previously known as The Fife Energy Park Offshore Demonstration Wind Turbine ("FEPODWT")).

This document sets out MS LOT's opinion on the basis of the information provided in Arcus Consultancy Services Ltd ("Arcus") on behalf of OREC's Scoping Report dated April 2017. This Opinion can only reflect the proposal as currently described by the Developer. The matters addressed by the Developer in the scoping report have been carefully considered and use has been made of professional judgment and experience in order to adopt this Opinion. The Developer proposes to submit an addendum to the original Environmental Statement ("ES addendum"). The EIA Regulations which came into force on 16th May 2017 (discussed further below) use the terminology Environmental Impact Assessment Report ("EIA Report"), replacing the term Environmental Statement, therefore for the avoidance of confusion this Scoping Opinion also uses the term EIA Report when referring to the information that the Developer is required to provide. It should be noted that when it comes to consider the EIA Report, MS LOT will take account of relevant legislation and guidelines (as appropriate). MS LOT will not be precluded from requiring additional information if it is considered necessary in connection with the EIA Report submitted with that application when considering the application for the variation of the section 36 consent.

MS LOT have consulted on the Scoping Report and the responses received have been taken into account in adopting this opinion. MS LOT is satisfied that the topics identified in the Scoping Report encompass those matters required by the Electricity Works (Environmental Impact Assessment) (Scotland) 2017 Regulations (as amended) considering the transitional arrangements.

The following topics are to be **scoped in** to the EIA Report:

- Landscape and Visual
- Noise
- Socio-economics
- Climate Change and Carbon Balance
- Ornithology

The following topics can be **scoped out** of the EIA Report:

- Ecology
- Water Resources and Coastal Hydrology
- Cultural Heritage
- Tourism, Land Use and Commercial Fisheries
- Navigation
- Telecommunications and Existing Infrastructure
- Shadow Flicker
- Access and Traffic
- Human Health
- Health and Safety

2 Introduction

2.1 Background to this scoping opinion

2.1.1 I refer to your email of 13th April 2017 requesting a scoping opinion from MS-LOT in relation to your intention to apply for an variation to extend the operational life of the LDT from 5 to 15 years under section 36C of the Electricity Act 1989 (as amended). The request was made under regulation 7 of The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000. The request was accompanied by a Scoping Report containing a plan sufficient to identify the site which is the subject of the proposed development and a brief description of the nature and purpose of the proposed development and of its possible effects on the environment. The Scoping Report was accepted on 4th May 2017**.**

2.1.2 The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations ("the 2017 EIA Regulations") came into force on the 16th May 2017. The new regulations transpose the requirements of the 2014 amendment (2014/52/EU) to the Environmental Impact Assessment ("EIA") Directive. The 2017 EIA Regulations revoke The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000. The 2017 EIA Regulations apply instead but under transitional arrangements in certain circumstances they apply in cases pre-existing as of the 16th May 2017 in a modified form. This is where an applicant for a section 36 consent or a marine licence for an EIA project has, before the 16th May 2017, either – (1) submitted an environmental statement in connection with an application to the Scottish Ministers; (2) made a request to the Scottish Ministers for a scoping opinion in connection with the project; or (3) made a request to the Scottish Ministers for a screening opinion. The 2017 EIA Regulations apply to applications for variations to section 36 consents.

2.1.3 Following the submission of a screening request on behalf of OREC, a formal screening opinion was issued by MS LOT on 16th March 2017.This confirmed that it is appropriate for the application to be considered as a variation under The Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations 2013. In regards to your request for a scoping opinion on the proposed content of the required EIA Report, MS LOT have, in accordance with the EIA Regulations, considered the documentation provided to date and consulted with the appropriate consultation bodies in reaching their scoping opinion.

2.1.4 Schedule 9 of the Act places on the developer a duty to "have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest". In addition, the developer is required to give consideration to the UK Marine Policy Statement, Scotland's National Marine Plan ("NMP"), Scottish Planning Policy, other relevant Policy and National Policy Planning Guidance, Planning Advice Notes, the relevant planning authority's Development Plans and any relevant supplementary guidance.

2.1.5 Please note that the EIA process is vital in generating an understanding of the biological, chemical and physical processes operating in and around the proposed development site and those that may be impacted by the proposed activities. We would however state that references made within the scoping document with regard to the significance of impacts should not prejudice the outcome of the EIA process

3 Description of development

3.1 Background to the development

3.1.1 The development consists of a single 7 megawatt ("MW") demonstration wind turbine off the East Fife coast at the Fife Energy Park, Methil.

3.1.2 An application was submitted to the Scottish Ministers in July 2012 under Section 36 of the Electricity Act 1989 (as amended) for the construction and operation of a single 7 MW demonstration wind turbine off the East Fife coast at the Fife Energy Park, Methil. This application was supported by an ES ("The original ES"). Subsequently, an addendum was submitted to the Scottish Ministers on 03 March 2013 which detailed an increase in the size of boreholes required for the turbine foundation.

3.1.3 Consent was granted by the Scottish Ministers on 03rd May 2013. The turbine is now operational and measures 196 metres ("m") from mean sea level to blade tip with a rotor diameter of 171 m. In addition to the turbine itself, the LTD also comprises of the following elements:

- A personnel bridge connection between the Fife Energy Park and the turbine tower;
- An onshore crane pad on the Fife Energy Park; and
- An onshore Control compound.

3.1.4 Subsequently, an application to vary the operational noise limits as detailed in Condition 13 and Annex 3 of the consent was made to Scottish Ministers on 3rd October 2014 and subsequently approved on 23rd March 2016.

3.1.5 Consent for the LDT was originally granted to Scottish Enterprise, with ownership of the consent being first assigned to Samsung Heavy Industries UK on 22nd July 2013 and subsequently assigned to ORE Catapult on 24th November 2015. In conjunction with the Section 36 consent, two Marine Licences were also obtained; one for a 'Marine Renewable Energy Project in the Territorial Sea and UK Controlled Waters adjacent to Scotland' and one for 'Dredging and Deposit of Solid Waste in the Territorial Sea and UK Controlled Waters adjacent to Scotland' as required by the Marine (Scotland) Act 20103.

3.1.6 A number of conditions were attached to the consent of which, Condition 1 specified the following:

"The consent is for a period from the date the consent is granted until the date occurring 5 years after the Final Commissioning of the turbine. Written confirmation of the date of the Final Commissioning of the turbine must be provided by the Company to the Scottish Ministers, the Planning Authority and Scottish Natural Heritage no later than one calendar month after the Final Commissioning of the Development."

3.1.7 The proposed application for a variation in regards to the operational lifetime of the turbine proposes the following variation to Condition 1:

"The consent is for a period from the date the consent is granted until the date occurring 15 years after the Final Commissioning of the turbine. Written confirmation of the date of the Final Commissioning of the turbine must be provided by the Company to the Scottish Ministers, the Planning Authority and Scottish Natural Heritage no later than one calendar month after the Final Commissioning of the Development."

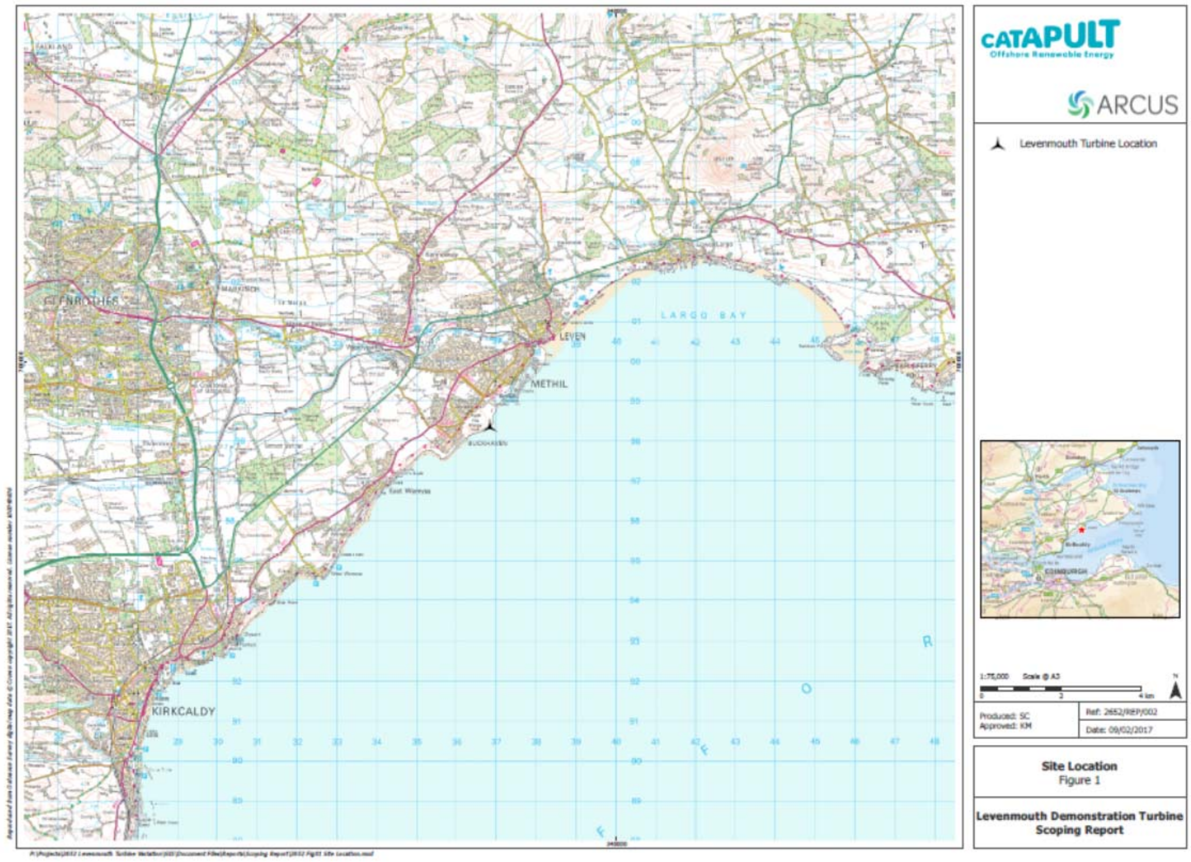

Figure 1 - Location of proposed development

4 Aim of this Scoping Opinion

4.1 The scoping process

4.1.1 Scoping provides the first identification, and likely significance, of the environmental impacts of the proposal and the information needed to enable their assessment. The scoping process is designed to identify which impacts will or will not need to be addressed in the EIA Report. This includes the scope of impacts to be addressed and the method of assessment to be used. The scoping process also allows consultees to have early input into the EIA process, to specify their concerns and to supply information that could be pertinent to the EIA process. In association with any comments herein, full regard has been given to the information contained within the scoping opinion request documentation submitted.

4.1.2 As this Scoping Opinion concerns an application for a variation, the focus is on the main respects where the likely significant effects on the environment of the proposed development would differ from those described in the original ES that was prepared in connection with the relevant section 36 consent.

4.1.3 MS-LOT have also used this opportunity to provide advice in relation to the licensing requirements in addition to the EIA requirements (see Appendix II)

5 Consultation

5.1 The consultation process

5.1.1 On receipt of the scoping opinion request documentation, MS-LOT, in accordance with the EIA Regulations, initiated a 28 day consultation process, which commenced on 04/05/17. The following bodies were consulted:

- British Telecom (BT)
- Chamber of Shipping (COS)
- Civil Aviation Authority (CAA)
- Defence Infrastructure Organisation (DIO)
- East Lothian Council (ELC)
- Edinburgh City Council (ECC)
- Fife Council (FC)
- Fisheries Management Scotland (FMS)
- Forthwind Ltd (FW)
- Historic Environment Scotland (HES)
- Joint Radio Company (JRC)
- Marine Safety Forum (MSF)
- Marine Scotland Compliance (MSC)
- Maritime & Coastguard Agency (MCA)
- National Air Traffic Services (NATS)
- North & East Coast Regional Inshore Fisheries Group (NECR IFG)
- Northern Lighthouse Board (NLB)
- Royal Society for the Protection of Birds Scotland (RSPB)
- Royal Yachting Association (RYA)
- Scottish Canoe Association (SCA)
- Scottish Creel Fishermens Federation (SCFF)
- Scottish Environment Protection Agency (SEPA)
- Scottish Fishermen’s Federation (SFF)
- Scottish Fishermen’s Organisation (SFO)
- Scottish Natural Heritage (SNH)
- Scottish Wildlife Trust (SWT)
- The Crown Estate (TCE)
- Transport Scotland Ports & Harbours (TSPH)
- Transport Scotland Trunk Road Operations (TSTRO)
- Whale and Dolphin Conservation (WDC)

- Scottish Creel Fishermens Federation (SCFF)

5.1.2 From the list above a total of 17 responses were received. MSS, when requested, provided advice on Socio-Economics and Ornithology. The purpose of the consultation was to obtain advice and guidance from each consultee in respect of the information which each of them believe should be scoped in or out of the EIA.

5.1.3 MS-LOT are satisfied that the requirements for consultation have been met in accordance with the EIA Regulations. The sections below highlight issues which are of particular importance with regards to the EIA Report. Full consultation responses are attached in Appendix 1 and each should be read in full for detailed requirements from individual consultees. MS-LOT expects all consultee concerns to be addressed in the EIA Report unless otherwise stated.

6 Contents of the EIA Report

6.1 Requirements from the EIA Regulations

6.1.1 As detailed above, new EIA Regulations came into force on the 16th May 2017. As this scoping request has been received before that date the transitional arrangements outlined in the 2017 EIA Regulations apply. This means the factors to be considered in the EIA Report are those detailed in The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000, Schedule 4. It is considered good practice to set out within the EIA Report the qualifications and experience of all those involved in collating, assessing or presenting technical information.

6.1.2 EU guidance on EIA identifies the following qualities of a good ES (now known as an EIA Report):

- Includes a clear structure with a logical sequence, for example describing existing baseline conditions, predicted impacts (nature, extent and magnitude), scope for mitigation, agreed mitigation measures, significance of unavoidable/residual impacts for each environmental topic.
- Includes a table of contents at the beginning of the document.
- Includes a clear description of the development consent procedure and how EIA fits within it.
- Reads as a single document with appropriate cross-referencing.
- Is concise, comprehensive and objective.
- Is written in an impartial manner without bias.
- Includes a full description of the development proposals.

- Makes effective use of diagrams, illustrations, photographs and other graphics to support the text.
- Uses consistent terminology with a glossary.
- References all information sources used.
- Has a clear explanation of complex issues.
- Contains a good description of the methods used for the studies of each environmental topic.
- Covers each environmental topic in a way which is proportionate to its importance.
- Provides evidence of good consultations.
- Includes a clear discussion of alternatives.
- Makes a commitment to mitigation (with a programme) and to monitoring.
- Has a Non-Technical Summary ("NTS") which does not contain technical jargon
- Further guidance can be found at http://ec.europa.eu/environment/eia/eia-support.htm

6.2 Non-Technical Summary ("NTS")

6.2.1 This should be a concise stand-alone document written in a manner that is appealing to read and easily understood. The NTS should highlight key points set out in the EIA Report. The non-technical summary should include:

- a description of the project including a map and figures as appropriate;
- a description of the main environmental impacts the project is likely to have;
- a description of the measures envisaged to prevent, reduce and offset any significant adverse effects; and
- an outline of the main alternatives studied, including an indication of the main reasons for the primary choice of the project, taking into account the environmental effects of those alternatives and the project as proposed.

6.3 Mitigation

6.3.1 Within the EIA Report it is important that all mitigating measures are:

- clearly stated;
- accurate;
- assessed for their environmental effects;
- assessed for their effectiveness;
- fully described with regards to their implementation and monitoring, and;;
- described in relation to any consents or conditions

6.3.2 The EIA Report should contain a mitigation table providing details of all proposed mitigation discussed in the various chapters. Refer to Appendix I for consultee comments on specific baseline assessment and mitigation.

6.3.3 Where potential environmental impacts have been fully investigated but found to be of little or no significance, it is sufficient to validate that part of the assessment by stating in the EIA Report:

- the work has been undertaken;
- what this has shown i.e. what impact if any has been identified, and
- why it is not significant?

7 Interests to be Considered Within the EIA Report

7.1 Introduction

7.1.1 The Scoping Report has considered the environment under the following headings and topics, these are addressed in turn below. This section contains a summary of the main points raised by consultees and MS-LOT's opinion on whether potential effects should be scoped in or out. The consultation responses are contained in Appendix I and the Developer is advised to carefully consider these responses and use the advice and guidance contained within them to inform the EIA Report.

7.2 Issues Arcus consider can be Scoped in:

7.3 Landscape and Visual

7.3.1 The scoping report concluded that the LDT will not physically change nor will its location. The cumulative baseline environment has changed since the LDT was consented in 2012. This means that the cumulative effects of the LDT are likely to be different to those assessed in 2012. LVIA practice and guidance has changed since the 2012 LVIA was prepared. This means that effects will be presented differently and may be assessed in different ways. While these changes to baseline and guidance are important, the effects of the operational LDT are well understood and the geographical extent of significant effects can be qualified.

7.3.2 East Lothian Council ("ELC") advised that the Scoping Report proposes to produce an SLVIA in accordance with current guidelines and they support this. ELC advise that the previous visualisations do not comply with current SNH guidelines and should be re-done in line with their current guidance.

7.3.3 The Scoping Report identifies three viewpoints that were previously used to assess the impact on East Lothian. ELC would not agree a single viewpoint from East Lothian is sufficient to be representative of the East Lothian coastline and recreational users of the coast including beach visitors, golfers and walkers on the John Muir Way; users of the Aberlady Bay Nature Reserve, the impact on the coastal Special Landscape Area of the Port Seton to North Berwick Coast; and coastal settlements.

7.3.4 Gullane is one of the closest points in East Lothian to the turbine. However the viewpoint that was previously submitted is not from the coastal edge. A more appropriate viewpoint would be from the high water mark on Gullane Beach at approximate grid ref. 347660, 683310. This would give a more accurate representation of the impact of the proposal without the interrupting foreground.

7.3.5 ELC also request a viewpoint from the summit of North Berwick Law as a well used current and historic viewpoint and for cumulative impact.

7.3.6 The City of Edinburgh Council had no comments to make.

7.3.7 Forthwind welcome the inclusion of both their consented Offshore Wind Demonstration Project and their proposed Offshore Wind Turbine Demonstration Array and advised in their response that according to SNH and Marine Scotland viewpoints, the Forthwind technology will become the predominant technology within the area.

7.3.8 Scottish Natural Heritage advise that there is no requirement to scope in seascape, landscape and visual considerations into the EIA Report.

7.3.9 **MS LOT consider that the advice from ELC should be followed and advise that seascape, landscape and visual considerations require to be scoped in to the EIA Report.**

7.4 Socio-Economics

7.4.1 The Scoping Report suggests that there are no significant changes to the socio-economic baseline, guidance or assessment methodology. An economic appraisal will be submitted with the application which will summarise the local and national economic impacts of the LDT to date and assess the potential direct and indirect effects of extending the consent period by a further 10 years.

7.4.2 East Lothian Council had no comments on socio-economics. ELC note the approach appears to be that where there were not considered to be significant impacts in the original ES, topics can be scoped out. It is possible there may be some areas where the impacts were considered not to be significant due to their short duration (5 years) and this should be considered in deciding whether to scope topics in or out.

7.4.3 ECC and FC had no comments to make.

7.4.4 Marine Scotland Science ("MSS"), in their response on socio-economics, advised that it should be scoped in to the EIA Report. If the project has been in place for 5 years then there is value in evaluating the socio-economic impact to date (e.g. were the initial jobs figures accurate), when compared to the initial appraisal, and projecting this out to calculate the impact of the 10 year extension. The main focus of this should be on the key metrics outlined: GVA and 'Full Time Equivalent' (FTE) employment.

7.4.5 MS LOT would draw the Developers attention to a Marine Scotland publication on licensing guidance for socio-economic applications with a particular case study focus on offshore wind that will be available soon as this may be helpful.

7.4.6 **MS LOT advise that socio-economics should be scoped in to the EIA Report.**

7.5 Climate Change and Carbon Balance

7.5.1 The Scoping report considers that operation of the LDT has the potential to displace electricity generated from fossil fuels and consequently prevent CO^2 from being released from other forms of energy generation.

7.5.2 Climate Change Impact Assessment (CCIA) is a new form of environmental assessment required by the new EIA Directive 2014/52/EU. This assessment will consider how the LDT could influence climate change, and also how vulnerable the LDT is to changes in the future baseline environment as a result of climate change.

7.5.3 East Lothian Council agree that climate change and carbon balance should be included as one of the main benefits of renewable energy is its beneficial impact on climate change. If figures are given on number of homes supplied, this should make clear whether this is based on Scottish or UK consumption levels.

7.5.4 **MS LOT welcome the inclusion of a Climate Change Impact Assessment and agree with the proposed assessment methodology. MS LOT also agree that figures should be given on the number of**

homes supplied.

7.6 Issues Arcus consider can be Scoped out:

7.7 Noise

7.7.1 The Scoping Report considers that as there are no physical changes proposed to the LDT, no significant effects are predicted and thus it is proposed that this topic will be scoped out. Under the requirements of the Project Environmental Monitoring Plan ("PEMP"), the Applicant advises they will continue to monitor operational noise from the LDT and operate within the agreed noise limits. In order to ensure compliance with these limits, the LDT is shut down under certain wind speeds and directions.

7.7.2 East Lothian Council, City of Edinburgh Council and Fife Council had no comments on noise.

7.7.3 Forthwind requested that assessment of the operational noise impact of extending the LDT operational consent by a further 10 years, both in isolation and cumulatively, should be addressed within the EIA Report. The cumulative noise impact assessment should utilise the measured noise levels taken from the operational LDT and be assessed, as a minimum, against the following baseline noise requirements:

1) Measured background noise at sensitive locations;
2) Predicted noise levels for the consented Forthwind Project; and
3) Predicted noise levels for the Forthwind Array Project that received a scoping opinion from Marine Scotland on 12 April 2017.

7.7.4 Forthwind consider that the extension of the LDT operational consent could have a significant impact on the commercial operations of the Forthwind project. Forthwind suggests that the cumulative operational noise impact of extending the LDT operational consent by a further 10 years is assessed along with the obligation on the operator to identify mitigation to both reduce the cumulative noise impact on the local Methil community and avoid potential financial impact on the Forthwind development. In addition Forthwind intend to submit a further application to bring the total number of turbines to 9.

7.7.5 Marine Scotland has commissioned CH2M to review the potential challenges associated with ensuring that the apportionment of noise levels between Forthwind and OREC can be monitored and controlled to ensure that local residential receptors are protected.

7.7.6 CH2M concluded, in a technical note to MS LOT of April 2017, that it is apparent that the operation of both the Catapult and Forthwind facilities should be able to operate within the noise requirements of the consent conditions, but that is not to say that it should be permitted to operate without physical checks on that compliance.

7.7.7 Physical measurement for at least the first 2 years of the joint operation of both facilities would at least be able to indicate compliance with the consent conditions, and if required enable the operators to adjust the control mechanisms to ensure compliance. This is important as the exact noise levels from the Forthwind turbines have not, as far as CH2M is aware, been confirmed, and hence there is potential for some uncertainty in the emissions from this source. It is also important given the lack of clarity of the night time apportionment between the two facilities, which is not as clear as the day time split in levels.

7.7.8 **MS LOT advise that noise should be scoped in to the EIA report. Assessment of the operational noise impact of extending the LDT operational consent by a further 10 years, both in isolation and cumulatively, should be addressed within the EIA Report. The cumulative noise impact assessment should utilise the measured noise levels taken from the operational LDT and be assessed, as a minimum, against baseline noise requirements.**

7.8 Ecology

7.8.1 The Scoping Report considers that continued operation of the LDT is not anticipated to have any effects to designated sites or terrestrial ecology aspects (i.e. terrestrial habitats and (non-avian) species). No significant effects are predicted and therefore the Scoping Report suggests that these elements can be scoped out.

7.8.2 The Scoping Report considers it likely that localised changes in marine ecology may have occurred as a result of the construction and presence of the LDT structures in intertidal and subtidal environments. The precise nature of changes to marine habitats and benthos is unknown; however it is considered that any changes in the baseline are likely to be of a minor magnitude and localised scale, potentially with beneficial effects for marine epifauna and associated species. Therefore it is proposed to scope ecology out of the EIA Report.

7.8.3 East Lothian Council agree with the conclusions of the report on ecology and ornithology as regards potential impacts on East Lothian. ELC note that SNH have recently undertaken consultation on a proposed Special Protection

Area at Outer Firth of Forth and St Andrews Bay Complex, which is not noted as a change in the baseline.

7.8.4 City of Edinburgh Council and Fife Council have no comments on Ecology.

7.8.5 SEPA advise that the variation of Condition 1 to extend the operational life from five years to fifteen years does not raise any issues for them.

7.8.6 SNH advise that they agree with the receptors that have been identified for scoping out (this includes, birds, marine mammals, fish and benthic interests).

7.8.7 Whale & Dolphin Conservation agree that marine mammals can be scoped out of the EIA Report.

7.8.8 **MS LOT advise that Ecology (not including ornithology) can therefore be scoped out of the EIA Report.**

7.9 Ornithology

7.9.1 The Scoping Report considers that as no physical changes are proposed to the LDT as built, the construction and decommissioning effects remain unchanged and therefore will not be considered in the EIA Report.

7.9.2 Based on the previous assessment and preliminary analysis of the operational monitoring results, it is anticipated that operational impacts on ornithological resources will not be significant and therefore the Developer proposes to scope out an assessment of the operational effects.

7.9.3 The Developer suggests that this approach will be confirmed following detailed analysis of the monitoring data undertaken at the LDT. Should the detailed analysis identify any significant effects, an assessment of the operational effect of the LDT will be included in the EIA Report, the approach of which would be agreed in advance with MSS and SNH.

7.9.4 Fife Council advise that on the basis that further detailed analysis of monitoring data is required to fully assess the operational effect of the LDT on ornithology, they do not consider appropriate at this stage to scope out operational effects on ornithology.

7.9.5 Forthwind disagrees with the ORE Catapult proposal to scope out ornithology from the EIA Report, and it is their view that the LDT assessment should address the additional cumulative ornithological impact of an extended 10 year operation and as a minimum should take into consideration the consented two turbine Forthwind Offshore Wind Demonstration Project and the proposed Forthwind Offshore Wind Turbine Demonstration Array.

7.9.6 RSPB Scotland do not agree with the decision to scope out ornithology and consider this topic to be of high significance.

7.9.7 RSPB Scotland advise that the Scoping report does not acknowledge that the development is also now located in the Outer Firth of Forth and St Andrews Bay Complex proposed Special Protection Area (pSPA). Consideration should be given to the breeding and wintering qualifying interest of this site and Marine Scotland should carry out a Habitat Regulations Appraisal to assess whether the development affects the Natura site. Such an assessment should also include impacts on the Firth of Forth and Forth Islands SPA. An assessment of cumulative impacts with other developments in the Firth of Forth should also be conducted. Pre and post-construction monitoring data could be used to assess any impact on the pSPA and the Firth of Forth and Forth islands SPAs.

7.9.8 RSPB note that in the Project Environmental Monitoring Programme ("PEMP"), eider (a qualifying species for the Firth of Forth SPA and pSPA) are highlighted as a bird where density has significantly declined post construction.

Peak density: 185.5 birds/km2 pre-construction vs 94.5 birds/km2 operation;
Peak-mean density: 119.5 birds/km2 pre-construction vs 41.8 birds/km2 operation.

7.9.9 SNH advised that ornithology can be scoped out as a receptor under EIA. SNH also advise that for Habitats Regulation Assessment (HRA) it is unlikely that further information will be required from the applicant to inform advice for the AA, taking into account the nature of the variation (an extension in operational lifespan from 5 to 15 years), the fact that the turbine is already constructed and operating and available information for post-consent monitoring for the existing LDT development.

7.9.10 In terms of consideration of Natura sites and this proposal, SNH note that:

- The original appropriate assessment concluded no adverse effect on site integrity to the Firth of Forth SPA and that
- The turbine was in place before the Outer Forth and St Andrews Bay pSPA was consulted on.

7.9.11 The populations of birds in the vicinity of the turbine will include some interests of the Outer Firth of Forth and St Andrews Bay Complex pSPA.

However, SNH anticipate that while there will be Likely Significant Effect (LSE) on relevant bird interests due to displacement, not collision, they anticipate that there will be No Adverse Effect on Site Integrity (NAESI) as a result of the proposed variation.

7.9.12 SNH are still in the process of considering OREC's year 3 post-consent monitoring ornithology report and associated information, which was submitted by OREC in order to comply with conditions of the current consent. SNH advise that review of the report will fully inform their advice for HRA and including future requirements for monitoring for this proposal, taking into account the context of other consented developments (Forthwind's current consent for two turbines) and proposed developments (Forthwind's proposed extension to 9 turbines). Advice at this stage is therefore given without prejudice to our advice for these reports.

7.9.13 MSS advise that that section 5.3.4 the Scoping Report states "it is anticipated that operational impacts on ornithological resources will not be significant", suggesting that an assessment is required to determine whether this is assumption is valid. It is therefore unclear why the report then goes on to state "therefore it is also proposed to scope out an assessment of the operational effects" on birds. This is underlined by the later text indicating that "This approach will be confirmed following detailed analysis of the monitoring data undertaken at the LDT. Should the detailed analysis identify any significant effects, an assessment of the operational effect of the LDT will be included in the ES Addendum". This analysis should be undertaken and presented within the EIA Report. MSS advise that it does not seem appropriate to exclude ornithological impacts from the assessment.

7.9.14 **MS LOT advise that ornithology should be scoped in to the EIA Report due to the location of the turbine within the pSPA, the potential for significant effects due to the increase in the operational life of the turbine and the uncertainty at this stage over the monitoring results.**

7.10 Water Resources and Coastal Hydrology

7.10.1 The Scoping Report considers that as the LDT will not involve physical alterations to the existing infrastructure, there will be no changes to the assessment of effects undertaken in 2012. All potential effects were assessed as being of minor or negligible significance and are therefore not significant in terms of the EIA Regulations. As such, it is considered that water resources and coastal hydrology resources can be scoped out of the EIA Report.

7.10.2 East Lothian Council had no comment on water resources and coastal hydrology.

7.10.3 SEPA made no other comments other than they had no issues.

7.10.4 **MS LOT advise that water resources and coastal hydrology can be scoped out of the ES.**

7.11 Cultural Heritage

7.11.1 The Scoping Report considers that Cultural heritage, in this context means the above and below ground archaeological resource, built heritage, the historic landscape and any other elements which may contribute to the historical and cultural heritage of the area. As the Original ES did not predict any significant direct or indirect effects on cultural heritage assets, and due to the fact that there are no physical changes proposed to the LDT, it is considered that cultural heritage can be scoped out of the EIA Report as there will be no significant effects.

7.11.2 East Lothian Council do not consider it likely there will be significant impacts on Cultural Heritage interests in East Lothian however, they have highlighted that views from high points such as the Lomonds, the Garleton Hills, North Berwick Law, Traprain should be shown to be considered because they are historically key views for navigation and pilgrimage routes.

7.11.3 Historic Environment Scotland note that the original ES (2012) for the proposals did not identify any significant effects on historic environment interests and that their predecessor body, Historic Scotland, did not object to the proposals (24 August 2012). In light of the fact that there will be no physical changes to the Levenmouth Demonstration Turbine as a result of the variation, and that no additional heritage assets within their remit have been designated during the intervening period, Historic Environment Scotland are content to agree with the Scoping Report and do not consider that the proposals will give rise to additional effects on their historic environment interests.

7.11.4 **MS LOT advise that cultural heritage should be scoped out of the ES. ELC concerns over views from high points such as the Lomonds, the Garleton Hills, North Berwick Law, Traprain should be considered under SLVIA.**

7.12 Tourism, Land Use and Commercial Fisheries

7.12.1 The Scoping Report considers that as the Original ES did not predict any significant effects on land or marine based tourism, land use, or commercial fisheries, and due to the fact that the LDT is operational and thus no further temporary exclusion zones are required for construction activities, it is unlikely that the variation to extend of the operational life of the LDT will have significant effects on these topics. It is therefore considered that tourism, land use and commercial fishery resources can be scoped out of the EIA Report.

7.12.2 East Lothian Council believe views from the coast, which are important for tourism in East Lothian, should be considered. They advised any impact on views could be included in the section on Landscape.

7.12.3 Historic Environment Scotland, in light of the fact that there will be no physical changes to the LDT as a result of the variation, and that no additional heritage assets within their remit have been designated during the intervening period, are content to agree with the Scoping Report and do not consider that the proposals will give rise to additional effects on their historic environment interests.

7.12.4 The Scottish Fishermen's Federation provided a nil response in regard to fisheries interests.

7.12.5 **MS LOT advise that Tourism, Land Use and Commercial Fisheries can be scoped out of the EIA Report**.

7.13 Navigation

7.13.1 The Scoping report considers that as the original ES did not predict any significant effects on navigational safety and given that no complaints regarding any limitations to shipping, fishing or recreational activities in the vicinity of the LDT have been received to date, it is unlikely that the variation to extend of the operational phase of the LDT will have significant effects on navigational safety and thus this topic will not be considered in the EIA Report.

7.13.2 The Maritime & Coastguard Agency, advised that as there will be no change to any built or physical aspects of the 'as built' LDT they have no objection to the extension and variation to condition 1 of the current consent (see MCA response for suggested condition).

7.13.3 The Northern Lighthouse Board advise they are content with the extension of operational life from five years to 15 years and provided no further comments

7.13.4 RYA Scotland agrees that as no physical change is proposed for the LDT, navigation and the effects on recreational boating can be scoped out of the EIA.

7.13.5 East Lothian Council have no comments on Navigation.

7.13.6 **MS LOT advise that as no physical changes have been proposed and no navigational consultees raised any concerns then navigation can be scoped out of the EIA Report.**

7.14 Telecommunications and Existing Infrastructure

7.14.1 The Scoping report considers that as the Original ES did not predict any significant effects on existing infrastructure and due to the fact that no complaints regarding radio and television interference have been received to date, it is unlikely that the extension of the operational phase of the LDT will have significant effects on existing infrastructure. As no further construction activities are required as part of the Variation, potential effects on below ground infrastructure will not be considered further.

7.14.2 BT Radio Network Protection provided a nil return response.

7.14.3 The Defence Infrastructure Organisation provided no objection to the proposal but advised that if the application is altered in any way they must be consulted again as even the slightest change could unacceptably affect them.

7.14.4 NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal and does not conflict with safeguarding criteria after the proposed development was examined from a technical safeguarding aspect.

7.14.5 East Lothian Council had no comments on telecommunications and existing infrastructure

7.14.6 **MS LOT advise that Telecommunications and Existing Infrastructure can be scoped out of the EIA Report. NATS, DIO and BT will be again consulted during the application process**.

7.15 Shadow Flicker

7.15.1 The Scoping Report consider that as there are no physical changes proposed to the LDT as built, and that newly identified receptors are located within the assessment locations considered in the Original ES, no significant effects are predicted and thus this topic will not be considered further. As stated in the PEMP for the current consent, OREC will continue to monitor potential shadow flicker effects and follow the manual shut down procedure should effects occur.

7.15.2 East Lothian Council advised they had no comments on shadow flicker and no other consultee responses were received.

7.15.3 **MS LOT advise that Shadow Flicker can be scoped out of the EIA Report.**

7.16 Access and Traffic

7.16.1 The Scoping Report considers that The Fife Energy Park ("FEP") has two commercial port facilities operated by Forth Ports Ltd and suitable access for Heavy Goods Vehicles ("HGVs"). The Original ES considered the effects of the LDT on the road network and traffic volumes. The variation to extend the operational period of the LDT is not predicted to have any significant access and traffic effects and therefore this topic can be scoped out of further assessment.

7.16.2 East Lothian Council have no comment on access and traffic noting that the approach appears to be that if where there were not considered to be significant impacts in the ES, topics can be scoped out. They are of the opinion that it is possible there may be some areas where the impacts were considered to be not significant due to their short duration (5 years) and this should be considered in deciding whether to scope topics in or out.

7.16.3 Transport Scotland commented on both the original application and the first variation application. In correspondence dated 25 November 2014 they concluded that the proposed development will have no significant environmental impact on the trunk road network and its adjacent receptors as a result of increased development traffic.

7.16.4 Having reviewed the proposed variation Transport Scotland's position remains unchanged from the previous correspondence, and again confirm that the proposed development will have no significant impact on the trunk road network. Consequently, no further information is required in this regard.

7.16.5 East Lothian Council had no comments on access and traffic.

7.16.6 **MS LOT advise that access and traffic can be scoped out of the EIA Report.**

7.17 Human Health

7.17.1 The Scoping Report considers that the new EIA Directive (2014/52/EU) aims to achieve high levels of protection of human health and the environment. One of the key changes in the revised directive is that direct and indirect significant effects of a project on population and human health should be identified, described and assessed.

7.17.2 Assessment of the effects on human health requires the consideration of the accumulation of a number of effects assessed elsewhere in an EIA. It is considered that the key elements associated with wind energy developments which can affect human health include noise, shadow flicker and visual amenity.

7.17.3 As detailed in the PEMP, the LDT is shut down under wind speeds and wind directions when measurements suggest turbine noise levels may exceed the consented noise limits and when significant shadow flicker effects could occur. OREC will continue to monitor potential noise and shadow flicker effects and will follow the manual flicker control procedure should shadow flicker effects occur or undertake noise measurements should a valid noise complaint be lodged.

7.17.4 As there are no physical changes proposed to the LDT as built, and due to these commitments in the PEMP, effects on human health will not be significant and therefore are not considered further in the EIA Report.

7.17.5 East Lothian Council had no comments on human health and no other consultee comments were received.

7.17.6 **MS LOT advise that Human Health can be scoped out of the EIA Report.**

7.18 Health and Safety

7.18.1 The Scoping Report considers that no significant health and safety effects were predicted as part of the previous assessment for the LDT and to date, no reportable health and safety incidents have occurred at the site.

7.18.2 As no physical changes are required to the LDT, there will be no requirement to consider the potential interactions between construction works and the public. The LDT will continue to be managed in accordance with the Health and Safety at Work Act (1974) and Management of Health and Safety at Work Regulations (1999) and will comply with the current health and safety regulations. Health and safety during the decommissioning phase of the LDT will be controlled by the Decommissioning Plan.

7.18.3 East Lothian Council have no comment on health and safety noting that the approach appears to be that if where there were not considered to be significant impacts in the ES, topics can be scoped out. They are of the opinion that it is possible there may be some areas where the impacts were considered not to be significant due to their short duration (5 years) and this should be considered in deciding whether to scope topics in or out.

7.18.4 **MS LOT advise that as there are no physical changes required and the LDT will continue to be managed in accordance with the Health and Safety at Work Act (1974) and Management of Health and Safety at Work Regulations (1999) and will comply with current health and safety regulations then Health and Safety can be scoped out of the EIA Report.**

8 Marine Planning

8.1 Background

8.1.1 Offshore Renewable Energy development should be in accordance with the UK Marine Policy Statement and Scotland's NMP.

8.1.2 **The UK Marine Policy Statement 2011** – The UK Administrations share a common vision of having clean, healthy, safe, productive and biologically diverse oceans and seas. Joint adoption of a UK-wide Marine Policy Statement provides a consistent high-level policy context for the development of marine plans across the UK to achieve this vision. It also sets out the interrelationship between marine and terrestrial planning regimes. It requires that when the Scottish Ministers make decisions that affect, or might affect, the marine area they must do so in accordance with the Statement.

8.1.3 **Scotland's NMP 2015** – Developed in accordance with the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 (as amended), the NMP provides a comprehensive statutory planning framework for all activities out to 200 nautical miles. This includes policies for the sustainable management of a wide range of marine industries. The Scottish Ministers must make authorization and enforcement decisions, or any other decision that affects the marine environment, in accordance with the NMP. The NMP sets out a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of the Plan.

9 Land Use Planning

9.1 Background

9.1.1 The Scottish Government's planning policies are set out in the National Planning Framework, Scottish Planning Policy, Designing Places and Circulars.

9.1.2 The National Planning Framework is the Scottish Government's Strategy for Scotland's long term spatial development.

9.1.3 Scottish Planning Policy ("SPP") is a statement of Scottish Government policy on land use planning and contains:

- The Scottish Government's view of the purpose of planning,
- the core principles for the operation of the system and the objectives for key parts of the system,
- statutory guidance on sustainable development and planning under Section 3E of the Planning etc. (Scotland) Act 2006,
- concise subject planning policies, including the implications for development planning and development management, and
- The Scottish Government's expectations of the intended outcomes of the planning system.

9.1.4 Other land use planning documents which may be relevant to this proposal include:

- Planning Advice Note ("PAN") 2/2011: Archaeology – Planning Process and Scheduled Monument Procedures
- PAN 51: Planning, Environmental Protection and Regulation
- PAN 1/2011: Planning and Noise
- PAN 1/2013: Environmental Impact Assessment
- PAN 60: Planning for Natural Heritage
- PAN 62: Radio Telecommunications
- PAN 68: Design Statements
- PAN 75: Planning for Transport
- PAN 79: Water and Drainage
- Marine Guidance Note ("MGN") 543 (M+F) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – UK Navigational Practice, Safety and Emergency Response
- Scottish Planning Policy ("SPP")
- National Planning Framework 3

10 General EIA Report Issues

10.1 Gaelic Language

10.1.1 Where developments are located in areas where Gaelic is spoken, developers are encouraged to adopt best practice by publicising the project details in both English and Gaelic.

10.2 Application and EIA Report

10.2.1 A gap analysis template is attached at Appendix III to record the environmental concerns identified during the scoping process. This template should be completed and used to inform the preparation of the EIA Report. Please note that the EIA Report must contain all of the information specified in the scoping opinion. On submission of the application and supporting EIA Report, MS-LOT, via a gatecheck process, will review the completed template in conjunction with the EIA Report to ensure this is the case before the application is officially accepted. The gatecheck will also include an EIA audit. If information requested at scoping stage has not been provided in the EIA Report then the applicant will be asked to provide that information before the application can be accepted.

10.2.2 Please note all aspects of this scoping opinion should be considered when preparing a formal application to reduce the need to submit additional information in support of the application. The consultee comments presented in this opinion are designed to offer an opportunity to consider all material issues relating to the development proposals.

10.2.3 The exact nature of the work that is needed to inform the EIA may vary depending on the design choices. The EIA must address this uncertainty so that there is a clear explanation of the potential impact of each of the different scenarios. It should be noted that any changes produced after the EIA Report is submitted may require further environmental assessment and public consultation.

10.2.4 In assessing the quality and suitability of applications, the MS-LOT will use the gap analysis and this scoping opinion in assessment of the application. In addition to scoping, applications are required to go through a gate check process. See Appendix II for further information on this. In the event of a submitted application not containing essential information, MS-LOT reserves the right not to accept the application. Developers are advised not to publicise applications in the local or national press, until their application has been accepted by MS-LOT.

10.3 Judicial review

10.3.1 All decisions may be subject to judicial review. A judicial review statement should be made available to the public.

Signed

Alan Keir
05/07/17
Authorised by the Scottish Ministers to sign in that behalf

Appendix I: Consultee Responses

Consultee Comments Relating to ORE Catapult

Statutory Consultees

Local Authority – East Lothian Council
Local Authority – Edinburgh City Council
Local Authority – Fife Council
Scottish Environment Protection Agency (SEPA)
Scottish Natural Heritage (SNH)

Non Statutory Consultees

BT Network Radio Protection (BT)
Defence Infrastructure Organisation (DIO)
Forthwind Limited (FW)
Historic Environment Scotland (HES)
Maritime and Coastguard Agency (MCA)
National Air Traffic Services (NATS)
Northern Lighthouse Board (NLB)
Royal Society for the Protection of Birds Scotland (RSPB)
Royal Yachting Association (RYA)
Scottish Fishermen’s Federation (SFF)
Transport Scotland (Trunk Road Operations) (TSTRO)
Whale and Dolphin Conservation (WDC)

East Lothian Council

I refer to your consultation on the above and note the Scoping Report submitted by Arcus Consultancy Services Ltd (Arcus) on behalf of Offshore Renewable Energy Catapult (OREC) and have the following comments:

Policy

We agree with the inclusion of review of policy and legislation identified within the original ES. The review should include consideration of Scottish Planning Policy 2014 in particular whether there are any implications for assessment of impacts arising from paragraph 170 stating "*Areas identified for wind farms should be suitable for use in perpetuity*".

Although obviously the turbine is outwith our area the plan does give an indication of sensitivities within our area. For information, the current local plan in East Lothian is the East Lothian Local Plan 2008 which can be found here: http://www.eastlothian.gov.uk/info/204/local_development_plan/231/statutory_development_plans/3. This plan will be replaced by the East Lothian Local Development Plan (PDP) which has been submitted for examination. This contains proposed designations of Special Landscape Areas in East Lothian. Technical Note 9 which supports this document contains further information on Landscape Character Areas and potential sensitivities of the proposed Special Landscape Areas. This plan and supporting documents can be found here: http://www.eastlothian.gov.uk/info/204/local_development_plan/1777/proposed_local_development_plan . In addition, the Council has prepared non-statutory guidance on windfarms of over 12MW. This again provides some further information on potential impacts to our area from to wind turbine development.

Topics to be scoped out

We have no comment on noise, water resources and coastal hydrology; navigation; telecoms and existing infrastructure, shadow flicker, access and traffic, human health and health and safety, or on socio-economics. We note the approach appears to be that if where there were not considered to be significant impacts in the ES, topics can be scoped out. It is possible there may be some areas where the impacts were considered not to be significant due to their short duration (5 years) and this should be considered in deciding whether to scope topics in or out.

On Cultural Heritage, we do not consider it is likely there will be significant impacts on interests in East Lothian however, there are some issues which should be shown to have been considered. These are views to high points (the Lomonds) from high points within East Lothian (the Garleton Hills, North Berwick law, Traprain); these are historically key views for navigation; and pilgrimage routes for example North Berwick to St Andrews including the important view to land.

On tourism, there are views from the coast which is important for tourism in East Lothian, including views from golf courses and beaches. Again this is unlikely to be significant but should be considered; as any impact is through views this could be included in the proposed section on landscape.

Ecology

We agree with the conclusions of the report on ecology and ornithology as regards potential impacts on East Lothian. We note that SNH have recently undertaken consultation on a proposed Special Protection Area at Outer Firth of Forth and St Andrews Bay Complex, which is not noted as a change in the baseline. We expect SNH will comment on whether or not this should be considered.

Landscape

The Scoping Report proposes to produce an SLVIA in accordance with current guidelines and we support this. We agree with section 6.1.2 which notes that since the original ES the cumulative baseline has changed particularly with the construction of the wind farm at Earlseat to the west of the LDT, and consent for turbines close by within the Firth of Forth.

We support the proposal in section 6.1.4 to review the original assessment of landscape and visual effects to identify if there are any discrepancies between the effects assessed and the effects ‘as built’. We agree that the previous visualisations do not comply with current SNH guidelines and should be re-done in line with their current guidance.

The Scoping Report identifies three viewpoints that were previously used to assess the impact on East Lothian. We would not agree a single viewpoint from East Lothian is sufficient to be representative of the East Lothian coastline and recreational users of the coast including beach visitors, golfers and walkers on the John Muir Way; users of the Aberlady Bay Nature Reserve, the impact on the coastal Special Landscape Area of the Port Seton to North Berwick Coast; and coastal settlements.

Gullane is one of the closest points in East Lothian to the turbine. However the viewpoint that was previously submitted is not from the coastal edge. A more appropriate viewpoint would be from the high water mark on Gullane Beach at approximate grid ref. 347660, 683310. This would give a more accurate representation of the impact of the proposal without the interrupting foreground.
We would also request a viewpoint from the summit of North Berwick Law as a well used current and historic viewpoint and for cumulative impact (see OS map).

Climate change and carbon balance

We agree this should be included as one of the main benefits of renewable energy is its beneficial impact on climate change. If figures are given on number of homes supplied, this should make clear whether this is based on Scottish or UK consumption levels.

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Edinburgh City Council

Thank you for consulting City of Edinburgh Council on this scoping opinion request.

Given that the proposal relates solely to an extension in the operational life of the turbine, we have no comments to make.

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Fife Council

Regarding the above, Fife Council would comment as follows at this stage:

The scoping report conclusion (section 7) states that ornithology is proposed to be scoped out and no further assessment will be undertaken. However, in the ornithology section 5.3.4 Conclusions it states that the approach to scope out assessment of the operational effects on ornithology will be confirmed following detailed analysis of the monitoring data undertaken at the LDT. It goes on to say that 'Should the detailed analysis identify any significant effects, an assessment of the operational effect of the LDT will be included in the ES Addendum, the approach of which would be agreed in advance with MSS and SNH.'

Therefore, on the basis that further detailed analysis of monitoring data is required to fully assess the operational effect of the LDT on ornithology, it is not considered appropriate at this stage to scope out operational effects on ornithology.

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Scottish Environmental Protection Agency

The variation of Condition 1 to extend the operational life from five years to fifteen years does not raise any issues for SEPA.

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Scottish Natural Heritage

Thank you for consulting us on the Scoping Opinion for the variation of the consent for the Levenmouth Demonstration Turbine (LDT). This variation is for an increase in duration of operation of the turbine from 5 to 15 years.

The scoping report has identified impacts that should be scoped in and out of the ES Addendum. We advise that we agree with the receptors that have been identified for scoping out (this includes, birds, marine mammals, fish and benthic interests).

We note that the scoping report indicates scoping in Seascape, Landscape and Visual Impacts and as such an assessment will be undertaken. We advise that this is not necessary. Despite there being changes to the baseline from when this turbine was originally consented, development proceeding after this turbine was consented will have been required to take this turbine into account in their cumulative assessment. We therefore advise that there is no requirement to scope in seascape, landscape and visual considerations into the ES.

We advise that for HRA it is unlikely that further information will be required from the applicant to inform our advice for the AA, taking into account the nature of the variation (an extension in operational lifespan from 5 to 15 years), the fact that the turbine is already constructed and operating and available information for post-consent monitoring for the existing LVT development.

In terms of consideration of Natura sites and this proposal, we note that:

- The original appropriate assessment concluded no adverse effect on site integrity to the Firth of Forth SPA and that
- The turbine was in place before the Outer Forth and St Andrews Bay pSPA was consulted on.

The populations of birds in the vicinity of the turbine will include some interests of the Outer Firth of Forth and St Andrews Bay Complex pSPA. However, we anticipate while there will be Likely Significant Effect (LSE) on relevant bird interests due to displacement, not collision, we anticipate that there will be No Adverse Effect on Site Integrity (NAESI) as a result of the proposed variation.

We are still in the process of considering the year 3 post-consent monitoring report and associated information. Review of the report / information will fully inform our advice for HRA and including future requirements for monitoring for this proposal, taking into account the context of other consented developments (Forthwind 2 turbine) and proposed developments (Forthwind extension, 9 turbines).

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BT Network Radio Protection

NIL RETURN from BT Radio Network Protection

Defence Infrastructure Organisation

I am writing to tell you that the MOD has no objection to the proposal.
The application is to extend the operational life of the wind turbine situated at grid reference 336813, 698362 from five years to 15 years.
If the application is altered in any way we must be consulted again as even the slightest change could unacceptably affect us.

Forthwind

Thank you for providing us with the opportunity to comment on the scoping request relating to the ES addendum to support a proposal to vary the Section 36 consent for the Levenmouth Demonstration Turbine (LDT) Forthwind recognises the necessity and importance of providing platforms to test, validate and demonstrate new offshore wind technologies and we are supportive of the objectives of the LDT. However, the approach taken in the scoping report and ORE Catapult's request to extend the operational consent by an additional 10 years creates material environmental and commercial concerns for Forthwind.

Specifically, Forthwind requests that Marine Scotland requires ORE Catapult to address the following aspects in the LDT extension Environment Statement:

(a) Assessment of the operational noise impact of extending the LDT operational consent by a further 10 years, both in isolation and cumulatively, within the Environment Statement. The cumulative noise impact assessment should utilise the measured noise levels taken from the operational LDT and be assessed, as a minimum, against the following baseline noise requirements:

1) Measured background noise at sensitive locations;
2) Predicted noise levels for the consented Forthwind Project; and
3) Predicted noise levels for the Forthwind Array Project that received a scoping opinion from Marine Scotland on 12 April 2017.

(b) That the LDT extension ES identifies appropriate mitigation measures, where necessary, to reduce the cumulative noise impact on the local Methil community and to avoid potential operational and commercial impacts on Forthwind operations.

(c) The assessment of cumulative ornithological impacts on the area by extending the LDT operational consent by a further 10 years within the Environment Statement. The cumulative ornithological impact assessment, as a minimum, should further consider the following projects:

1) The consented Forthwind Project; and
2) The Forthwind Array Project that received a scoping opinion from Marine Scotland on 12 April 2017.

Further information on the Forthwind reasoning is provided in Annex 1 of this letter. As highlighted above, Forthwind are not opposed to the proposed extension of the LDT by 10 years and indeed can identify a number of synergies between our development and the aims of the LDT and ORE Catapult. We have had an initial discussion on these points with ORE Catapult, to be clear about our concerns at this stage and we will continue to work with ORE Catapult and Marine Scotland to secure mutually agreeable outcomes to the issues we have identified. This can hopefully ensure that there is a consistent approach towards cumulative impact assessment, reflecting the change in baseline resulting from the award of Forthwind's current consent, as well as our published plans to extend the scope of the Forthwind project.

I hope that our legitimate concerns are understood and can be addressed within the resultant LDT extension application and we look forward to further discussions to help inform the application. Should Marine Scotland, or ORE Catapult, have any questions or require clarification to any aspect raised within this letter, please do not hesitate to contact me.

ANNEX 1 – FORTHWIND REASONING FOR INCLUSION OF SPECIFIC ENVIRONMENTAL ASPECTS WITHIN THE LDT EXTENSION APPLICATION ENVIRONMENT STATEMENT

Noise

The LDT Scoping report concludes that "As there are no physical changes proposed to the LDT, no significant effects are predicted and thus it is proposed that this topic will not be considered further." Forthwind disagrees with the ORE Catapult proposal to scope out noise from the ES as the LDT scoping report fails to take account of a major information gap in the original Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT – the preceding name for the LDT) ES and further external developments in the Methil area since the original S36 application and ES were produced; namely:

• The original FEPODWT ES of 2011 is inadequate to support any assessment of predicated impact associated with the provision of a 10-year operational extension to the LDT. The reason being is that the original FEPODWT ES used an impact model built on predicted turbine noise data based on the maximum permissible turbine noise emission limits (derived for the most noise sensitive properties) which ensured compliance. The LDT turbine produces higher noise levels than that calculated within the ES. This underestimation was realised when complaints from the public were received on the noise produced by the Samsung turbine following commissioning, necessitating the need to vary the licence.

Since the original application, OREC have measured operational noise data from the LDT turbine to support a subsequent variation to the consent in March 2016. However, again the consent was based on noise impacts for a turbine with an operation window to 2019 and not to 2029. The noise impact assessment should be reassessed utilising this information to identify the potential operational noise impact, both in isolation and cumulatively, with other consented and planned developments for the extended 10-year operational period.

• Since the original FEPODWT application, consent has been granted to a nearby 2 turbine Forthwind Offshore Wind Demonstration Project. The Forthwind ES identified that the location of the LDT ensures that cumulative effects are likely to occur in combination with the Forthwind development in certain wind conditions for the period that both developments are in operation (as the LDT operates close to or above the ETSU-R-97 limits, thus absorbing most of the available local noise space). As mitigation Forthwind committed to managing and reducing cumulative noise impact to sensitive properties, based on the understanding that the LDT would cease operations in 2019 in accordance with the development consent. This would have meant that the period of overlap in operations between the original LDT consent and the Forthwind project was anticipated to be between 6 and 18 months (a point acknowledged in the Forthwind Project consent). This meant, with the implementation of proposed Forthwind mitigation measures for the period of operational overlap, the cumulative noise impact was not significant and Forthwind could operate within the limits defined by ETSU-R-97, with limited commercial impact.

The extension of the LDT operational consent could have a significant impact on the commercial operations of the Forthwind project. Forthwind suggests that the cumulative operational noise impact of extending the LDT operational consent by a further 10 years is assessed along with the obligation on the operator to identify mitigation to both reduce the cumulative noise impact on the local Methil community and avoid potential financial impact on the Forthwind development.

• In November 2016 Forthwind submitted a scoping report to Marine Scotland seeking their scoping opinion in respect of the Environment Statement for the proposed Forthwind Offshore Wind Turbine Demonstration Array. Forthwind suggests that the cumulative effect of the LDT operational extension with the 9 turbine Forthwind Demonstration array is considered by the LDT ES and evidence provided how this will be taken into account and identify mitigation to both reduce the cumulative noise impact on the local Methil community and avoid financial impact potentially inflicted on the Forthwind development. It should be noted that Forthwind submitted its proposal 2 months before the LDT screening request was submitted to Marine Scotland and 5 months before LDT submitted their scoping report; as such there is an onus on the LDT to demonstrate how it will manage cumulative impact with the Forthwind Array development.

Ornithology

The LDT Scoping report concludes that "Based on the previous assessment and preliminary analysis of the operational monitoring results, it is anticipated that operational impacts on ornithological resources will not be significant and therefore it is also proposed to scope out an assessment of the operational effects." Forthwind disagrees with the ORE Catapult proposal to scope out ornithology from the ES.

Although the scoping report does acknowledge that changes have been made to both ornithological impact assessment guidance and methodologies, it discounts the relevance of these changes and does not offer to undertake any assessment of the resultant impacts by extending the operational period by 10 years (even though the original assessment was for only a 5-year period). It is self-evident that extending an operational period by 3 times will have a resultant increase in ornithological impact. It is essential that the LDT ES considers how collision risk to birds and potential displacement of birds is assessed for the extended operational period of the proposal.

It should be noted that the LDT turbine currently absorbs a proportion of the natural ornithological capacity to adapt to impacts (both in terms of collision risk and disturbance) – in particular to the nearshore seabird population. This consequently reduces the available space for further developments within the area. Forthwind, in good faith, have expended significant resource in the development of the Forthwind Array project (based on the assumption that the LDT was to be decommissioned in 2019). Arguably this capacity should be "released" for projects that are under development and consulted upon before the LDT scoping request and that the subsequent LDT extension ES takes into consideration the measured ornithological baseline (minus the estimated impact of an operational LDT) and further consider the cumulative impact with the Forthwind consented development and the proposed Forthwind array.

As the development landscape in the area has significantly changed, the LDT extension ES has to address the additional cumulative ornithological impact of an extended 10 year operation and as a minimum should take into consideration the consented two turbine Forthwind Offshore Wind Demonstration Project and the proposed Forthwind Offshore Wind Turbine Demonstration Array.

Landscape and Visual Impact

Forthwind welcome the inclusion of both our consented Offshore Wind Demonstration Project and our proposed Offshore Wind Turbine Demonstration Array. According to SNH and Marine Scotland viewpoints, the 2B Energy technology will become the predominant technology within the area

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Historic Environment Scotland

Thank you for your consultation which we received on 04 May 2017 about the above scoping report. We have reviewed the details in terms of our historic environment interests. This covers world heritage sites, scheduled monuments and their settings, category A-listed buildings and their settings, inventory gardens and designed landscapes, inventory battlefields and historic marine protected areas (HMPAs).

Fife Council's archaeological and cultural heritage advisors will also be able to offer advice on the scope of the cultural heritage assessment. This may include heritage assets not covered by our interests, such as unscheduled archaeology, and category B- and C-listed buildings.

Proposed Development

I understand that the proposals are for the variation of Condition 1 of the existing Section 36 Consent for the Levenmouth Demonstration Turbine (previously known at the Fife Energy Park Offshore Demonstration Wind Turbine). The variation proposes to extend the operational lifespan of the consented development for 10 years. I understand that there will be no change to any built or physical aspects of the Levenmouth Demonstration Turbine.

Scope of assessment

We have reviewed the Scoping Report (April 2017) and note that it is proposed to scope the Cultural Heritage topic area out of the assessment. We note that the original Environmental Statement (2012) for the proposals did not identify any significant effects on our historic environment interests and that our predecessor body, Historic Scotland, did not object to the proposals (24 August 2012). In light of the fact that there will be no physical changes to the Levenmouth Demonstration Turbine as a result of the variation, and that no additional heritage assets within our remit have been designated during the intervening period, we are content to agree

with the Scoping Report as we do not consider that the proposals will give rise to additional effects on our historic environment interests.
We hope this is helpful. Please contact us if you have any questions about this response.

Marine and Coastguard Agency

Thank you for your email dated 4 May 2017 requesting MCA comments to the variation request from Arcus Consultancy Services Ltd (Arcus) on behalf of Offshore Renewable Energy Catapult (OREC) for an extension in the operational life of the LDT, from five years to 15 years.

Recognising that there will be no change to any built or physical aspects of the ‘as built’ LDT we have no objection to the extension and variation to the licence condition 1, however I would like to request an additional licence condition as follows:

- No part of the authorised development may commence until Marine Scotland, in consultation with the MCA, has given written approval for an Emergency Response Co-operation Plan (ERCoP) which includes full details of the ERCoP for the construction, operation and decommissioning phases of that part of the authorised development in accordance with the MCA recommendations contained within MGN543 "Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues".

In addition, I can confirm that licence condition 17 (“The works must be maintained by the Company at all times in good repair.”) is not necessary and we would be content for it to be removed.

National Air Traffic Services

The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal.

However, please be aware that this response applies specifically to the above consultation and only reflects the position of NATS (that is responsible for the management of en route air traffic) based on the information supplied at the time of this application.

This letter does not provide any indication of the position of any other party, whether they be an airport, airspace user or otherwise. It remains your responsibility to ensure that all the appropriate consultees are properly consulted.

If any changes are proposed to the information supplied to NATS in regard to this application which become the basis of a revised, amended or further application for approval, then as a statutory consultee NERL requires that it be further consulted on any such changes prior to any planning permission or any consent being granted.

Northern Lighthouse Board

Thank you for your correspondence dated 04 May 2017 requesting a response to the application for an extension to the operational life of the Levenmouth Demonstration Turbine.

We would advise that the Northern Lighthouse Board are content with the extension of operational life from five years to 15 years.

Royal Society for the Protection of Birds

Thank you for consulting RSPB Scotland on an extension to the operational period of the Levenmouth Demonstration Turbine (LDT) for a further 10 years.
When RSPB Scotland responded to the original planning applicaton for this development in September 2012 we considered the short time the turbine will be operational (a maximum of five years) in our assessment that the impacts would be minimal.

We do not agree with the decision to scope out ornithology and consider this topic to be of high significance within the Environmental Statement.

The Scoping report does not acknowledge that the development is also now located in the Outer Firth of Forth and St Andrews Bay Complex proposed Special Protection Area (pSPA).

Consideration should be given to the breeding and wintering qualifying interest of this site and Marine Scotland should carry out a Habitat Regulations Appraisal to assess whether the development affects the Natura site. Such an assessment should also include impacts on the Firth of Forth and Forth Islands SPA. An assessment of cumulative impacts with other developments in the Firth of Forth should also be conducted.

Pre and post-construction monitoring data could be used to assess any impact on the pSPA andthe Firth of Forth and Forth islands SPAs. An intention to carry out an analysis of any changes in number/distribution of birds is highlighted in the Project Environmental Monitoring Programme
(PEMP – published in August 2016) and we request that this is carried out as part of this assessment. Particularly as the project is now at its third year of operation.
Page 32 of Annex D of the PEMP states:

It is intended that more detailed analysis to compare operational phase monitoring data with the pre-construction baseline data collected for the EIA will be carried out after the third year of operation, when trends in the distribution and abundance of birds may become evident. This could examine whether there has been any statistically significant difference in the occurrence of birds within 500 m of the turbine location (e.g. by comparing densities of each species between years) and could also examine whether or not habituation to the turbine occurs (e.g. by comparing mean distance to turbine).
A comparison should also be made using WeBs data from the BTO or data collected as part of other projects to determine how bird numbers have changed in the wider area over the same time period.
If consent is given such analysis should continue over time with a regular monitoring programme developed.
It is noted that in the PEMP that eider (a qualifying species for the Firth of Forth SPA and pSPA) are highlighted as a bird where density has significantly declined post construction.

> Peak density: 185.5 birds/km2 pre-construction vs 94.5 birds/km2 operation;
> Peak-mean density: 119.5 birds/km2 pre-construction vs 41.8 birds/km2 operation.

The PEMP also highlights that pre-construction monitoring was limited to late summer and autumn, missing the main breeding and wintering period for qualifying interests in the SPA and pSPA. With such a limited baseline and as a single turbine recording meaningful information on changes in bird usage of the area or displacement behaviour is difficult.

With a longer operational life and as a demonstration project there is an opportunity to embed more robust monitoring and trial techniques that could be used in other off-shore developments.

For example the deployment of cameras on the turbine to record collision which may be missed during 12 hours a month of vantage point surveys. Novel techniques could also be used to accurately measure flight heights through the survey area.

Royal Yachting Association

As no physical change is proposed for LDT, RYA Scotland agrees that navigation and the effects on recreational boating can be scoped out of the EIA.

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Scottish Fishermen's Federation

Apologies for lateness but it is a NIL RESPONSE from SFF.

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Transport Scotland

We refer to your recent correspondence on the above development. This information has been passed to SYSTRA Limited for review in their capacity as Term Consultants to Transport Scotland – Trunk Road and Bus Operations (TRBO). Based on the review undertaken, we would provide the following comments.

It is understood that Arcus Consultancy Services Ltd (Arcus) on behalf of Offshore Renewable Energy Catapult (OREC) have requested a variation to the consent originally granted by Scottish Ministers in May 2013 with a varied consent also granted in March 2016. The variation is for an extension in the operational life of the LDT, from five years to 15 years with no change to any built or physical aspects of the 'as built' LDT.

Transport Scotland commented on both the original application and the first variation application. In our correspondence of 25 November 2014, we concluded that the proposed development will have no significant environmental impact on the trunk road network and its adjacent receptors as a result of increased development traffic.
Having reviewed the proposed variation, our position remains unchanged from the previous correspondence, and we can again confirm that the proposed development will have no significant impact on the trunk road network. Consequently, we do not require any further information in this regard.

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Whale & Dolphin Conservation

Thank you for including WDC in the Proposed Section 36 Variation for the extension of the operational life of the Levenmouth demonstration turbine from 5 to 15 years.
We agree that marine mammals can be 'scoped out' of the ES addendum.

Appendix II: Licensing Process

Application

The application letter must detail how many licences are being sought, what marine licensable activities are proposed and what legislation the application is being made under.

Developers should be aware that the EIA Report should also be submitted in a user-friendly PDF format which can be placed on the Scottish Government website. Developers are asked to issue the EIA Report directly to consultees. Consultee address lists can be obtained from Marine Scotland. Marine Scotland also requires 2 hardcopies to be submitted for onward distribution.

Scottish Natural Heritage ("SNH") has produced a Service Level Statement ("SLS") for renewable energy consultation. This statement provides information regarding the level of input that can be expected from SNH at various stages of the EIA process. Annex A of the SLS details a list of references, which should be fully considered as part of the EIA process. A copy of the SLS and other vital information can be found on the renewable energy section of their website – www.snh.org.uk.

Ordnance Survey ("OS") Mapping Records

Developers are requested at application stage to submit a detailed OS plan showing the site boundary and location of all deposits and onshore supporting infrastructure in a format compatible with The Scottish Government's Spatial Data Management Environment ("SDME"), along with appropriate metadata. The SDME is based around Oracle RDBMS and ESRI ArcSDE and all incoming data should be supplied in ESRI shape file format. The SDME also contains a metadata recording system based on the ISO template within ESRI ArcCatalog (agreed standard used by The Scottish Government); all metadata should be provided in this format.

Gatecheck

MS-LOT undertakes a gatecheck prior to formal submission of applications and advises you to take full advantage of this service. The gatecheck is not designed as an in depth evaluation of the content of an EIA Report. However, it will allow MS-LOT the confidence that minimum legislative requirements have been met prior to formal submission of the EIA Report. This should reduce the risk of the potential requirement for you to submit an addendum to the EIA Report and therefore be subject to re-advertisement and re-consultation for 30 days. In order to assist the gatecheck process, a thorough gap analysis (Appendix II) of the issues identified in this Scoping Opinion should be drawn up for submission with the EIA Report. It should be noted that gatecheck will only take place if the final and full version of the

EIA Report is submitted.

Advertisement

Where the developer has provided MS-LOT with an EIA Report, the developer must publish their proposals in accordance with Regulation 14 of The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 . Licensing information and guidance, including the specific details of the adverts to be placed in the press, can be obtained from Marine Scotland.

If additional information is submitted further public notices will be required.

Appendix III: Gap Analysis

Gap Analysis template.xlsx

APPLICANT TO COMPLETE								FOR MS-LOT ONLY				
Consultee					Applicant				Reviewed			
Consultee	Number/reference	Consultee's response	Chapter/paragraph	Summary of response (Key concern, etc)	Response from applicant	Evidence eg. ES reference	Comments	Comments	by	date	by	date

APPENDIX 6.1

NOISE TECHNICAL REPORT

Arcus

Levenmouth Demonstration Turbine
Environmental Assessment
Decmber 2017 Revision 2.

NOISE & VIBRATION

Audit sheet

Rev.	Date	Description	Prepared	Verified
1	30/11/2017	First version for review	MMC	MJ
2	06/12/2017	Updated consistency points	MMC	

This report has been prepared for the named client only and expressly for the purposes set out in our appointment and we owe no duty of care to any third parties in respect of its content. Therefore, unless expressly agreed by us in signed writing, we hereby exclude all liability to third parties, including liability for negligence, save only for liabilities that cannot be so excluded by operation of applicable law.

Contents

Non-Technical Summary

Hoare Lea (HL) have been commissioned by Arcus to undertake a noise assessment of the proposed extension to the operational life of the Levenmouth Demonstration Turbine. Noise is emitted by the turbine during operation. The level of noise emitted by the source and the distance from those sources to the receiver locations are the main factors determining levels of noise at receptor locations.

Operational turbines emit noise from the rotating blades as they pass through the air. This noise can sometimes be described as having a regular 'swish'. The amount of noise emitted tends to vary depending on the wind speed. When there is little wind the turbine rotors will turn slowly and produce lower noise levels than during high winds when the turbine reaches its maximum output and maximum rotational speed. Background noise levels at nearby properties will also change with wind speed, increasing in level as wind speeds rise due to wind in trees and around buildings, etc.

Noise levels from operation of the turbine have been determined at locations around the site potentially affected by noise. Surveys have been performed to establish existing baseline noise and operational levels at a number of locations. Noise limits have been derived from data about the existing noise environment (in the absence of turbine noise) based on the method stipulated in national planning guidance. The assessment takes full account of the potential combined effect of the noise from the Development along with the consented Forthwind Demonstration Project. Other, more distant wind farms were not considered as either not enough information was available or they did not make an acoustically relevant contribution to cumulative noise levels.

Predicted operational noise levels have been compared to limit values derived from the extant consent. Although an excess above the limits was predicted in some conditions, based on a conservative analysis, measures are available and have been put in place to mitigate these instances. Furthermore, cumulative effects including the Forthwind Demonstration Project are either negligible or result in total noise levels which remain within acceptable levels. It is concluded therefore that operational noise levels from the wind turbine will be within levels deemed, by national guidance, to be acceptable for wind energy schemes.

1. Introduction

1.1.1 This report presents an assessment of the effects of the proposed extension to the operational life of the Levenmouth Demonstration Turbine (the LDT) in terms of noise on nearby sensitive receptors.

1.1.2 The LDT was constructed following a consent supported by a 2012 Environmental Statement (ES), with Chapter 6 of that ES presenting the assessment of noise impact. This 2012 ES was based on a baseline survey undertaken in 2010 by Arcus. The present report presents the results of a survey in 2015 which complements this previous survey.

1.1.3 Since the turbine is now built and operational, construction effects are not relevant. The present chapter focuses on operational impacts, both for the scheme in isolation and cumulatively with other developments in the area. Specifically, the consented Forthwind Demonstration Project will be considered. The proposed Forthwind Offshore Wind Demonstration Array is currently at scoping stage with limited information available to allow a detailed impact assessment. The assessment for the proposed Forthwind Offshore Wind Demonstration Array will need to consider the impact of the proposed extension of the operational life of the LDT. Other, more distant wind farms were not considered because their potential noise contribution was considered negligible.

1.1.4 Once constructed and operating, wind turbines may emit two types of noise. Firstly, aerodynamic noise is a 'broad band' noise, sometimes described as having a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. This is a less natural sounding noise which is generally characterised by its tonal content. Traditional sources of mechanical noise comprise gearboxes or generators. Due to the acknowledged lower acceptability of tonal noise in otherwise 'natural' noise settings such as rural areas, modern turbine designs have evolved to minimise mechanical noise radiation from wind turbines. Aerodynamic noise tends to be perceived when the wind speeds are low, although at very low wind speeds the blades do not rotate or rotate very slowly and so, at these wind speeds, negligible aerodynamic noise is generated. In higher winds, aerodynamic noise is generally masked by the normal sound of wind blowing through trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise determines the subjective audibility of the wind farm. The relationship between wind turbine noise and the naturally occurring masking noise at residential dwellings lying around the Development will therefore generally form the basis of the assessment of the levels of noise against accepted standards.

1.1.5 An overview of environmental noise assessment and a glossary of noise terms are provided in Annex A.

2. Policy and Guidance Documents

2.1 Planning Policy and Advice Relating to Noise

2.1.1 Scottish Planning Policy (SPP)[1] provides advice on how the planning system should manage the process of encouraging, approving and implementing renewable energy proposals including onshore wind farms. Whilst SPP suggests noise impacts are one of the aspects that will need to be considered it provides no specific advice. Planning Advice Note PAN1/2011[2] provides general advice on the role of the planning system in preventing and limiting the adverse effects of noise without prejudicing investment in enterprise, development and transport. PAN1/2011 provides general advice on a range of noise related planning matters, including references to noise associated with both construction activities and operational wind farms. In relation to operational noise from wind farms, Paragraph 29 states that:

> *'There are two sources of noise from wind turbines - the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed, and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for Onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry [DTI] and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise.'*

2.1.2 The Scottish Government's Online Renewables Planning Advice on Onshore wind turbines[3] provides further advice on noise, and confirms that the recommendations of 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97)[4] "*should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments*". The aim of ETSU-R-97 is:

> *'This document describes a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities. The suggested noise limits and their reasonableness have been evaluated with regard to regulating the development of wind energy in the public interest. They have been presented in a manner that makes them a suitable basis for noise-related planning conditions or covenants within an agreement between a developer of a wind farm and the local authority.'*

2.1.3 The recommendations contained in ETSU-R-97 provide a robust basis for assessing the noise implications of a wind farm. ETSU-R-97 has become the accepted standard for such developments within the UK. Guidance on good practice on the application of ETSU-R-97 has been provided by the Institute of Acoustics (IOA Good Practice Guide or GPG)[5]. This was subsequently endorsed by the Scottish Government[6] which advised in the web based planning advice note that this *'should be used by all IOA members and those undertaking assessments to ETSU-R-97',* The methodology of ETSU-R-97 and the IOA GPG has therefore been referenced in the present assessment and is described in greater detail below.

2.1.4 With regard to infrasound and low-frequency noise, the above-referenced online planning advice note, Onshore wind turbines refers to a report for the UK Government which concluded that *'there is no evidence of health effects arising from infrasound or low frequency noise generated by the wind turbines that were tested'*. This subject is considered further in Section 5.4 and Annex A.

2.1.5 PAN1/2011 and the Technical Advice Note[7] accompanying PAN1/2011 note that construction noise control can be achieved through planning conditions that limit noise from temporary construction-sites, or by means of the Control of Pollution Act (CoPA) 1974[8]. The CoPA provides two means of controlling construction noise and vibration. Section 60 provides the Local Authority with the power to impose at any time operating conditions on the development site. Section 61 allows the developer to negotiate a prior consent for a set of operating procedures with the Local Authority before commencement of site works.

3. Scope and Methodology

3.1 Methodology for Assessing Wind Farm Operational Noise

3.1.1 The ETSU-R-97 assessment procedure specifies that noise limits should be set relative to existing background noise levels at the nearest properties and that these limits should reflect the variation in both turbine source noise and background noise with wind speed. The wind speed range which should be considered is between the cut-in speed (the speed at which the turbines begin to operate) for the turbines and 12 m/s, where all wind speeds are referenced to a ten-metre measurement height (refer to Annex F for a discussion of how wind speeds are referenced to ten metre height).

3.1.2 Separate noise limits apply for the day-time and night-time. Day-time limits are chosen to protect a property's external amenity whilst outside their dwellings in garden areas and night-time limits are chosen to prevent sleep disturbance indoors. Absolute lower limits, different for day-time and night-time, are applied where the measured background noise levels equates to very low levels (< 30 dB(A) to 35 dB(A) for day-time, and < 38 dB(A) during the night).

3.1.3 For both day and night-time periods, multiple samples of ten minute background noise levels using the $L_{A90,10min}$ measurement index are measured contiguously over a wide range of wind speed conditions (a definition of the $L_{A90,10min}$ index is given in Annex A). The measured noise levels are then plotted against the simultaneously measured wind speed data and a 'best-fit' curve is fitted to the data to establish the background noise level as a function of wind speed.

3.1.4 The ETSU-R-97 day-time noise limit is then set to the greater of either: a level 5 dB(A) above the best-fit curve to the background noise data over a 0-12 m/s wind speed range <u>or</u> a fixed level in the range 35 dB(A) to 40 dB(A). The night-time noise limit is set as the greater of: a level 5 dB(A) above the best-fit background curve <u>or</u> a fixed level of 43 dB(A). This fixed lower night-time limit of 43 dB(A) was set in ETSU-R-97 on the basis of World Health Organization (WHO) guidance[9] for the noise inside a bedroom and an assumed difference between outdoor and indoor noise levels with windows open. In the time since ETSU-R-97 was released, the WHO guidelines were revised to suggest a lower internal noise level, but conversely, a higher assumed difference between outdoor and indoor noise levels. Notwithstanding the WHO guideline revisions, the ETSU-R-97 limit remains consistent with current national planning policy guidance with respect to night-time noise levels. In addition, following revision of the night-time WHO criteria, ETSU-R-97 has been incorporated into planning guidance for Wales, England and Scotland and at no point during this process was it felt necessary to revise the guidance within ETSU-R-97 to reflect the change in the WHO guideline internal levels. The advice contained within ETSU-R-97 remains a valid reference on which to continue to base the fixed limit at night.

3.1.5 The noise limits defined in ETSU-R-97 relate to the total noise occurring at a dwelling due to the combined noise of all operational wind turbines. The assessment will therefore need to consider the combined operational noise of the Development with other wind farms in the area to be satisfied that the combined cumulative noise levels are within the relevant ETSU-R-97 criteria. The IOA GPG also states that if the contribution of another wind farm is 10 dB or more below that of another wind farm, its relative contribution is considered negligible. ETSU-R-97 also requires that the baseline levels on which the noise limits are based do not include a contribution from any existing turbine noise, to prevent unreasonable cumulative increases.

3.1.6 Please note that the term 'noise emission' relates to the sound power level actually radiated from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level (the perceived noise) at any receptor location due to the combined operation of all wind turbines on the Development.

3.2 Operational Noise Criteria

3.2.1 Following consultation with Marine Scotland and Fife Council, in March 2016 the Scottish Ministers granted an application to vary the initial consent for the LDT. The variation comprised a change of wording for condition 13 and a replacement of the numerical noise limits stated in Annex 3 of the original consent, which were based on the survey results referenced in the 2012 ES. These specific limits were replaced with a more generic statement:

> *"At standardised 10 m wind speeds not exceeding 12 ms-1, the rating level of noise emissions (measured as LA90,10 min) from the wind turbine, when measured at any dwelling in existence prior to the installation of the Development or at any dwelling which has been given planning permission prior to such installation, shall not exceed:*
>
> *• The greater of 35 dB(A) or 5 dB above the prevailing background noise (LA90,10 min) between the hours of 07:00-23:00; and*
>
> *• The greater of 43 dB(A) or 5 dB above the prevailing background noise (LA90,10 min) between the hours of 23:00-07:00."*

3.2.2 These noise limits are consistent with ETSU-R-97 which was described in the previous section. The wording of Condition 13 was changed to correctly reference these limits as set out in Annex 3 of the original consent. It is therefore possible to determine noise limits based on background noise measurements under different conditions, such as those which prevail at the site in different wind directions. As these limits are based on ETSU-R-97, they represent relevant criteria on which to base the assessment of the LDT. Consideration of prevailing background noise levels in different directions is also consistent with the IOA GPG.

3.2.3 Consequently, the test applied to operational noise is whether or not the calculated wind farm noise immission levels at nearby noise sensitive properties lie below these noise limits, which are themselves based on ETSU-R-97. Depending on the levels of background noise the satisfaction of the noise limits can lead to a situation whereby, at some locations under some wind conditions and for a certain proportion of the time, the wind farm noise may be audible. However, noise levels at the properties in the vicinity of the Development will still be within levels considered acceptable under the ETSU-R-97 assessment method.

3.3 Operational Wind Turbine Emissions Data

3.3.1 The LDT is currently operational at the site and is a variable speed, pitch regulated machine with a rotor diameter of 172 m. It is installed at the following coordinate: easting/northing 336816 / 698362. Due to its variable speed operation, the sound power output of the turbine varies considerably with wind speed, being quieter at the lower wind speeds when the blades are rotating more slowly. Due to the nature of the LDT turbine (being a demonstration turbine), there are no formal tested noise emission data available.

3.3.2 In the 2012 ES, the assessment of the proposal was based on theoretical emissions levels. Since the LDT was since installed and is operational, it has now been possible to undertake measurements of noise from the turbine, as described later in the present report. These measurements were however supplemented by a predictive noise model to better represent the variation in turbine noise levels from the LDT at different wind speeds, as well as allowing an assessment of the relative decrease of noise levels at more distant locations.

3.3.3 Table 1 provides a sound emission profile for the LDT turbine which is based on generic data and considered to provide a reasonable representation of the evolution of measured noise levels with wind speeds, rather than an absolute level representative of the emissions of the turbine. This was also based on information that the turbine reached its rated power (and therefore, in common with other similar turbines, its maximum level of noise emissions) at a standardised wind speed of 7 m/s. Table 2 provides a representative emission spectrum based on other comparable size turbines. The resulting predictions at the closest three locations were adjusted to match with the measured levels in different conditions (see Section 4.5).

3.3.4 Reduced noise operation is available for most modern variable speed, pitch-regulated wind turbine models and allows the sound power output of the turbine to be reduced across a range of operational wind speeds, albeit with some loss of electrical power generation. These systems are generally similar in that they rely on the turbine's computer based controller adjusting either the pitch of the blades or holding back the rotational speed of the blades to reduce emitted noise under selected wind conditions (direction, speed or some combination of the two). In this manner, noise management only comes into play (and therefore potential power generation capacity is only lost) for those conditions under which it is required. Noise control modes for the LDT are under development, and although likely to be available in the near future there was no specific information which could be used at this stage. The control system of the LDT however allows the turbine to be turned off in different wind conditions or at different times.

3.3.5 A predictive model was also required to evaluate the potential cumulative noise effects from the consented Forthwind Demonstration Project as part of the cumulative noise assessment. This was based on the emission levels assumed in the Forthwind ES which were considered preliminary and were based on theoretical predictions, with the addition of a conservative margin of +2 dB for potential uncertainties in accordance with current good practice. See Table 1 for the resulting emission levels, and Table 2 for the representative spectra set out in the Forthwind ES and which was also based on generic data.

Table 1 - Wind Turbine Sound Power Levels Used in the Noise Assessment

Standardised Wind Speed (m/s)	Sound Power Level (dB L_{Aeq})	
	LDT turbine – noise emission profile*	Forthwind 2B turbines
4	107.8	103.0
5	111.0	105.6
6	114.0	108.2
7	116.0	110.1
8	116.0	111.0

Standardised Wind Speed (m/s)	Sound Power Level (dB L_{Aeq})	
	LDT turbine – noise emission profile*	Forthwind 2B turbines
9	116.0	112.5
10	116.0	113.7
11	116.0	111.1
12	116.0	108.5

**Modelled relative evolution of noise with wind speed (rather than absolute level)*

Table 2 - Octave Band Sound Power Spectrum (dB L_{Aeq}) For Reference Wind Speed Conditions (v_{10} = 8 m/s)

Octave Band Centre Frequency (Hz)	A-Weighted Sound Power Level (dB(A))	
	LDT turbine – noise emission profile	Forthwind 2B turbines
63	92.6	92.6
125	101.6	101.6
250	108.6	108.6
500	109.6	109.6
1000	105.6	105.6
2000	101.6	101.6
4000	96.6	96.6
8000	91.6	91.6

3.4 Choice of Wind Farm Operational Noise Propagation Model

3.4.1 The ISO 9613-2 model[10] has been used where required to calculate noise immission levels as advised in the IOA GPG. The model accounts for the attenuation due to geometric spreading, atmospheric absorption, and barrier and ground effects. All attenuation calculations have been made on an octave band basis and therefore account for the sound frequency characteristics of the turbines.

3.4.2 For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of four metres above local ground level and an air absorption based on a temperature of 10°C and 70% relative humidity. A receiver height of four metres will be typical of first floor windows and result in slightly higher predicted noise levels than if a 1.2 to 1.5 metre receiver height were chosen in the ISO 9613 algorithm. There are no screening effects found at the site and therefore this element was excluded from the model.

3.4.3 As the LDT is located close to the shoreline, propagation occurs effectively over land and a ground factor of G=0.5 can be used as advised in the IOA GPG. For the more distant Forthwind turbines, propagation over water occurs and in that case a factor of G=0 (fully reflective or "hard" ground) was used. In addition, several references[11,12] also propose an additional factor of $10log(d/d_0)$ to account for enhanced propagation over the sea in some atmospheric conditions. The reference distance d_0 would vary in reality based on a range of factors but a value of d_0 of 1 km was assumed in line with the latest guidance[12]. In addition, a detailed study[11] points out that when the offshore noise propagation reaches the shore, reflection effects of the shoreline lead to reductions of typically 3 decibels (dB). Therefore, for properties which are clearly located inland, such as Locations 1 to 3 in Table 3, a factor of 3 dB was deducted from the calculated levels for the Forthwind turbines. For the other assessment locations which are situated closer to the edge of the shore, this reduction was not applied as a precautionary measure.

3.4.4 This method is consistent with the recommendations of the above-referenced Institute of Acoustics Good Practice Guide which provides recommendations on the appropriate approach when predicting wind turbine noise levels. The IOA GPG also allows for directional effects to be taken into account within the noise modelling: under upwind propagation conditions between a given receiver and the wind farm the noise immission level at that receiver can be as much as 10 dB(A) to 15 dB(A) lower than the level predicted using the ISO 9613-2 model. However, predictions have initially been made assuming downwind propagation from every turbine to every receptor at the same time as a worst-case.

4. Baseline and survey data

4.1 General Description

4.1.1 The LDT is located in the Fife Energy Park which is an industrial/commercial area on the coast in Buckhaven. The noise environment in the surrounding area is generally influenced by industrial activity, particularly from the nearby Burntisland Fabrications Ltd (BiFab) site. Noise from these activities are permitted 24 hours a day: therefore, although they tend to occur mainly during the day-time, work also sometimes occurs at night depending on the BiFab site works schedule. In addition, coastal water movements were a clear contributor particularly in onshore wind conditions. Other sources of noise include birdsong and distant light aircraft.

4.2 Assessment locations

4.2.1 A total of three noise monitoring locations were previously agreed with the Local Authority, Fife Council, as being representative of the background noise environment for the nearest residences to the LDT. Measurements were undertaken by Arcus in 2010 at these three locations, as detailed in the 2012 ES. The locations used are shown on the plan in Annex B and listed at the start of Table 3. These measurements were used in the 2012 ES but no analysis of was made of how these background noise levels vary with wind direction.

4.2.2 Supplementary measurements were collected by Hoare Lea over a period of approximately nine weeks from 13 August 2015 to 18 October 2015. This additional monitoring was undertaken both in periods when the LDT turbine was operating and not operating: the aim was to evaluate how both background noise and turbine noise levels varied at the Site with regard to wind speed and wind direction. For example, it was observed that background noise levels appeared to increase under broadly onshore winds likely due to the influence of coastal waves.

4.2.3 The three locations used for these measurements were selected to be as similar as possible to the three locations that were used during the 2010 Arcus operational noise assessment, however it was decided that it was preferable to conduct monitoring within the Fife Energy Park site to avoid any potential access complications and associated delays that could be incurred by monitoring at residential properties. Locations 1 and 2 that have been used in the survey described in this report are the same as those that were used in the Arcus survey (being within the Fife Energy Park). A proxy was chosen for location 3 which was closer to the turbine and further from residential properties, being located on the south-western site boundary of the Fife Energy Park, as opposed to Location 3 shown in the 2012 ES, which was in the garden of 12 Erskine Street. Both locations are highlighted on the plan in Annex B. The background noise environment was however considered reasonably representative in all cases for all properties selected. Further detailed information about the locations, the equipment used and pictures of the survey locations are presented in Annex C.

4.2.4 Additional assessment locations were also considered in the ES for the Forthwind Demonstration Project (Forthwind ES), and these become relevant when considering cumulative impacts. These are also set out in Table 3 below. The resulting list of receptor locations is not intended to be exhaustive but sufficient to be representative of the receptors closest to the LDT and other schemes considered. The Forthwind ES describes the details of the baseline background noise monitoring undertaken to derive noise limits at these additional locations using the method set out in ETSU-R-97.

Table 3 - Noise Assessment Locations (approximate Easting / Northing)

No.	Property	Easting	Northing
1	Location 1 - 20 Wellesley Road	336441	698727
2	Location 2 - 94 Wellesley Road	336229	698480
3	Location 3 - 12 Erskine St*	336092	698226
4	13 Shore Street	336120	698042
5	26 Back Dykes	333834	696495
6	3 Cave Cottages	334211	696883
7	51-57 West High Street	335791	697727
8	9 Shore Street	335955	697932

** In the 2015 measurements described in the present report, measurements were undertaken at a proxy location at the following coordinates: 336299, 698202 (see Annex C).*

4.3 2015 Noise survey description

4.3.1 Measurements were undertaken between 13th August 2015 and 19th October 2015. This equates to a total monitoring period of approximately 9 weeks. During this period, the LDT turbine was both operating and stopped at different times, but otherwise operated without specific mitigation measures in place. This allowed measurements over a wide range of conditions for both background (or residual) noise levels in the absence of turbine noise and ambient noise levels which consist of the noise from the wind turbines and other non-wind-turbine-related noise sources.

4.3.2 The monitoring equipment used for the 2015 survey consisted of two Rion NL52 and one Rion NL32 logging sound level meters, enclosed in environmental cases. All monitoring equipment used during the survey met the requirements of Type 1 / Class 1 noise monitoring equipment. All microphones were mounted at 1.2 to 1.5 m above local ground height and windshields, suitable for use in elevated wind conditions, were fitted to the microphones for all measurements. The microphone windshields used were supplied by the equipment manufacturer and are quoted by the equipment manufacturer as maintaining the Type 1 / Class 1 performance of the system when fitted. Full details of the equipment used during the Hoare Lea survey can be found in Annex C of this report.

4.3.3 The sensitivity of all measurement systems used during the initial survey was checked on site by means of a calibrated acoustic calibrator at the beginning, end and periodically during the survey. No significant (>0.5 dB) changes in sensitivity were observed on any of the monitoring systems. All systems were set to log the L_{A90} measurement descriptor in 10 minute periods, as required for the measurement procedures set out in ETSU-R-97 and the IOA GPG. The internal clocks on the sound level meters were all synchronized with Greenwich Mean Time (GMT) by the use of a Global Positioning System (GPS) receiver. The clock on the met mast from which wind data was subsequently collected for the analysis of the measured noise levels as function of wind speed was also set to GMT.

4.3.4 It should be noted that, during the entire 2015 survey period, it was our understanding that activity at the BiFAB plant was relatively reduced, and in particular that the site was not operating during the night. Whilst it was noted that there was a Lidar system installed on the site at the start of the survey period with an associated generator (see plan of Annex B), and that this may have had an effect on the measured ambient noise levels at Locations 2 and 3, the Lidar system and generator had been removed by the time of the first site visit to service the monitoring equipment (i.e., the Lidar was removed within the first three weeks of the survey period) and the analysis of the measured noise levels at Location 2 and 3 suggests that the generator did not significantly affect the measurements whilst it was installed.

4.4 Wind speed analysis

4.4.1 The ETSU-R-97 assessment method requires noise data to be related to wind speed data at a standardised height of ten metres, with wind speeds either directly measured at a height of ten metres or by calculation from measurement at other heights.

4.4.2 In both the 2010 and 2015 surveys, the measurements were referenced to wind speeds at the turbine’s hub height (110 m) and expressed at a standard height of 10 m using a standard correction factor (see Annex F). The resulting “standardised wind speeds” are therefore derived in accordance with the preferred method set out in the IOA GPG, to account for the potential effect of site-specific wind shear.

4.4.3 For the 2010 survey, wind speeds measured at 70 m and 51 m height were used to extrapolate the 110 m high wind speed, as allowed in the IOA GPG: see the 2012 ES for details. For the 2015 survey, an anemometry mast located on the site (easting/northing 336447, 698309) measured wind directly at 110 m height.

4.5 Measured Background Noise Levels

4.5.1 The present section first considers background measurements taken either in 2010, prior to construction of the LDT, and in 2015 during turbine shutdown periods.

4.5.2 Following additional consultation, and as a simplifying assumption, it was decided to consider two main wind direction sectors:

- Onshore: wind directions of 20 to 190 degrees from north.
- Offshore: wind directions of 190 to 20 degrees from north.

4.5.3 To maximise the amount of background data obtained, and the effective range of wind directions and wind speeds in the dataset, the 2010 and 2015 background datasets were combined at each location and a revised analysis undertaken for day-time and night-time periods in both of the above wind direction sectors. The day-time analysis was undertaken over the entire day-time period, 07:00 to 23:00, as stated in the 2016 varied condition, which was consented following consultation with Fife Council and Marine Scotland. Although the general procedure of ETSU-R-97 defines day-time limits based on backgrounds measured during quiet periods of the day (see 2012 ES), ETSU-R-97 does allow for consideration of other periods of the day in some cases. In the present case, the strong influence of industrial activities in the noise environment at the site makes this a relevant consideration.

4.5.4 The measured data was analysed in line with good practice, with periods of rainfall and atypical noise excluded where relevant. More specifically:

- The 10 minute periods before, during and after a 10-minute period within which the rain gauge installed at Location 1 registered rainfall were excluded. This is to minimise the effect of rainfall hitting the microphone windshield and the effect of wet road surfaces on measured noise levels. Since the rain gauge that was installed at the site is a tipping bucket gauge, there is the possibility that the period before or after rainfall was recorded could have included some rain, but insufficient rain to cause the bucket to tip, hence the periods before and after rainfall have been excluded. Any data removed from the analysis in this way is indicated on the charts as blue circles.
- For the 2015 dataset, the turbine operational status was determined by reference to its operational data, with the turbine being considered “off” if the mean power generation during a 10-minute period was less than 0.01 MW.

4.5.5 Figures D1 to D12 of Annex D show the results of the background noise measurements at all three locations considered. The background noise data are presented in terms of $L_{A90,10min}$ background noise levels plotted as a function of ten metre height wind speed. Four plots are shown for each location, separated into onshore and off-shore conditions for both day-time periods and night-time periods.

4.5.6 Best-fit lines were then generated using a polynomial fit of a maximum of 4^{th} order. These lines of best-fit were then used to derive noise limits for day-time and night-time in accordance with the extant

LDT consent conditions described above (section 3.2). These conditions define noise limits based in part on background noise levels, which may vary at different times and in different wind conditions, or the level of industrial activity in the area for example. The resulting noise limits, used for the purpose of the present assessment, are set out in Table 4 and Table 5.

Table 4 - Day time $L_{A90,T}$ Noise Limits Derived from the Baseline Noise Survey According to ETSU-R-97

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Onshore winds: 20-190										
Location 1 - 20 Wellesley Road	43.2	45.0	47.1	49.6	52.1	54.4	56.6	58.3	59.6	60.4
Location 2 - 94 Wellesley Road	42.9	43.5	44.4	45.8	47.6	49.6	51.7	53.7	55.4	56.5
Location 3 - 12 Erskine St	42.7	45.0	47.6	50.4	53.1	55.6	57.8	59.6	61.2	62.5
Offshore winds: 190-20										
Location 1 - 20 Wellesley Road	43.5	44.3	45.0	45.6	46.1	46.4	46.7	46.8	46.8	46.8
Location 2 - 94 Wellesley Road	43.3	44.0	45.0	46.1	47.2	48.4	49.6	50.7	51.8	52.7
Location 3 - 12 Erskine St	41.9	42.2	43.1	44.8	47.2	50.1	53.2	56.0	56.0	56.0

Table 5 - Night time $L_{A90,T}$ Noise Limits Derived from the Baseline Noise Survey According to ETSU-R-97

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Onshore winds: 20-190										
Location 1 - 20 Wellesley Road	43.0	43.0	43.0	45.4	49.5	53.1	55.6	56.2	56.2	56.2
Location 2 - 94 Wellesley Road	43.0	43.0	43.0	43.0	43.8	46.6	49.5	51.9	52.8	52.8

Property	Standardised Wind speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Location 3 - 12 Erskine St	43.0	43.0	44.6	47.6	51.1	54.9	58.0	59.7	59.7	59.7
Offshore winds: 190-20										
Location 1 - 20 Wellesley Road	43.0	43.0	43.0	43.0	43.0	43.5	44.7	46.0	46.0	46.0
Location 2 - 94 Wellesley Road	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.0	49.3	51.4
Location 3 - 12 Erskine St	43.0	43.0	43.0	43.0	43.7	47.6	52.4	57.3	57.3	57.3

4.6 Derived operational noise levels

4.6.1 Operational noise levels were also determined from the 2015 survey (only), using the periods in which the turbine was operational. This was determined as periods for which the mean power generation was positive. During the monitoring period, the turbine was operating without any mitigation applied.

4.6.2 In this analysis, the periods outside the hours of 23:00 to 07:00, e.g. any periods outside of night-time hours, were excluded. The reason for this is that background noise levels would be expected to be lower during the night-time as compared to daytime, but turbine noise levels would be similar for the same wind speed during day and night. Consequently, filtering out daytime periods would be expected to result in a more accurate determination of the turbine noise levels for a given wind speed.

4.6.3 The measurements were separated into 90° wide wind direction bins, in order to minimise the scatter in the data. For each of the off-shore and on-shore wind conditions described above, a specific representative 90° sector was selected based on a wider analysis.

4.6.4 For each wind direction sector considered, the measurements were then separated into 1 m/s wide wind speed bins, for standardised 10 m height wind speed from 3 m/s up to 12 m/s. The average measured noise level in each 1 m/s wind speed bin was then calculated for each group of data. This was considered more applicable than a trend-line analysis when assessing the variation of noise relative to wind speeds for noise levels strongly influenced by a wind turbine.

4.6.5 As ambient (total) noise levels are measured, it is necessary to determine the contribution from non-wind turbine related noise sources. This can be achieved by subtracting the non-wind turbine related noise levels (i.e. noise levels measured in the absence of operation of the wind turbine) from the total ambient noise levels (which comprise the non-wind turbine related noise sources plus the operational wind turbine noise). For the purpose of this analysis, the turbine switch-off period considered were restricted to the 2015 survey.

4.6.6 The final step is, for each 1 m/s bin within each wind direction sector, was therefore to logarithmically subtract the turbine off noise level from the turbine on noise level in the corresponding wind speed bins. This results in an estimate of the turbine noise level at each wind speed and for each wind direction sector, with the influence of noise sources other than the turbine being minimised. Due to the logarithmic nature of the decibel scale, however, this subtraction cannot be reliably applied if the noise level with the turbine off is greater than the noise level with the turbine on, minus 3 dB. Where this is the case in the present analysis, the corrected levels were taken as the residual noise levels.

4.6.7 The Figures in Annex E show, for each location: charts of the measured L_{A90} noise levels separated into 1 m/s bins for turbine being both on and off, for two 90 degree wind sectors. To represent the onshore wind conditions, the 90° wind direction sector (easterly winds) was selected as it tended to represent the upper end of noise levels. For offshore conditions, the 240° sector (west/south west) was chosen for location 1 and the 0° sector (north) for locations 2 and 3, based on the observed data. The following charts then present these results and the background-corrected ambient noise levels obtained (when the correction could be applied).

4.6.8 In some wind direction sectors, limited data was obtained at higher wind speeds, whereas other wind sectors had valid results over a wider range. The variations in turbine noise levels in different wind directions are likely due to propagation or directivity effects but the variation in noise with wind speed would be expected to be the same in these different sectors. Furthermore, at higher wind speeds the influence of non-turbine noise sources becomes more significant and, based on the characteristics of the turbine, no significant noise increase was expected beyond 7 m/s. The predictive model and assumed emission profile of Table 1 was therefore used to complement the measured data by adjusting predictions to best match measured corrected ambient levels over the range for which the clearest measurement results were obtained. The relevant charts of Annex E illustrate this by showing the adjusted predicted noise levels (dashed orange line) in relation to the derived corrected measured levels (short black lines).

4.6.9 For location 3, 12 Erskine St, the derived operational noise levels at the proxy measurement location were corrected by a further factor of -2.9 dB, based on the predictive model developed, to account for the closer proximity of the actual measurement location (in the 2015 survey) to the LDT compared to the location of the relevant noise sensitive receptors.

4.6.10 The resulting derived operational noise levels are set out below in Table 6. No assessment of tonality was undertaken as part of this analysis as this aspect was not raised in consultation.

Table 6 – Derived corrected operational noise levels from the LDT (L_{A90}, dB)

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Onshore winds: 20-190										
Location 1 - 20 Wellesley Road	37.8	38.8	42.0	45.0	47.0	47.0	47.0	47.0	47.0	47.0
Location 2 - 94 Wellesley Road	38.2	39.2	42.4	45.4	47.4	47.4	47.4	47.4	47.4	47.4
Location 3 - 12 Erskine St	36.1	37.1	40.3	43.3	45.3	45.3	45.3	45.3	45.3	45.3
Offshore winds: 190-20										
Location 1 - 20 Wellesley Road	33.8	34.8	38.0	41.0	43.0	43.0	43.0	43.0	43.0	43.0
Location 2 - 94 Wellesley Road	35.5	36.5	39.7	42.7	44.7	44.7	44.7	44.7	44.7	44.7
Location 3 - 12 Erskine St	33.3	34.3	37.5	40.5	42.5	42.5	42.5	42.5	42.5	42.5

5. Noise Effects Assessment

5.1 Operational noise assessment – prior to mitigation

5.1.1 The assessment (shown in tabular form in Table 7 and Table 8) shows a comparison of the derived operational noise levels of Table 6 with the noise limits set out in Tables 4 and 5 for the three assessment locations closest to the LDT. It is apparent from Table 8 that, at Location 2 (94 Wellesley Road), the operational levels determined from the LDT exceed the derived night-time limits for a range of wind speeds (as highlighted): 6 to 8 m/s (onshore winds) and 7 to 8 m/s (offshore winds). This would therefore represent a potentially significant operational noise effect.

5.1.2 This is however based on the conservative limits derived in the present assessment. If background noise levels consistently increased during night-time periods, for example due to industrial activity, increased noise limits may be derived under the extant consent conditions and a different assessment outcome could be determined as a result.

Table 7 - Difference between the derived day time noise limits (L_{A90}, dB) of Table 4 with the derived wind farm noise immission levels (Table 6). Negative values indicate the noise immission level is below the limit.

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Onshore winds: 20-190										
Location 1 - 20 Wellesley Road	-5.4	-6.1	-5.1	-4.5	-5.0	-7.4	-9.5	-11.3	-12.6	-13.4
Location 2 - 94 Wellesley Road	-4.7	-4.3	-2.0	-0.4	-0.2	-2.2	-4.3	-6.3	-8.0	-9.1
Location 3 - 12 Erskine St	-6.6	-7.9	-7.3	-7.1	-7.8	-10.3	-12.5	-14.3	-15.9	-17.2
Offshore winds: 190-20										
Location 1 - 20 Wellesley Road	-9.7	-9.5	-7.0	-4.6	-3.1	-3.4	-3.7	-3.8	-3.8	-3.8
Location 2 - 94 Wellesley Road	-7.8	-7.5	-5.3	-3.4	-2.5	-3.7	-4.9	-6.0	-7.1	-8.0
Location 3 - 12 Erskine St	-8.6	-7.9	-5.6	-4.3	-4.7	-7.6	-10.7	-13.5	-13.5	-13.5

Table 8 - Difference between the derived day time noise limits (L_{A90}, dB) of Table 5 with the derived wind farm noise immission levels (Table 6). Negative values indicate the noise immission level is below the limit.

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Onshore winds: 20-190										
Location 1 - 20 Wellesley Road	-5.2	-4.2	-1.0	-0.4	-2.5	-6.1	-8.6	-9.2	-9.2	-9.2
Location 2 - 94 Wellesley Road	-4.8	-3.8	-0.6	**2.4**	**3.6**	**0.8**	-2.1	-4.5	-5.4	-5.4
Location 3 - 12 Erskine St	-6.9	-5.9	-4.3	-4.3	-5.8	-9.6	-12.7	-14.4	-14.4	-14.4

Property	Standardised Wind speed (m/s)									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Offshore winds: 190-20										
Location 1 - 20 Wellesley Road	-9.2	-8.2	-5.0	-2.0	0.0	-0.5	-1.7	-3.0	-3.0	-3.0
Location 2 - 94 Wellesley Road	-7.5	-6.5	-3.3	-0.3	**1.7**	**1.7**	-0.1	-2.3	-4.6	-6.7
Location 3 - 12 Erskine St	-9.7	-8.7	-5.5	-2.5	-1.2	-5.1	-9.9	-14.8	-14.8	-14.8

5.2 Operational Noise mitigation measures

5.2.1 The operational noise levels from the LDT can be reduced in several ways to result in compliance with the derived noise limits.

5.2.2 First of all, in common with most turbine models, the LDT turbine's control system can stop the turbine operating according to a schedule of different wind conditions and/or different times of the day. Such a schedule is currently in place for the LDT to mitigate excesses above the limits identified in previous studies.

5.2.3 Alternatively, a reduction in the operational noise levels produced by the LDT could also potentially be achieved by use of noise control modes, as described in Section 3.3. Noise control modes for the LDT are under development but likely to be available in the near future and may therefore be employed by the LDT in its future operational life.

5.2.4 The Applicant is committed to operate the LDT in a manner to reduce the operational noise levels to comply with applicable noise limits presented in Condition 13 and Annex 3 of the extant consent using either of these measures or a combination of them.

5.3 Cumulative noise levels

5.3.1 Table 9 presents derived noise levels for the LDT at a wider range of assessment locations (Table 1) including properties which were assessed for the Forthwind Demonstration Project application, in onshore wind conditions. This represents the conditions of most elevated noise levels. The additional locations considered are all located south of Location 3, 12 Erskine St, so predicted noise levels were derived from those determined at Location 3 with additional propagation corrections applied based on the predictive model developed.

Table 9 - Derived corrected operational noise levels from the LDT (L_{A90}, dB) – onshore winds (20-190)

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Location 1 - 20 Wellesley Road	37.8	38.8	42.0	45.0	47.0	47.0	47.0	47.0	47.0	47.0
Location 2 - 94 Wellesley Road	38.2	39.2	42.4	45.4	47.4	47.4	47.4	47.4	47.4	47.4
Location 3 - 12 Erskine St	36.1	37.1	40.3	43.3	45.3	45.3	45.3	45.3	45.3	45.3
13 Shore Street	35.7	36.7	39.9	42.9	44.9	44.9	44.9	44.9	44.9	44.9
26 Back Dykes	18.2	19.2	22.4	25.4	27.4	27.4	27.4	27.4	27.4	27.4
3 Cave Cottages	20.2	21.2	24.4	27.4	29.4	29.4	29.4	29.4	29.4	29.4
51-57 West High Street	30.9	31.9	35.1	38.1	40.1	40.1	40.1	40.1	40.1	40.1
9 Shore Street	33.3	34.3	37.5	40.5	42.5	42.5	42.5	42.5	42.5	42.5

5.3.2 Table 10 presents predicted levels from the consented Forthwind Demonstration Project at the same locations, determined from the assumed emission levels set out in Section 3.3 using the model described in section 3.4. This model is based on assuming downwind conditions from the turbines to the receptors, which in this case correspond to onshore wind conditions. By comparison of Tables 9 and 10, it can be observed that predicted levels from the Forthwind Demonstration Project are more than 10 dB below those derived for the LDT at both locations 1 and 2. In accordance with guidance from the IOA GPG referenced above, this means that cumulative effects are negligible at these locations. The above-described mitigation measures would reduce noise levels for the LDT in some wind conditions, but the noise levels from the Forthwind scheme would still clearly be below the derived noise limits by a wide margin. Locations 1 and 2 are therefore not considered further in this section.

5.3.3 Table 11 presents cumulative noise levels obtained through energy summation of levels from Tables 9 and 10 at the remaining locations.

Table 10 - Predicted operational noise levels from the Forthwind Demonstration Project (L_{A90}, dB) – downwind

Property	Standardised Wind speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Loc1 - 20 Wellesley Road	25.8	26.3	28.9	31.5	33.4	34.3	35.8	37.0	34.4	31.8
Loc2 - 94 Wellesley Road	26.1	26.6	29.2	31.8	33.7	34.6	36.1	37.3	34.7	32.1
Loc3 - 12 Erskine St	26.4	26.9	29.5	32.1	34.0	34.9	36.4	37.6	35.0	32.4
13 Shore Street	30.0	30.5	33.1	35.7	37.6	38.5	40.0	41.2	38.6	36.0
26 Back Dykes	24.5	25.0	27.6	30.2	32.1	33.0	34.5	35.7	33.1	30.5
3 Cave Cottages	25.4	25.9	28.5	31.1	33.0	33.9	35.4	36.6	34.0	31.4
51-57 West High Street	29.7	30.2	32.8	35.4	37.3	38.2	39.7	40.9	38.3	35.7
9 Shore Street	29.8	30.3	32.9	35.5	37.4	38.3	39.8	41.0	38.4	35.8

Table 11 - Predicted cumulative operational noise levels (L_{A90}, dB) – onshore conditions (20-190)

Property	Standardised Wind speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Loc3 - 12 Erskine St	36.5	37.5	40.7	43.6	45.6	45.7	45.8	46.0	45.7	45.5
13 Shore Street	36.7	37.6	40.7	43.6	45.6	45.8	46.1	46.4	45.8	45.4
26 Back Dykes	25.4	26.0	28.7	31.4	33.3	34.0	35.2	36.3	34.1	32.2
3 Cave Cottages	26.6	27.2	29.9	32.7	34.6	35.2	36.4	37.4	35.3	33.5
51-57 West High Street	33.4	34.1	37.1	40.0	41.9	42.3	42.9	43.5	42.3	41.5
9 Shore Street	34.9	35.8	38.8	41.7	43.7	43.9	44.4	44.8	43.9	43.4

5.3.4 Table 12 reproduces the noise limits derived in the Forthwind Demonstration Project ES, based on a baseline noise survey at the additional locations considered. For 13 Shore Street, the noise limit derived at Location 3, 12 Erskine St was applied as the location was considered representative.

Table 12 - Noise limits derived in the Forthwind Demonstration Project ES (L_{A90}, dB)

Property	Standardised Wind speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Daytime										
26 Back Dykes	n/a	42.2	43.7	45.0	46.0	46.9	47.7	48.3	48.8	49.2
3 Cave Cottages	n/a	42.2	43.7	45.0	46.0	46.9	47.7	48.3	48.8	49.2
51-57 West High Street	n/a	44.5	46.1	47.4	48.4	49.2	49.8	50.2	50.6	50.9
9 Shore Street	n/a	44.5	46.1	47.4	48.4	49.2	49.8	50.2	50.6	50.9
Night-time										
26 Back Dykes	n/a	45.4	45.5	45.6	45.9	46.2	46.5	46.9	47.4	47.9
3 Cave Cottages	n/a	45.4	45.5	45.6	45.9	46.2	46.5	46.9	47.4	47.9
51-57 West High Street	n/a	47.2	47.4	47.6	47.9	48.2	48.6	49	49.4	49.9
9 Shore Street	n/a	47.2	47.4	47.6	47.9	48.2	48.6	49	49.4	49.9

5.3.5 Finally, table 13 shows a comparison between the cumulative levels of Table 11 with relevant noise limits. This demonstrates that, for all the assessment locations at which cumulative effects are not negligible, the predicted cumulative noise levels remain below the relevant noise limits during onshore wind conditions for which propagation conditions are favourable. During offshore wind conditions, propagation of noise from the turbines of the Forthwind Demonstration Project, situated 1 to 2 km away from the locations considered, would be adversely affected, resulting in reduced noise levels in most of the relevant conditions. These offshore conditions are therefore considered likely to correspond to negligible or acceptable effects too, based on the above conclusions.

Table 13 - Difference between the derived noise limits of Tables 4, 5 and 12 (L_{A90}, dB) with the cumulative wind farm noise immission levels (Table 11). Negative values indicate the noise immission level is below the limit.

Property	**Standardised Wind speed (m/s)**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Daytime										
Loc3 - 12 Erskine St	-6.2	-7.5	-6.9	-6.8	-7.5	-9.9	-11.9	-13.6	-15.5	-17.0
13 Shore Street	-6.0	-7.4	-6.9	-6.8	-7.5	-9.8	-11.7	-13.2	-15.4	-17.1
26 Back Dykes	n/a	-16.2	-15.0	-13.6	-12.7	-12.9	-12.5	-12.1	-14.7	-17.0
3 Cave Cottages	n/a	-15.0	-13.8	-12.4	-11.4	-11.7	-11.3	-10.9	-13.5	-15.7
51-57 West High Street	n/a	-10.4	-9.0	-7.4	-6.5	-6.9	-6.9	-6.7	-8.3	-9.5
9 Shore Street	n/a	-8.7	-7.3	-5.7	-4.7	-5.3	-5.4	-5.4	-6.7	-7.6
Night-time										
Loc3 - 12 Erskine St	-6.5	-5.5	-3.9	-3.9	-5.5	-9.2	-12.2	-13.7	-14.0	-14.1
13 Shore Street	-6.3	-5.4	-3.9	-3.9	-5.5	-9.1	-11.9	-13.2	-13.9	-14.3
26 Back Dykes	n/a	-19.4	-16.8	-14.2	-12.6	-12.2	-11.3	-10.7	-13.3	-15.7
3 Cave Cottages	n/a	-18.2	-15.6	-13.0	-11.3	-11.0	-10.1	-9.5	-12.1	-14.4
51-57 West High Street	n/a	-13.1	-10.3	-7.6	-6.0	-5.9	-5.7	-5.5	-7.1	-8.5
9 Shore Street	n/a	-11.4	-8.6	-5.9	-4.2	-4.3	-4.2	-4.2	-5.5	-6.6

5.3.6 The Applicant has been in discussion with the developer of the Forthwind Demonstration Project in order to agree procedures to suitably manage cumulative noise levels, in consultation with Fife Council in the event that the Forthwind Demonstration Project is constructed and operated. Condition 28(i) of the Forthwind Demonstration Project states:

"an agreed and operational protocol agreement between the Company and FEPOWDT [the LDT] regarding the apportionment and control of noise which ensures that noise impacts from the combined developments do not exceed the allowable environmental limits"

5.3.7 Until such time as the condition has been discharged, the Forthwind Demonstration Project turbines cannot be operated. Furthermore Condition 29 of the Forthwind Demonstration Project consent states:

"If the monitoring of noise levels undertaken in accordance with the Noise Measurement and Mitigation Scheme show that the noise of the Development, either alone or in combination with FEPODWT [the LDT], exceeds the agreed noise limits the operation of the WTGs comprising this Development [Forthwind] must cease immediately. The operation of the WTGs must remain ceased until such time as the Company has satisfied the Scottish Ministers, in consultation with FC, that appropriate mitigation measures, as specified in the Noise Measurement and Mitigation Scheme or any other such measures as defined by Scottish Ministers, have been put in place".

5.3.8 These conditions as applied to the Forthwind Demonstration Project secures acceptable cumulative noise levels in practices should the LDT and the Forthwind Demonstration Project operate simultaneously.

5.4 Low Frequency Noise, Vibration and Amplitude Modulation

5.4.1 Low frequency noise and vibration resulting from the operation of wind farms are issues that have been attracting a certain amount of attention over recent years. Consequently Annex A includes a detailed discussion of these topics. In summary of the information provided therein, the current recommendation is that ETSU-R-97 should continue to be used for the assessment and rating of operational noise from wind farms.

5.4.2 Annex A also discusses the most recently published research on the subject of wind turbine blade swish Amplitude Modulation (or AM). As a consequence of the combined results of this research, and in particular the development by the IOA of an objective technique for identifying and quantifying AM noise, as well as a review of the subjective response to AM noise by a Government-commissioned research group, a penalty-type approach to account for instances of increased AM outside what is expected from 'normal' blade swish has been proposed. The Scottish Government is currently reviewing these recommendations in the context of the Scottish planning system[13].

5.5 Evaluation of Residual Effects

Table 14 – Summary of effects

Potential Effect	Evaluation of Effect
Operational Noise	Noise criteria have been established in accordance the extant consent conditions which are based on ETSU-R-97. These criteria are achievable using operational mitigation measures. At some locations under some wind conditions and for a certain proportion of the time, the wind farm noise may be audible; however, operational noise immission levels are acceptable in terms of the guidance commended by planning policy for the assessment of wind farm noise, and therefore considered not significant in EIA terms.

6. Monitoring

6.1.1 It is proposed that, should planning consent be granted for the Variation, a noise condition incorporating the extant condition 13 attached to the consented LDT (Section 3.2) is applied. Such a condition includes the requirement that, in the event of a noise complaint, noise levels resulting from the operation of the LDT are measured to demonstrate compliance with relevant noise limits. Such monitoring would be done in full accordance with ETSU-R-97.

7. Summary of Key Findings and Conclusions

7.1.1 Hoare Lea have been commissioned by Arcus to undertake a noise assessment of the proposed extension to the operational life of the Levenmouth Demonstration Turbine. Noise is emitted by the turbine during operation. The level of noise emitted by the source and the distance from those sources to the receiver locations are the main factors determining levels of noise at receptor locations.

7.1.2 Operational turbines emit noise from the rotating blades as they pass through the air. This noise can sometimes be described as having a regular ‘swish’. The amount of noise emitted tends to vary depending on the wind speed. When there is little wind the turbine rotors will turn slowly and produce lower noise levels than during high winds when the turbine reaches its maximum output and maximum rotational speed. Background noise levels at nearby properties will also change with wind speed, increasing in level as wind speeds rise due to wind in trees and around buildings, etc.

7.1.3 Noise levels from operation of the turbine have been determined at locations around the site potentially affected by noise. Surveys have been performed to establish existing baseline noise and operational levels at a number of locations. Noise limits have been derived from data about the existing noise environment (in the absence of turbine noise) based on the method stipulated in national planning guidance. The assessment takes full account of the potential combined effect of the noise from the Development along with the consented Forthwind Demonstration Project. Other, more distant wind farms were not considered as either not enough information was available or they did not make an acoustically relevant contribution to cumulative noise levels.

7.1.4 Predicted operational noise levels have been compared to limit values derived from the extant consent. Although an excess above the limits was predicted in some conditions, based on a conservative analysis, measures are available and have been put in place to mitigate these instances. Furthermore, cumulative effects including the Forthwind Demonstration Project are either negligible or result in total noise levels which remain within acceptable levels. It is concluded therefore that operational noise levels from the wind turbine will be within levels deemed, by national guidance, to be acceptable for wind energy schemes.

8. References

1 Scottish Planning Policy (SPP), Scottish Government, 2014.
2 Planning Advice Note 1/2011: Planning & Noise, Scottish Government, March 2011.
3 Scottish Government, Online Renewables Planning Advice, Onshore Wind Turbines (http://www.gov.scot/Resource/0045/00451413.pdf). Updated May 28, 2014.
4 ETSU-R-97, the Assessment and Rating of Noise from Wind Farms, Final ETSU-R-97 Report for the Department of Trade & Industry. The Working Group on Noise from Wind Turbines, 1997.
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6 Letter from John Swinney MSP, Scottish Government, 29/05/2013
7 PAN1/2011 Technical Advice Note – Assessment of Noise, Scottish Government, March 2011.

8 Control of Pollution Act, Part III, HMSO, 1974.
9 Environmental Health Criteria 12 – Noise. World Health Organisation, 1980.
10 ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation', International Standards Organisation, 1996.
11 M. Boué (KTH/Vinforsk), Long-Range Sound Propagation Over the Sea with Application To Wind Turbine Noise, Final report for the Swedish Energy Agency project 21597-3.
12 Swedish Environmental Protection Agency, Measuring and Calculating Sound From Wind Turbines, Guidance Document, June 2013.
13 Scottish Government, Onshore Wind Policy Statement (January 2017), http://www.gov.scot/Publications/2017/01/7344/6

Annex A - General Approach to Noise Assessment & Glossary

A.1 Some sound, such as speech or music, is desirable. However, desirable sound can turn into unwanted noise when it interferes with a desired activity or when it is perceived as inappropriate in a particular environment.

A.2 When assessing the effects of sound on humans there are two equally important components that must both be considered: the physical sound itself, and the psychological response of people to that sound. It is this psychological component which results in those exposed differentiating between desirable sound and unwanted noise. Any assessment of the effects of sound relies on a basic appreciation of both these components. This Annex provides an overview of these topics. A glossary of acoustic terminology is included at the end of this Annex.

A.3 The assessment of environmental noise can be best understood by considering physical sound levels separately from the likely effects that these physical sound levels have on people, and on the environment in general.

A.4 Physical sound is a vibration of air molecules that propagates away from the source. As acoustic energy (carried by the vibration back and forth of the air molecules) travels away from the source of the acoustic disturbance it creates fluctuating positive and negative acoustic pressures in the atmosphere above and below the standing atmospheric pressure. For most types of sound normally encountered in the environment these acoustic pressures are extremely small compared to the atmospheric pressure. When acoustic pressure acts on any solid object it causes microscopic deflections in the surface. For most types of sound normally encountered in the environment these deflections are so small they cannot physically damage the material. It is only for the very highest energy sounds, such as those experienced close to a jet engine for example, that any risk of physical damage exists. For these reasons, most sound is essentially neutral and has no cumulative damaging physical effect on the environment. The effects of environmental sound are therefore limited to its effects on people or animals.

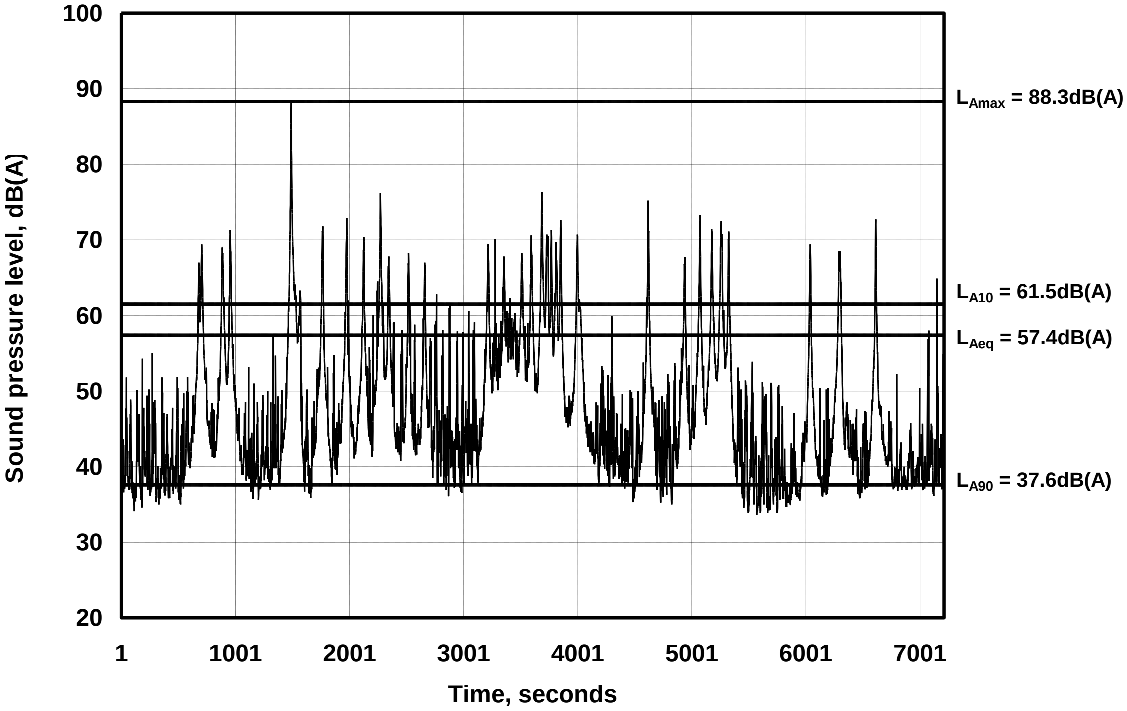
A.5 Before reviewing the potential effects of environmental sound on people, it is useful first to consider the means by which physical sound can be quantified.

Indicators of Physical Sound Levels

A.6 Physical sound is measured using a sound level meter. A sound level meter comprises two basic elements: a microphone which responds in sympathy with the acoustic pressure fluctuations and produces an electrical signal that is directly related to the incident pressure fluctuations, and a meter which converts the electrical signal generated by the microphone into a decibel reading. Figure A1 shows an example of the time history of the decibel readout from a sound level meter located approximately 50 metres from a road. The plot covers a total time period of approximately 2 hours. The peaks in the sound pressure level trace correspond to the passage of individual vehicles past the measurement location.

A.7 Assigning a single value to the time varying sound pressure level presented in Figure A1 is clearly not straightforward, as the sound pressure level varies by over 50 dB with time. To overcome this, the measurement characteristics of sound level meters can be varied to emphasise different features of the sound that are thought to be most relevant to the effect under consideration.

Figure A1 Sample plot of the sound pressure level measured close to a road over a period of approximately two hours.



Objective measures of noise

A.8 The primary purpose of measuring environmental noise is to assess its effects on people. Consequently, any sound measuring device employed for the task should provide a simple readout that relates the objectively measured sound to human subjective response. To achieve this, the instrument must, as a minimum, be capable of measuring sound over the full range detectable by the human ear.

A.9 Perceived sound arises from the response of the ear to sound waves travelling through the air. Sound waves comprise air molecules oscillating in a regular and ordered manner about their equilibrium position. The speed of the oscillations determines the frequency, or pitch, of the sound, whilst the amplitude of oscillations governs the loudness of the sound. A healthy human ear is capable of detecting sounds at all frequencies from around 20 Hz to 20 kHz over an amplitude range of approximately 1,000,000 to 1. Even relatively modest sound level meters are capable of detecting sounds over this range of amplitudes and frequencies, although the accuracy limits of sound level meters vary depending on the quality of the unit. When undertaking measurements of wind turbine noise, as with all other noise measurements, it is important to select a measurement system that possesses the relevant accuracy tolerances and is calibrated to a matching standard.

A.10 Whilst measurement systems exist that are capable of detecting the range of sounds detected by the human ear, the complexities of human response to sound make the derivation of a likely subjective response from a simple objective measure a non-trivial problem. Not only does human response to sound vary from person to person, but it can also depend as much on the activity and state of mind of an individual at the time of the assessment, and on the 'character' of the sound, as it can on the actual level of the sound. In practice, a complete range of responses to any given sound may be observed. Thus, any objective measure of noise can, at best, be used to infer the average subjective response over a sample population.

Sound Levels and Decibels

A.11 Because of the broad amplitude range covered by the human ear, it is usual to quantify the magnitude of sound using the decibel scale. When the amplitude of sound pressure is expressed using decibels (dB) the resultant quantity is termed the sound pressure level. Sound pressure levels are denoted by a capital 'L', as in L dB. The conversion of sound pressure from the physical quantity of Newton per square metre, or Nm-2, to sound pressure level in dB reduces the range from 0 dB at the threshold of hearing to 120 dB at the onset of pain. Both of these values are derived with respect to the hearing of the average healthy young person.

A.12 Being represented on a logarithmic amplitude scale, the addition and subtraction of decibel quantities does not follow the normal rules of linear arithmetic. For example, two equal sources acting together produce a sound level 3 dB higher than either source acting individually, so 40 dB + 40 dB = 43 dB and 50 dB + 50 dB = 53 dB. Ten equal sound sources acting together will be 10 dB louder than each source operating in isolation. Also, if one of a pair of sources is at least 10 dB quieter than the other, then it will contribute negligibly to the combined noise level. So, for example, 40 dB + 50 dB = 50 dB.

A.13 An increase in sound pressure level of 3 dB is commonly accepted as the smallest change of any subjective significance. An increase of 10 dB is often claimed to result in a perceived doubling in loudness, although the basis for this claim is not well founded. An increase of 3 dB is equivalent to a doubling in sound energy, which is the same as doubling the number of similar sources. An increase of 10 dB is equivalent to increasing the number of similar sources tenfold, whilst an increase of 20 dB requires a hundredfold increase in the number of similar sources and an increase of 30 dB requires a thousand times increase in the number of sources.

Frequency Selectivity of Human Hearing and A-weighting

A.14 Whilst the hearing of a healthy young individual may detect sounds over a frequency range extending from less than 20 Hz to greater than 20 kHz, the ear is not equally sensitive at all frequencies. Human hearing is most sensitive to sounds containing frequency components lying within the range of predominant speech frequencies from around 500 Hz to 4000 Hz. Therefore, when relating an objectively measured sound pressure level to subjective loudness, the frequency content of the sound must be accounted for.

A.15 When measuring sound with the aim of assessing subjective response, the frequency selectivity of human hearing is accounted for by down-weighting the contributions of lower and higher frequency sounds to reduce their influence on the overall reading. This is achieved by using an 'A'-weighting filter. Over the years, the A-weighting has become internationally standardised and is now incorporated into the majority of environmental noise standards and regulations in use around the world to best replicate the subjective response of the human ear. A-weighting filters are also implemented as standard on virtually all sound measurement systems.

A.16 Sound pressure levels measured with the A-weighting filter applied are referred to as 'A weighted' sound pressure levels. Results from such measurements are denoted with a subscripted capital A after the 'L' level designation, as in 45 dB LA, or alternatively using a bracketed 'A' after the 'dB' decibel designation, as in 45 dB(A).

Temporal Variation of Noise and Noise Indices

A.17 The simple A-weighted sound pressure level provides a snapshot of the sound environment at any given moment in time. However, as is adequately demonstrated by Figure A1, this instantaneous sound level can vary significantly over even short periods of time. A single number indicator is therefore required that best quantifies subjective response to time varying environmental noise, such as that shown in Figure A1. The question thus arises as to how temporal variations in level should be accounted for. This is most often achieved in practice by selecting a representative time period and calculating either the average noise level over that time period or, alternatively, the noise level exceeded for a stated proportion of that time period, as discussed below.

Equivalent Continuous Sound Level, $L_{Aeq,T}$

A.18 The equivalent continuous sound level, or $L_{Aeq,T}$ averages out any fluctuations in level over time. It is formally defined as the level of a steady sound which, in a stated time period 'T' and at a given location, has the same sound energy as the time varying sound. The $L_{Aeq,T}$ is a useful 'general' noise index that has been found to correlate well with subjective response to most types of environmental noise.

A.19 The equivalent continuous sound level is expressed $L_{Aeq,T}$ in dB, where the A–weighting is denoted by the subscripted 'A', the use of the equivalent continuous index is denoted by the subscripted 'eq', and the subscripted 'T' refers to the time period over which the averaging is performed. So, for example, 45 dB $L_{Aeq,1hr}$ indicates that A-weighted equivalent continuous noise level measured over a one hour period was 45 dB.

A.20 The disadvantage of the equivalent continuous sound level is that it provides no information as to the temporal variation of the sound. For example, an $L_{Aeq,1hr}$ of 60 dB could result from a sound pressure level of 60 dB(A) continuously present over the whole hour's measurement period, or it could arise from a single event of 96 dB(A) lasting for just 1 second superimposed on a continuous level of 30 dB(A) which exists for the remaining 59 minutes and 59 seconds of the hour long period. Clearly, the subjective effect of these two apparently identical situations (if one were to rely solely on the L_{Aeq} index) could be quite different.

A.21 The aforementioned feature can produce problems where the general ambient noise level is relatively low. In such cases the $L_{Aeq,T}$ can be easily 'corrupted' by individual noisy events. Examples of noisy events that often corrupt $L_{Aeq,T}$ noise measurements in situations of low ambient noise levels include birdsong or a dog bark local to a noise monitoring point, or an occasional overflying aircraft or a sudden gust of wind. This potential downside to the use of $L_{Aeq,T}$ as a general measurement index is of particular relevance to the assessment of ambient noise in quiet environments, such as those typically found in rural areas where wind farms are developed.

A.22 Despite these shortcomings in low noise environments, the $L_{Aeq,T}$ index is increasingly becoming adopted as the unit of choice for both UK and European guidance and legislation, although this choice is often as much for reasons of commonality between standards as it is for overriding technical arguments. In the Government's current planning policy guidance notes the $L_{Aeq,T}$ noise level is the index of choice for the general assessment of environmental noise. This assessment is undertaken separately for day time ($L_{Aeq,16hr}$ 07:00 to 23:00) and night time ($L_{Aeq,8hr}$ 23:00 to 07:00) periods. However, it is often the case for quiet environments, or for non-steady noise environments, that more information than can be gleaned from the $L_{Aeq,T}$ index may be required to fully assess potential noise effects.

Maximum, L_{Amax}, and percentile exceeded sound level, $L_{An,T}$

A.23 Figure A1 shows, superimposed on the time varying sound pressure level trace and in addition to the $L_{Aeq,T}$ noise level, examples of three well established measurement indices that are commonly used in the assessment of environmental noise impacts. These are the maximum sound pressure level, L_{Amax}, the 90 percentile sound pressure level, $L_{A90,T}$ and the ten percentile sound pressure level, $L_{A10,T}$.

A.24 The $L_{Amax,F}$ readings is suited to indicating the physical magnitude of the single individual sound event that reaches the maximum level over the measurement period, but it gives no indication of the number of individual events of a similar level that may have occurred over the time period.

A.25 Unlike the $L_{Aeq,T}$ index and the $L_{Amax,F}$ indices, percentile exceeded sound levels, percentage exceeded sound levels provide some insight into the temporal distribution of sound level throughout the averaging period. Percentage exceeded sound levels are defined as the sound level exceeded by a fluctuating sound level for n% of the time over a specified time period, T. They are denoted by $L_{An,T}$ in dB, where 'n' can take any value between 0% and 100%.

A.26 The $L_{A10,T}$ and $L_{A90,T}$ indices are the most commonly encountered percentile noise indices used in the UK.

A.27 The 10%'ile index, or $L_{A10,T}$ provides a measure of the sound pressure level that is exceeded for 10% of the total measurement period. It therefore represents the typical upper level of sound associated with specific events, such as the passage of vehicles past the measurement point. It is the traditional index adopted for road traffic noise. This index is useful because traffic noise is not usually constant, but rather it fluctuates with time as vehicles drive past the receptor location. The $L_{A10,T}$ therefore characterises the typical level of peaks in the noise as vehicles drive past, rather than the lulls in noise between the vehicles.

A.28 The $L_{A90,T}$ noise index is the noise level exceeded for 90% of the time period, T. It provides an estimate of the level of continuous background noise, in effect performing the inverse task of the $L_{A10,T}$ index by detecting the lulls between peaks in the noise. It is for this reason that the $L_{A90,T}$ noise index is the favoured unit of measurement for wind farm noise where, for the reasons discussed above, the generally low $L_{Aeq,T}$ noise levels are easily corrupted by intermittent sounds such as those produced by livestock, agricultural vehicles or the occasional passing vehicle on local roads. The $L_{A90,T}$ noise level represents the typical lower level of sound that may be reasonably expected to be present for the majority (90%) of the time in any given environment. This is usually referred to as the 'background' noise level.

Temporal Variations Outside the Noise Index Averaging Periods, 'T'

A.29 Averaging noise levels over the time period 'T' of the $L_{Aeq,T}$ and $L_{An,T}$ noise indices can successfully account for variations in noise over the time period, T. Some variations, however, exhibit trends over longer periods. At larger distances from noise sources meteorological factors can significantly affect received noise levels. At a few hundred metres from a constant level source of noise the potential variation in noise levels may be greater than 15 dB(A). To account for this variability consideration must be taken of meteorological conditions, particularly wind direction, when measurements and predictions are undertaken. As a general rule, when compared with the received noise level under neutral wind conditions, wind blowing from the source to the receiver can slightly enhance the noise level at the receiver (typically by no more than 3 dB(A)), but wind blowing from the receiver to the source can very significantly reduce the noise level at the receiver (typically by 15 dB(A) or more).

A.30 A similar effect occurs under conditions of temperature inversion, such as may exist after sunset when radiative cooling from the ground lowers the temperature of the air lying at low level more quickly than the air at higher levels, by loss of temperature through convective effects. This results in the air temperature increasing with increasing height above the ground. Depending on the source to receiver distance relative to the heights of the source and receiver, this situation can lead to sound waves becoming 'trapped' in the layer of air lying closest to the ground. The consequence is that noise levels at receptor locations can increase relative to those experienced under conditions of a neutral temperature gradient or a temperature lapse. The maximum increases compared to neutral conditions are similar to those experienced under downwind conditions of no more than around 3 dB(A). It is also worth noting that temperature lapse conditions, which is the more usual situation where temperature decreases with increasing height, can result in reductions in noise level at receptor locations by 15 dB(A) or more compared with the neutral conditions. The similarity between the magnitude of potential variations in noise levels for wind induced and temperature induced effects is not surprising, as the physical mechanisms behind the variations in level are the same for both situations: both variations result from changes in the speed of sound as a function of height above local ground level.

A.31 Temperature inversions on very still days can also affect noise propagation over much larger distances of several kilometres. These effects can produce higher than expected noise levels even at these very large distances from the source. A classic example that many people have experienced is the distant, usually inaudible, railway train that suddenly sounds like it is passing within a few hundred metres of a dwelling. However, these situations must generally be considered as rare exceptions to the usually encountered range of noise propagation conditions, especially in the case of wind farm noise as they rely on calm wind conditions under which wind turbines do not operate.

Effects of Sound on People

A.32 Except at very high peak acoustic pressures, the energy levels in most environmental sounds are too low to cause any physical disruption in any part of the body, just as they are too low to cause any direct physical damage to the environment. The main effects of environmental sound on people are therefore limited to possible interference with specific activities or to some kind of annoyance response. Some researchers have claimed statistical associations between environmental noise and various long term health effects such as clinical hypertension or mental health problems, although there is no consensus on possible causative mechanisms. Evidence in support of health effects other than annoyance and some indicators of sleep disturbance is weak. However, the theory that psychological stress caused by annoyance might contribute to adverse health effects in otherwise susceptible individuals seems plausible. Health effects in the 'more usual' definition of physiological health therefore remain as a theoretical possibility which has neither been proved nor disproved. However, the World Health Organisation (WHO) defines health in the wider context of:

> *'a state of complete physical, mental and social well-being and not merely the absence of infirmity'.*

And within this wider context potential health effects of environmental noise are summarised by the World Health Organisation as:

- interference with speech communications;
- sleep disturbance;
- disturbance of concentration;
- annoyance; and
- social and economic effects.

Speech Interference

A.33 The instantaneous masking effects of unwanted noise on speech communication can be predicted with some accuracy by using specialist methods of calculation, but the overall effect of a small amount of speech interference on everyday life is harder to judge. The significance of speech masking depends on the context in which it occurs. For example, isolated noise events could interfere with telephone conversations by masking out particular words or parts of words but, because of the high redundancy in normal speech, the masking of individual words can often have no significant effect on the intelligibility of the overall message. Notwithstanding the above, noise levels from wind farms at even the closest located dwellings in otherwise quiet environments are usually no more than around 30 dB(A) indoors, even with windows open. This internal noise level is 5 dB(A) below the 35 dB(A) suggested by the World Health Organisation as the lowest potential cut-on level for issues relating to speech intelligibility.

Sleep Disturbance

A.34 Although sleep seems to be a fundamental requirement for humans, the most significant effect of sleep loss seems to be increased sleepiness the next day. Sleep normally follows a regular cyclic pattern from awake through light sleep to deep sleep and back, this cycle repeating several times during the night at around 90 minute intervals. Most people wake for short periods several times every night as part of the normal sleep cycle without necessarily being aware of this the next day. REM, or rapid eye movement, sleep is associated with dreaming and occurs several times each night during the lighter sleep stages.

A.35 Electroencephalography (EEG) and similar techniques can be used to detect transient physiological responses to noise at night. Transient responses can be detected by short bursts of activity in the recorded waveforms which often settle back down to the same pattern as immediately before the event. Sometimes a transient response will be the precursor of a definite lightening of sleep, or even of an awakening, but often no discernible physical event happens at all.

A.36 These results suggest that at least parts of the auditory system remain fully operational even while the listener is asleep. The main purpose of this seems to be to arouse the listener in case of danger or in case some particular action is required which cannot easily be accomplished whilst remaining asleep. On the other hand, the system appears to be designed to filter out familiar sounds which experience suggests do not require any action. A very loud sound is likely to overcome the filtering mechanism and wake the listener, while intermediate and quieter sounds might only wake a listener who has a particular focus on those specific sounds. There is no evidence that the transient physiological responses to noise whilst asleep are anything other than normal. There is also considerable anecdotal evidence that people habituate to familiar noise at night, although some of the research evidence on this point is contradictory.

A.37 There is no consensus on how much sleep disturbance is significant. Some authorities take a precautionary approach, under which any kind of physiological response to noise is considered important, irrespective of whether there are any next day effects or not. Other studies suggest that transient physiological responses to unfamiliar stimuli at night are merely an indication of normal function and do not need to be considered as adverse effects unless they contribute to significant next-day effects. Recent World Health Organisation guidelines based mainly on laboratory studies suggest indoor limit values of 30 dB L_{Aeq} and 45 dB L_{Afmax} to avoid sleep disturbance, while other studies carried out in-situ, where habituation to the noise in question may have occurred, have found that much higher levels can be tolerated without any noticeable ill-effects.

Noise Annoyance

A.38 Noise annoyance describes the degree of 'unwantedness' of a particular sound in a particular situation. People's subjective response to noise can vary from not being bothered at all, through a state of becoming aware of the noise, right through to the point of becoming annoyed by the noise when it reaches a sufficiently high level. There is no statutory definition of noise annoyance.

A.39 Numerous noise annoyance surveys carried out over the last three decades have attempted to establish engineering relationships between the amount of noise measured objectively using sound level meters and the amount of community annoyance determined from questionnaires. The chief outcome of 'reported annoyance' has been measured using a very large range of different ideas. Both the wording of any questionnaire used and the context in which the question is put, and the manner in which it is therefore interpreted by respondents, can be very important. Some researchers are developing standardised questionnaire formats to encourage greater comparability between different studies, but this does not address the possibility of different contextual effects.

A.40 Notwithstanding these problems, there is a general consensus that average reported annoyance increases with aggregate noise level in long term static situations. However, there has been comparatively little research and consequently no real agreement on the effects of change. Some studies have found that even small changes in noise level can have unexpectedly large consequences on reported annoyance, while others have found the opposite. The most likely explanation for these apparent discrepancies is that underlying or true annoyance depends on many non-acoustic factors in addition to noise level alone, and that the extent to which reported annoyance actually represents underlying annoyance can be highly dependent on context. As a consequence, attempts to find a common relationship across all noise sources and listening situations have generally floundered. This task has been complicated by the great range of individual sensitivities to noise observed in the surveys, often affected as much by attitude as by noise level.

A.41 Whether or not an exposed individual has a personal interest in a given sound often has a significant bearing on their acceptance of it. For example, if recipients gain benefit from an association with the sound producer, or if they accept that the sound is necessary and largely unavoidable, then they are likely to be more tolerant of it. This is often the case even if they don't necessarily consider it desirable. A good example of this is road traffic noise which is the dominant noise heard by over 90% of the population but results in relatively few complaints.

A.42 Notwithstanding the fact that attitudes may be as important as overall levels in determining the acceptance of a particular noise, there still remains a need to objectively quantify any changes in noise level. Whilst it may not be possible to attribute a particular degree of annoyance to a given noise level, an objective measure of noise that bears some relationship to annoyance is still useful. This objective measure enables an assessment of the effect of changes to be assessed on the basis that any reduction in overall noise level must be beneficial. Possible noise mitigation measures form a central consideration of any noise assessment, so an appropriate methodology must be adopted for assessing the effectiveness of any noise mitigation measures adopted.

A.43 When assessing the potential effects of any new source of noise, it is common practice to compare the A-weighted 'specific' noise level produced by the new source (usually measured using the $L_{Aeq,T}$ index) against the existing A-weighted 'background' noise level measured using the $L_{A90,T}$ index, as this is the typical level of noise that can be reasonably expected to be present the majority of the time to potentially 'mask' the new 'specific' noise. The assessment is therefore undertaken within the context of the existing noise environment. In some circumstances it may prove equally instructive to compare the absolute level of a new specific noise against accepted absolute levels defined in standards or other relevant documents. The assessment is therefore undertaken against benchmark values, rather than against the context of the existing noise environment. Whatever approach is actually adopted for final assessment purposes, and often a combination of the two approaches is appropriate, it is important that the relevance of both contextual and benchmark assessments are at least considered in all cases.

A.44 Table 4.1 of the WHO Guidelines presents guideline benchmark values for environmental noise levels in specific environments. The noise levels relevant to residential dwellings are listed here in Table A1.

Table A1 Relevant Extracts from Table 4.1 'Guideline Values for Community Noise in Specific Environments'

Specific Environment	Critical Health Effects	$L_{Aeq,T}$	Time base (hrs)	L_{Amax} (dB)
Outdoor living area	Serious annoyance, day time and evening	55	16	-
	Moderate annoyance, day time and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, day time and evening	35	16	-

Specific Environment	Critical Health Effects	$L_{Aeq,T}$	Time base (hrs)	L_{Amax} (dB)
	Sleep disturbance, night time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoors)	45	8	60
School class rooms (included for potential effects on concentration)	Speech intelligibility, disturbance of information extraction, message communication	35	-	-

A.45 The text accompanying the Table in the WHO Guidelines explains that the levels given in the Table are set at the lowest levels at which the onset of any adverse health due to exposure to noise has been identified. The text continues:

> *'These are essentially values for the onset of health effects from noise exposure. It would have been preferred to establish guidelines for exposure-response relationships. Such relationships would indicate the effects to be expected if standards were set above the WHO guideline values and would facilitate the setting of standards for sound pressure levels (noise immission standards)'.*

A.46 In addition to consideration of the absolute A-weighted level of a new specific source of noise, other properties of the noise can heighten its potential effects when introduced into an existing background noise environment. Such properties of noise are commonly referred to as 'acoustic features' or the 'acoustic character'. These acoustic features can set apart the new source of noise from naturally occurring sounds. Commonly encountered acoustic features associated with transport and machinery sources, for example, can include whistles, whines, thumps, impulses, regular or irregular modulations, high levels of low frequency sound, rumbling, etc.

A.47 Due to the potential of acoustic features to increase the effects of a noise over and above the effects that would result from an otherwise 'bland' broad band noise of the same A-weighted noise level, it is common practice to add a 'character correction' to the specific noise level before assessing its potential effects. The resulting character corrected specific noise level is often referred to as the 'rated' noise level. Such character corrections usually take the form of adding a number of decibels to the physically measured or calculated noise level of the specific source. Typical character corrections are around +5 dB(A), although the actual correction depends on the subjective significance of the particular feature being accounted for.

A.48 The objective identification and rating of acoustic features can introduce a requirement to analyse sound in greater detail than has thus far been discussed. To this point all discussion has focussed on the use of the overall A-weighted noise level. This single figure value is derived by summing together all the acoustic energy present in the signal across the entire audible spectrum from around 20 Hz to 20,000 Hz, albeit with the lower and higher frequency contributions down-weighted in accordance with the A-weighting filter characteristics to account for the reduced sensitivity of the human ear at these frequencies.

A.49 However, in order to identify the presence of tones (which are concentrations of acoustic energy over relatively small bands of frequency), or in order to identify excessive levels of low frequency noise, it may be necessary to determine the acoustic energy present in the noise signal across much smaller frequency bands. This is where the concept of octave band analysis, fractional (e.g. 1/3, 1/12, 1/24) octave band analysis, or even narrow band Fast Fourier Transform (FFT) analysis is introduced. The latter enables signals to be resolved in frequency bandwidths of down to 1 Hz or even less, thereby enabling tonal content to be more easily identified and measured. As standard, noise emission data for wind turbines is supplied as octave band data, with narrow band tests also being undertaken to establish the presence of any tones in the radiated noise spectrum.

Effects of Noise on Wildlife

A.50 There are large numbers of papers in the literature which describe the effects of noise on birds and animals, both wild and livestock.

A.51 Just as the assessment of noise effects on humans is made difficult by the variability of responses between different people and between different situations, assessment of noise effects on wildlife is even more problematical, not least due to the problem of monitoring the response of wildlife to noise.

A.52 For larger species it may be possible to install telemetry on the body of the animal to relay information about its body systems (e.g. heart rate, temperature etc.). However, the minimum physical sizes of telemetry systems means this is not an option for smaller species. Also, even where it is possible, the fact that the animals must first be captured to have a system installed disturbs them, and the results of the subsequent study may be biased. In the absence of such telemetric data, researchers must rely on observations such as flight from nests, short term departure from usually populated areas and deviations from expected line of travel. However, flock and pack instincts often mean that just one animal changing course or taking flight can result in all the others doing the same.

A.53 The only truly robust determinant to the effects of noise on wildlife is the long term desertion of traditionally inhabited areas, or a reduction in breeding numbers. However, even these factors can be brought into question when the noise is a result of some other local activity, such as the passage of vehicles. In these cases it is often difficult to establish whether the observed effect is a consequence of the visual disturbance or the noise.

A.54 Direct comparisons of results between species, or even between different research findings into the same species, are therefore often unclear, and it is difficult to draw firm conclusions as to the effects of noise on wildlife, other than in a highly generalised manner.

A.55 General features apparent from the literature are that the most sensitive time for animals is during nesting or breeding seasons. Those that take flight whilst sitting on their eggs or tending their young can leave them open to predators, even if they return fairly quickly. However, many species have been shown to habituate to noise of all types, including road traffic noise, aircraft noise or even the decreasing effectiveness with time of impulsive type bird scarers, such as those used around airports.

Low Frequency Noise and Vibration – Wind Farms

A.56 One issue that has increasingly been raised concerning potential noise effects of operational wind farms relates not to the overall noise levels, but to the specific issue of low frequency sound. However, confusion sometimes arises from the use of the generalised term ‘low frequency sound’ to describe specific effects that may, or sometimes may not, actually relate the low frequency character of the sound itself.

A.57 In this respect there are three distinct characteristics of sound that should be clearly differentiated between:

- Low frequency sound in the range from around 20 Hz to 200 Hz, which therefore lies within the commonly referenced range of human hearing of around 20 Hz to 20,000 Hz;
- Very low frequency sound, or infrasound, below 20 Hz, which therefore lies below the commonly referenced lower frequency limit of human hearing;
- Amplitude modulated sound that characterises the ‘swish, swish’ sound sometimes heard from rotating wind turbine blades.

A.58 Looking at the first two of the three types of sound referred to in the preceding bullet points, a distinction is usually made between low frequency sound and very low frequency sound, otherwise termed infrasound. This distinction is based on the fact that the frequency range of audible noise is generally taken to be from 20 Hz to 20,000 Hz. Therefore, the range of frequencies from about 20 Hz to 200 HZ is usually taken to cover audible low frequency sound, whereas frequencies below 20 Hz are usually described as infrasound. The implication here is that low frequency sound is audible and infrasound is inaudible. However, this relatively arbitrary distinction between low frequency sound and infrasound can introduce some confusion in that frequencies below 20 Hz can still be heard provided they produce a sound pressure level at the ear of the listener that lies above the threshold of audibility of that listener to sound at that particular frequency.

A.59 The fact that low frequency sound and infrasound from wind farms has only relatively recently been highlighted as a potential problem by some groups does not mean that that the wind energy industry had not previously considered the issue. In fact the issue of low frequency sound was one of the predominant technical hurdles associated with the some of the earliest larger scale wind turbines installed in the USA. These turbines were of the ‘downwind’ type, ‘downwind’ referring here to the fact that the rotor blades were located downwind of the turbine tower rather than upwind of it, as is the case for current machines. It was found that the interruption of wind flow past the tower resulted in a region of lower than average wind speed immediately in the wake of the tower. The passage of the blades into this region of lower wind speed in the wake of the tower, then back into the higher wind speed as they emerged from the wake of the tower back into the main wind stream, resulted in the generation of low frequency sound, often in the subjective form of a distinctive impulse, often referred to as a ‘thump’ or ‘tower thump’. It was for this reason that modern day turbine configurations now have the blades upwind of the tower, as research and measurements demonstrated that low frequency sound radiation is reduced to sub-audible levels once the interaction of downwind tower wake effects with the rotating blades are removed from the design.

A.60 One of the problems inherent in the assessment of both low frequency sound and infrasound is the variability of hearing sensitivity across human subjects with otherwise healthy hearing. This threshold for sound below 200 Hz varies significantly more between different subjects than does the hearing threshold at higher frequencies. However, what is always true is that the perception threshold to lower frequency noise is much higher than the perception threshold for speech frequencies between around 250 Hz to 4,000 Hz. For example, the average person with healthy hearing is some 70 dB less sensitive to sounds at 20 Hz than to sounds that fall within the range of speech frequencies. An additional factor relevant to the perception of infrasound is that, although audibility remains below 20 Hz, tonality is lost below 16 Hz to 18 Hz, thus losing a key element of perception.

A.61 Both low frequency sound and infrasound are generally present all around us in modern life. They may be generated by many natural sources, such as thunder, earthquakes, waves and wind. They may also be produced by machinery including household appliances such as washing machines and air conditioning units, all forms of transport and by turbulence. The presence of low frequency sound and infrasound in our everyday lives is heightened by the fact that the attenuation of sound in air is significantly lower at low frequencies than at the mid to high frequencies. As a result, noise which has travelled over long distances is normally biased towards the low frequencies. However, the fact that human hearing naturally down-weights, or filters out, sounds of such low frequencies means we are generally not aware of its presence. It is only under circumstances when it reaches a sufficiently high level, for example in the ‘rumble’ of distant thunder or the sound of large waves crashing on a shore, that we become aware of its presence.

A-Weighting

A.62 It is because the human ear increasingly filters out sounds of lower frequencies that environmental noise measurements are undertaken as standard using sound level meters that apply the A-weighting curve, as it filters out lower frequency sounds to the same degree as the hearing of a healthy person with unimpaired hearing. The A-weighted sound level is used as a measure of subjective perception of sound unless there exists such a predominance of low frequency sound or infrasound relative to the level of sound at higher frequencies that the use of the A-weighting curve would down-weight the actual source of the problem to such a degree that the resultant objective noise levels do not truly reflect the potential subjective effects of the noise. It is for this reason that a number of alternative weighting curves have been developed, specifically aimed at better accounting for the assessment of low frequency sound and infrasound.

C-Weighting

A.63 One such curve is denoted C-weighting. Unlike the A weighting curve, which gradually reduces the significance of frequencies below 1000 Hz until at 10 Hz the attenuation is 70 dB, the C-weighting curve is flat to within 1 dB down to about 50 Hz and then drops by 3 dB at 31.5 Hz and 14 dB at 10 Hz. The C weighting curve was originally developed to reflect the fact that, at higher overall noise levels, low frequencies can have a greater subjective effect than at lower overall noise levels.

A.64 One relatively simple measure of undertaking a first-pass assessment as to whether low frequency sound is likely to be an issue is to determine the difference between the overall C weighted noise level and the overall A weighted noise level. The C weighted level includes contributions from low frequency sound, whereas the A weighted level filters it out. It has been suggested in that a level difference of more than 20 dB indicates that low frequency sound may be subjectively significant, but more detailed investigations are in practice required to determine whether or not this is actually the case.

G-Weighting

A.65 Another curve, termed the G weighting curve, has been specifically derived to provide a measure of the audibility of infrasound when considered separately from higher frequency noise. The G weighting curve falls off rapidly above 20 Hz and below 20 Hz it follows assumed hearing contours with a slope of 12 dB per octave down to 2 Hz.

A.66 Over the past few years there has been considerable attention paid to the possibility that operational wind farms may radiate sufficiently high levels of infrasound to cause health problems. It has, however, been the case that dedicated research investigations have shown this not to be the case.

A.67 As early as 1997 a report by Snow [2] gave details of a comprehensive study of infrasound and low frequency sound (up to around 100 Hz) and vibration measurements made in the vicinity of a wind farm. Measurements were made both on the wind farm site, and at distances of up to 1 kilometre. During the experiments a wide range of wind speeds and directions were recorded. It was found that the vibration levels at 100 metres from the nearest turbine itself were a factor of 10 lower than those recommended for human exposure in the most critical buildings (i.e. laboratories for precision measurements), and lower again than the limits specified for residential premises. A similar comparison with recognised limits for assessing structural damage showed that the measured vibrations were a factor of 100 below the recommended guidelines at 100 metres from the turbines.

A.68 Noise and vibration levels were found to comply with recommended residential criteria even on the wind turbine site itself. Although low level infrasonic (i.e. below 20 Hz) periodic noise from the wind farm was detected by instrumentation at distances up to 1 kilometre, the measuring instruments used were much more sensitive than human hearing. Based on his measurements Snow concluded that subjective detection of the wind turbines may be apparent at this distance, but if this is the case it will be due to higher frequency components (which are more readily masked by general ambient environmental noise) and not the low frequency components which lie below the threshold of audibility.

A.69 In 2003, findings on both low frequency sound and infrasound have been compiled into the previously referenced extensive review report commissioned by DEFRA and prepared by Dr G Leventhall [1]. Dr Leventhall notes that despite the numerous published studies there is little or no agreement about the biological effects of infrasound or low frequency sound on human health. Leventhall notes that direct evidence of adverse effects of exposure to low-intensity levels of infrasound (less than 90 dB) is lacking. He goes on to describe the low frequency hearing threshold i.e. the lowest levels which are audible to an average person with normal hearing. He notes the threshold at 4 Hz is about 107 dB, at 10 Hz it is about 97 dB and at 20 Hz it is 79 dB. As such, high levels of infrasound are required to exceed the hearing thresholds at such low frequencies. Leventhall therefore concluded that most people can be reassured that there will be no serious consequences to peoples' health from infrasound exposure.

A.70 Indeed, specifically in relation to wind farms and infrasound, Leventhall went further still with his statement of reassurance. This additional reassurance followed the voicing of concerns by some interested parties that, because infrasound and very low frequency vibrations could be measured from wind farms, then it must follow that these were a potential hazard and source of annoyance. In fact what those concerned observers failed to account for is that highly sensitive electronic measuring equipment designed solely to detect such infrasonic sounds and vibrations is orders of magnitude more sensitive than even the most sensitive human. Thus, whilst such measurement systems may be able to detect such low level phenomena, the same stimuli can have no effect on humans. In the light of this, Leventhall issued an open statement:

> *'I can state quite categorically that there is no significant infrasound from current designs of wind turbines. To say that there is an infrasound problem is one of the hares which objectors to wind farms like to run. There will not be any effects from infrasound from the turbines'.*

A.71 In 2004/2005 researchers from Keele University investigated the effects of the extremely low levels of vibration resulting from wind farms on the operation of a seismic array installed at Eskdalemuir in Scotland. This is one of the most sensitive ground-borne vibration detection stations in the world. The results of this study have frequently been misinterpreted, as just discussed for the DEFRA/Leventhall report, in that if infrasonic vibrations from wind farms can be measured, then they must consequentially have some potential effect on humans. In order to clarify their position, the authors have subsequently explained that [3]:

> *'The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect'.*

A.72 They then continue:

> *'Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health'.*

A.73 In relation to airborne infrasound as opposed to ground-borne vibrations, the researchers are equally robust in their conclusions, stating:

> *'The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect low frequency sound. There is no scientific evidence to suggest that infrasound [at such an extremely low level] has an impact on human health'.*

A.74 Even more recently, in 2006, the results of a study specifically commissioned by the UK Department of Trade and industry (DTI) to look at the effects of infrasound and low frequency noise (LFN) arising from the operation of wind farms have been published in what is commonly referred to as the DTI LFN Report [4].

A.75 The DTI LFN Report is a comprehensive study containing many pages of detailed results of measurements of both infrasound and low frequency sound around the three wind farms included in the study. These measurements were undertaken using measurement systems capable of detecting noise down to frequencies of 1 Hz, with results being reported up to a frequency of 500 Hz, thus extending beyond the full spectrum of what is normally considered to cover both infrasound (<20 Hz) and low frequency sound (20 Hz to 200 Hz).

A.76 The measurement locations at the three wind farms were selected to be at residential properties where occupants had raised concerns relating to low frequency sound disturbance. Noise immission measurements are reported both externally to and internally to the properties in question. In addition to these noise immission measurements, the results of noise emission measurements undertaken on a number of wind turbines are also reported with the aim of quantifying the level of infrasound actually emitted from individual wind turbines and wind farms.

A.77 Before summarising the findings of the DTI LFN Report, it is noted that the prevalence of the perceived problem of infrasound and/or low frequency sound is not a widespread one. Quoting from the Executive Summary to the DTI LFN Report:

> *'of the 126 wind farms operating in the UK, 5 have reports of low frequency sound problems which attract adverse comment concerning the noise. Therefore, such complaints are the exception rather than a general problem which exists for all wind farms'.*

A.78 The DTI LFN Report was actually commissioned primarily to investigate the effects of infrasound. This investigation was commissioned as a direct result of the claims made in the press concerning health problems arising from noise of such a low frequency 'that it is beyond the audible range, such that you can't hear it but you can feel it as a resonance'. For this reason the results pertaining to infrasound are reported separately from those pertaining to audible low frequency sound above 20 Hz.

A.79 In respect of infrasound, the DTI LFN Report is quite categorical in its findings: infrasound is not the perceived health threat suggested by some observers, nor should it even be considered a potential source of disturbance. Quoting from the Executive Summary to the DTI LFN Report:

> *'Infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion.*
>
> *The document "Community Noise" prepared for the World Health Organisation, states that "there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects". Other detection mechanisms of infrasound only occur at levels well above the threshold of audibility.*
>
> *It may therefore be concluded that infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour'.*

A.80 In conclusion, whilst is known that infrasound can have an adverse effect on people (potential adverse health impacts are listed by the World Health Organisation as stress, irritation, unease, fatigue, headache, possible nausea and disturbed sleep), these effects can only come into play when the infrasound reaches a sufficiently high level. This is a level above the threshold of audibility.

However, all available information from measurements on current wind turbines reveals that the level of infrasound emitted by these wind turbines lies below the threshold of human perception.

A.81 Indeed, in the face of the apparent misunderstanding of the conclusions reached in the various reports on infrasound, and how these conclusions should be applied to consideration of the radiation of such noise from wind farms, the British Wind Energy Association have issued a fact sheet relating to the subject [5]. This fact sheet concludes:

> *'With regard to effects of noise from wind turbines, the main effect depends on the listener's reaction to what they may hear. There are no direct health effects from noise at the level of noise generated by wind turbines. It has been repeatedly shown by measurements of wind turbine noise undertaken in the UK, Denmark, Germany and the USA over the past decade, and accepted by experienced noise professionals, that the levels of infrasonic noise and vibration radiated from modern, upwind configuration wind turbines are at a very low level; so low that they lie below the threshold of perception, even for those people who are particularly sensitive to such noise, and even on an actual wind turbine site'.*

Low Frequency Sound

A.82 A report prepared for DEFRA by Casella Stanger [6] lists wind farms as a possible source of audible low frequency sound (20 Hz to 200 Hz). However, this is one possible source in a list of many commonly encountered sources such as pumps, boilers, fans, road, sea and rail traffic, the wind, thunder, the sea, etc. The report only considers the general issues associated with low frequency sound and makes no attempt to quantify the potential problem associated with each of these sources. This is in contrast to other reports which have considered the specific situation associated with wind farms.

A.83 In respect of low frequency sound as opposed to infrasound, the DTI LFN Report identified that wind farm noise levels at the studied properties were, under certain conditions, measured at a level just above the threshold of audibility. The report therefore concluded that 'for a low frequency sensitive person, this may mean that low frequency sound associated with the operation of the three wind farms could be audible within a dwelling'. This conclusion was, however, placed into some context with the qualifying statement that 'at all measurement sites, low frequency sound associated with traffic movements along local roads has been found to be greater than that from the neighbouring wind farm'. In particular it was concluded that, although measurable and under some conditions may be audible, levels of low frequency sound were below permitted night time low frequency sound criteria, including the latest UK criteria resulting from the 2003 DEFRA study into the effects of low frequency sound.

A.84 Based on the findings of the DTI LFN Report, low frequency sound in the greater than 20 Hz frequency range may, under some circumstances, be measured to be of a comparable or higher level than the threshold of audibility. On such occasions this low frequency sound may become audible to low frequency sensitive persons who may already be awake inside nearby properties, but not to the degree that it will cause awakenings. However, such noise should still be assessed for its potential subjective effects in the conventional manner in which environmental noise is generally assessed. In particular, the subjective effects of this audible low frequency sound should not be confused with the claimed adverse health effect arguments concerning infrasound which, in any event, have now been shown from the results of the DTI LFN Report to be wholly unsubstantiated.

A.85 In November 2006 the UK Government released a statement [7] concerning low frequency sound, reiterating the conclusion of the DTI LFN report that:

> *'there is no evidence of health effects arising from infrasound or low frequency sound generated by wind turbines'.*

A.86 The Government statement concluded the position regarding low frequency sound from wind farms with the definitive advice to all English Local Planning Authorities and the Planning Inspectorate that PPS22 and ETSU-R-97 should continue to be followed for the assessment of noise from wind farms.

Blade Swish (Amplitude Modulation)

A.87 The noise assessment methodology presented in ETSU-R-97, sets out noise limits which already account for typically encountered levels of blade swish. Notwithstanding the conclusions and advice presented in the preceding paragraphs concerning both infrasound and low frequency sound, the DTI LFN Report went on to suggest that, where complaints of noise at night had occurred, these had most likely resulted from an increased amplitude modulation of the blade passing noise, making the 'swish, swish, swish' sound (often referred to as 'blade swish') more prominent than normal. Whilst it was therefore acknowledged that this effect of enhanced amplitude modulation of blade aerodynamic noise may occur, it was also concluded that there were a number of factors that should be borne in mind when considering the importance to be placed on the issue when considering present and proposed wind farm installations:

- it appeared that the effect had only been reported as a problem at a very limited number of sites (the DTI report looked at the 3 out of 5 U.K. sites where it has been reported to be an issue out of the 126 onshore wind farms reported to be operational at the time in 2006);
- the effect occurred only under certain conditions at these sites (the DTI LFN Report was significantly delayed while those involved in taking the measurements waited for the situation to occur at each location);
- at one of the sites concerned it had been demonstrated that the effect can be reduced to an acceptable level by the introduction of a Noise Reduction Management System (NRMS) which controls the operation of the necessary turbines under the relevant wind conditions (this NRMS had to be switched off in order to gain the data necessary to inform the DTI LFN Report);
- whilst still under review, it appeared that the most likely cause of the increased amplitude modulation was related to an increase in the stability of the atmosphere during evening and night time periods, hence the increased occurrence of such an effect at these times, but this effect had been shown by measurement of wind speed profiles to be extremely site specific;
- internal noise levels were below all accepted night time criteria limits and insufficient to wake residents, it was only when woken by other sources of a higher level (such as local road traffic) that there were self-reported difficulties in returning to sleep.

A.88 The Salford Report concluded that that the occurrence of increased levels of 'blade swish' was infrequent, but suggested it would be useful to undertake further work to understand and assess this feature of wind turbine noise. As a consequence of the findings of the report by the University of

Salford, the UK Department for Business, Enterprise and Regulatory Reform (BERR formerly the DTI) issued a statement in August 2007 [9] which concluded:

> *'A comprehensive study by Salford University has concluded that the noise phenomenon known as aerodynamic modulation (AM) is not an issue for the UK's wind farm fleet.*
>
> *AM indicates aerodynamic noise from wind turbines that is greater than the normal degree of regular fluctuation of blade swoosh. It is sometimes described as sounding like a distant train or distant piling operation.*
>
> *The Government commissioned work assessed 133 operational wind projects across Britain and found that although the occurrence of AM cannot be fully predicted, the incidence of it from operational turbines is low'.*

A.89 The statement then concludes with the advice:

> *'Government continues to support the approach set out in Planning Policy Statement (PPS) 22 – Renewable Energy. This approach is for local planning authorities to "ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels", through the use of the 1997 report by ETSU to assess and rate noise from wind energy development'.*

A.90 This represents an aspect of wind turbine noise which has become the subject of considerable research in the UK and abroad in the past years and the state of knowledge on the subject is rapidly evolving. An extensive research programme entitled 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' was published in 2013. This research, commissioned by RenewableUK (ReUK) was specifically aimed at identifying and explaining some of the key features of wind turbine AM noise.

A.91 Claims have emerged from different researchers that wind turbines were capable of generating noise with characteristics outwith that expected of them. This characteristic was an enhanced level of modulated aerodynamic noise that resulted in the blade swish becoming more impulsive in character, such that those exposed to it would describe it more as a 'whoomp' or 'thump' than a 'swish'. It could also become audible at distances from the wind turbines that were considerably greater than the distances at which blade swish could ordinarily be perceived. It has since emerged that this may be similar to the character of the noise identified in the DTI LFN study. Hence for the purposes of the ReUK project, any such AM phenomena with characteristics falling outside those expected of this "normal" AM (NAM) were therefore termed 'Other AM' (OAM).

A.92 The research identified the most likely cause of OAM noise is transient stall on the wind turbine blade (i.e. stall which occurs over a small area of each turbine blade in one part of the blade's rotation only). The occurrence of transient stall will be dependent on a combination of factors, including the air inflow conditions onto the individual blades, how these inflow conditions may vary across the rotor disc, the design of the wind turbine blades and the manner in which the wind turbine is operated. Variable inflow conditions may arise, for example, from any combination of wind shear, wind veer, yaw errors, turbine wake effects, topographic effects, large scale turbulence, etc. However the occurrence of OAM on any particular site cannot be predicted at this stage.

A.93 As a consequence of the combined results of the ReUK research, and most notably the development of objective techniques for identifying and quantifying AM noise and the ability to relate such an objective measure to the subjective response to AM noise, ReUK has proposed an AM test [11] for implementation as a planning condition, although this was subject to discussion.

A.94 The Institute of Acoustics (IOA) has recently published a standardised methodology [12] for the assessment and rating of AM magnitude. The method provides a decibel level each 10 minutes which represents the magnitude of the modulation in the noise, and minimises the influence of sources not related to wind turbines. The proposed method, unlike other methods that have previously been proposed, utilises as the core of its detection capability the fact that AM noise from wind turbines, by definition, exhibits periodicity at a rate that is directly related to the rotational speed of the source wind turbine. The IOA document does not however provide any thresholds or criteria methodology for using the resulting AM values.

A.95 The UK Government (DECC or Department of Energy and Climate Change, now obsolete) commissioned a review focused on the subjective response to AM with a view to recommend how this feature may be controlled. The outcome of this research has been published [13] in October 2016 by the Department for Business, Energy & Industrial Strategy (DBEIS). This report recommends the use of a “character penalty” approach, in which a correction is applied to the overall A-weighted noise level to account for AM in the noise in a manner similar to that used to assess tonality in the noise according to ETSU-R-97. This penalty is based on the above IOA methodology for detecting AM. The researchers make a number of recommendations for local authorities to consider and qualifications for the use of such controls, and note that the current state of knowledge on the subject and the implications of their proposed control is limited and that a period of testing and review over the next few years would be beneficial. The authors were however unable to provide clarity on how exactly the recommendations would operate in practice for any particular wind farm. On publication of the report, DBEIS encouraged local authorities in England to consider the research but provided limited guidance on how the outcomes were to be accounted for within the planning system. The Scottish Government is currently reviewing this report in the context of the Scottish planning system.

References for LFN and AM Section

[1] ‘A review of published research on low frequency noise and its effects’, G. Leventhall, report for DEFRA, 2003

[2] ‘Low frequency noise and vibration measurements at a modern wind farm’, D. Snow, ETSU Report ETSU W/13/00392/REP, 1997

[3] ‘Wind farm noise’, P. Styles, letter by Prof P Styles and S Toon printed in The Scotsman, August 2005.

[4] ‘The measurement of low frequency noise at three UK wind farms’, M. Hayes, DTI Report W/45/00656/00, 2006

[5] ‘Low frequency noise and wind turbines’, BWEA Briefing Sheet, 2005

[6] ‘Low frequency noise’, Report by Casella Stanger for DEFRA, 2001

[7] ‘Advice on Findings of the Hayes McKenzie Report on Noise Arising from Wind Farms’, URN 06/2162 (November 2006)

[8] 'Research into Aerodynamic Modulation of Wind Turbine Noise', Report by University of Salford, URN 07/1235 (July 2007)

[9] 'Government statement regarding the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise', BERR, Ref: 2007/033 (1st August 2007)

[10] Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect, Renewable UK, December 2013.

[11] Template Planning Condition on Amplitude Modulation (guidance notes), RenewableUK, December 2013.

[12] Institute Of Acoustics (IOA) Amplitude Modulation Working Group, Final Report, A Method for Rating Amplitude Modulation in Wind Turbine Noise, June 2016.

[13] Review of the evidence on the response to amplitude modulation from wind turbines, WSP for Department for Business, Energy & Industrial Strategy. https://www.gov.uk/government/publications/review-of-the-evidence-on-the-response-to-amplitude-modulation-from-wind-turbines

Glossary of Acoustic Terminology

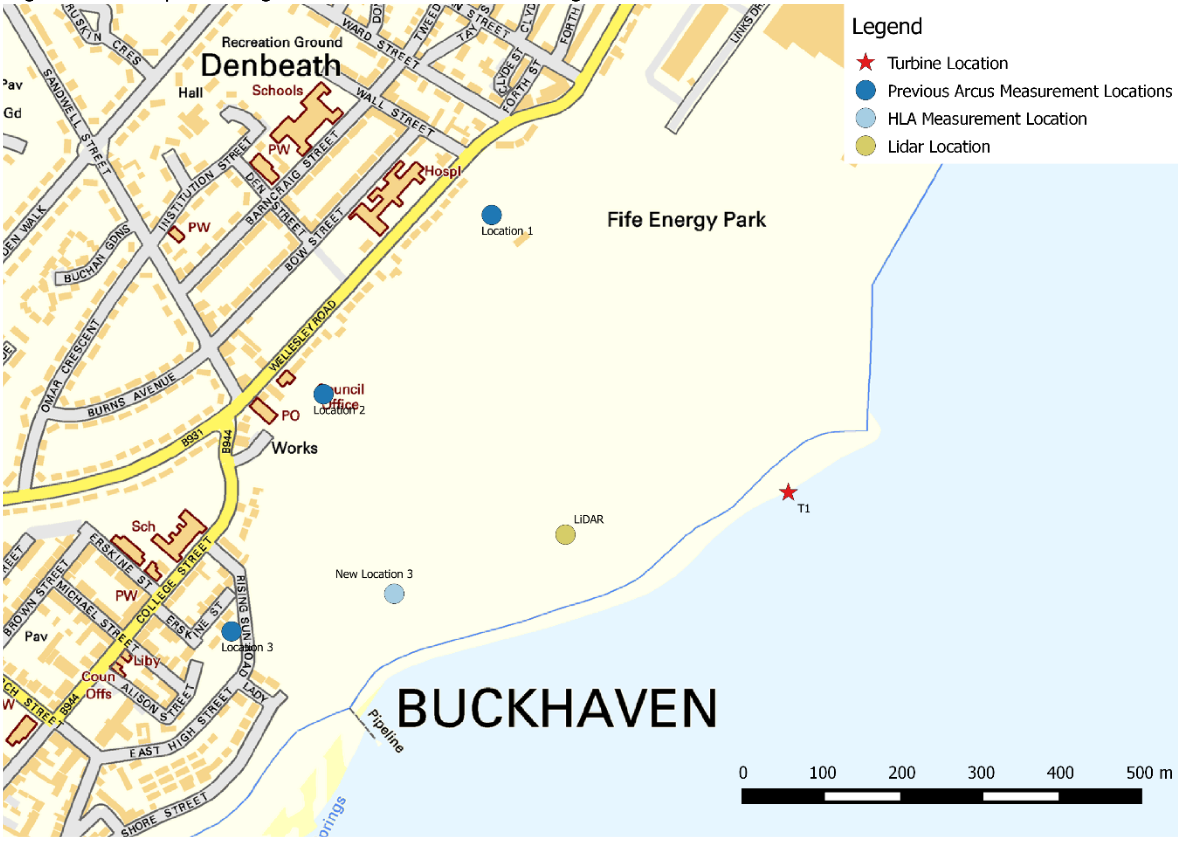
Terminology	Description
A-weighting	a filter that down-weights low frequency and high frequency sound to better represent the frequency response of the human ear when assessing the likely effects of noise on humans
acoustic character	one or more distinctive features of a sound (e.g. tones, whines, whistles, impulses) that set it apart from the background noise against which it is being judged, possibly leading to a greater subjective effects than the level of the sound alone might suggest
acoustic screening	the presence of a solid barrier (natural landform or manmade) between a source of sound and a receiver that interrupts the direct line of sight between the two, thus reducing the sound level at the receiver compared to that in the absence of the barrier
ambient noise	All-encompassing noise associated with a given environment, usually a composite of sounds from many sources both far and near, often with no particular sound being dominant
annoyance	a feeling of displeasure in this case evoked by noise
attenuation	the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.
audio frequency	any frequency of a sound wave that lies within the frequency limits of audibility of a healthy human ear, generally accepted as being from 20 Hz to 20,000 Hz
background noise	the noise level rarely fallen below in any given location over any given time period, often classed according to day time, evening or night time periods (for the majority of the population of the UK the lower limiting noise level is usually controlled by noise emanating from distant road, rail or air traffic)
dB	abbreviation for 'decibel'
dB(A)	abbreviation for the decibel level of a sound that has been A-weighted
decibel	the unit normally employed to measure the magnitude of sound
directivity	the property of a sound source that causes more sound to be radiated in one direction than another
equivalent continuous sound pressure level	the steady sound level which has the same energy as a time varying sound signal when averaged over the same time interval, T, denoted by LAeq,T
external noise level	the noise level, in decibels, measured outside a building
filter	a device for separating components of an acoustic signal on the basis of their frequencies

Terminology	Description
frequency	the number of acoustic pressure fluctuations per second occurring about the atmospheric mean pressure (also known as the ‘pitch’ of a sound)
frequency analysis	the analysis of a sound into its frequency components
ground effects	the modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver
hertz	the unit normally employed to measure the frequency of a sound, equal to cycles per second of acoustic pressure fluctuations about the atmospheric mean pressure
impulsive sound	a sound having all its energy concentrated in a very short time period
instantaneous sound pressure	at a given point in space and at a given instant in time, the difference between the instantaneous pressure and the mean atmospheric pressure
internal noise level	the noise level, in decibels, measured inside a building
L_{Aeq}	the abbreviation of the A-weighted equivalent continuous sound pressure level
L_{A10}	the abbreviation of the 10 percentile noise indicator, often used for the measurement of road traffic noise
L_{A90}	the abbreviation of the 90 percentile noise indicator, often used for the measurement of background noise
level	the general term used to describe a sound once it has been converted into decibels
loudness	the attribute of human auditory response in which sound may be ordered on a subjective scale that typically extends from barely audible to painfully loud
noise	physically: a regular and ordered oscillation of air molecules that travels away from the source of vibration and creates fluctuating positive and negative acoustic pressure above and below atmospheric pressure. Subjectively: sound that evokes a feeling of displeasure in the environment in which it is heard, and is therefore unwelcomed by the receiver
noise emission	the noise emitted by a source of sound
noise immission	the noise to which a receiver is exposed
noise nuisance	an unlawful interference with a person’s use or enjoyment of land, or of some right over, or in connection with it
octave band frequency analysis	a frequency analysis using a filter that is an octave wide (the upper limit of the filter’s frequency band is exactly twice that of its lower frequency limit)

Terminology	Description
percentile exceeded sound level	the noise level exceeded for n% of the time over a given time period, T, denoted by LAn,T
receiver	a person or property exposed to the noise being considered
residual noise	the ambient noise that remains in the absence of the specific noise whose effects are being assessed
sound	physically: a regular and ordered oscillation of air molecules that travels away from the source of vibration and creates fluctuating positive and negative acoustic pressure above and below atmospheric pressure subjectively: the sensation of hearing excited by the acoustic oscillations described above (see also 'noise')
sound level meter	an instrument for measuring sound pressure level
sound pressure amplitude	the root mean square of the amplitude of the acoustic pressure fluctuations in a sound wave around the atmospheric mean pressure, usually measured in Pascals (Pa)
sound pressure level	a measure of the sound pressure at a point, in decibels
sound power level	the total sound power radiated by a source, in decibels
spectrum	a description of the amplitude of a sound as a function of frequency
Standardised wind speed	Values of wind speed at hub height corrected to a standardised height of ten metres using the same procedure as used in wind turbine emission testing
threshold of hearing	the lowest amplitude sound capable of evoking the sensation of hearing in the average healthy human ear (0.00002 Pa)
tone	the concentration of acoustic energy into a very narrow frequency range

Annex B – Location Map

Figure B1 Map showing turbine and noise monitoring locations.



Annex C – Noise Monitoring Information

Noise Monitoring Information Sheet	
Name	Fife Energy Park Loc. #1
Description	Located the SLM at a similar position to that used previously by Arcus. The SLM is within the Energy Park close to the boundary wire fence with the garden of one of the nearest receptors to the north. The SLM was chained to this metal fence. Also installed at this location was a rain logger, which was also chained to the fence. Audible during equipment setup were local and distant road traffic noise, fork-lift working in the fabrication laydown area (reversing bleeper and other general noise), a general background of industrial type noise from the wider area. This general background may have had a contribution from the generator powering the LiDAR test rig. The turbine was not operating and therefore not audible during setup. On a return to the location with SHI staff the aerodynamic blade noise from the turbine was audible during a brief period of operation before the turbine stopped. The weather was bright and sunny with a light onshore (approximately south easterly) wind. SLM Location: 336441, 698727.

Equipment	**Type**	**Serial Number**	**Last Calibrated**
Sound Level Meter	Rion NL-52	00331819	29/06/2015
Microphone	Rion UC-59	04885	29/06/2015
Pre-amplifier	Rion NH-25	21770	29/06/2015
Calibrator	Brüel and Kjær 4231	2498799	10/03/2015
SLM Range	20-140		
Equipment	**Type**	**Serial Number**	
Rain Logger	Campbell Scientific CR200	4981	
Sensor	Davis Instruments Type 7852 0.2 mm rain gauge	N/A	

Data Collected						
File	**Time Start [UTC]**	**Time End [UTC]**	**Cal Start**	**Cal End**	**Drift**	**Notes**
0001	13/08/2015 12:20	02/09/2015 12:40	94.2	94.1	-0.1	No significant drift
0001	02/09/2015 12:50	25/09/2015 12:10	94.2	94.1	-0.1	No significant drift
0001	25/09/2015 12:20	18/10/2015 01:10	94.2	93.8	-0.4	No significant drift

Table C1 **Information on the measurement location, equipment and noise data at Fife Energy Park Loc. #1.**

Figure C1 **View of the monitoring location at Fife Energy Park Loc. #1 looking approximately north west.**

Figure C2 **View of the monitoring location at Fife Energy Park Loc. #1 looking approximately south east.**

Figure C3 **View of the monitoring location at Fife Energy Park Loc. #1 looking approximately south west.**

Noise Monitoring Information Sheet	
Name	Fife Energy Park Loc. #2
Description	Located the SLM at a similar position to that used previously by Arcus but located to the northern side of what now forms an access track around the perimeter of the site. The SLM is within the Energy Park close to the boundary fence. The nearest garden is across a small section of lower land which has been planted with trees. The SLM was chained to the wooden post of the fence adjacent to the site perimeter track. Audible during equipment setup were local and distant road traffic noise, tractors grading the ground surface and grass seed spreading and a general background of industrial type noise from the wider area. Also audible was birdsong and distant micro-light aircraft. The general background may have had a contribution from the generator powering the LiDAR test rig. The turbine was not operating and therefore not audible during setup. The weather was bright and sunny with a light onshore (approximately south easterly) wind. SLM Location: 336229, 698480.

Approximate SLM Location

Equipment	Type	Serial Number	Last Calibrated
Sound Level Meter	Rion NL-52	00331821	29/06/2015
Microphone	Rion UC-59	04887	29/06/2015
Pre-amplifier	Rion NH-25	21772	29/06/2015
Calibrator	Brüel and Kjær 4231	2498799	10/03/2015
SLM Range	20-140		

Data Collected

File	Time Start [UTC]	Time End [UTC]	Cal Start	Cal End	Drift	Notes
0001	13/08/2015 13:00	02/09/2015 12:00	94.2	94.2	0.0	No significant drift
0001	02/09/2015 12:10	25/09/2015 07:30	94.2	94.1	-0.1	No significant drift
0001	25/09/2015 11:50	16/10/2015 20:30	94.2	94.0	-0.2	No significant drift

Table C2 Information on the measurement location, equipment and noise data at Fife Energy Park Loc. #2.

Figure C4 **View of the monitoring location at Fife Energy Park Loc. #2 looking approximately south west.**

Figure C5 **View of the monitoring location at Fife Energy Park Loc. #2 looking approximately north west.**

Figure C6 **View of the monitoring location at Fife Energy Park Loc. #2 looking approximately north east.**

Noise Monitoring Information Sheet	
Name	Fife Energy Park Loc. #3
Description	The previous location used by Arcus was at one of the nearest dwellings located to the south west of the site within the rear garden of 12 Erskin Street. The SLM was on this occasion located at the closest point towards these receptors locations whilst remaining within the boundary of the site. This location is next to the site boundary fence (chained to the fence) and there is now a rising area of land between the measurement position and the majority of the site (estimated at 20 metres high). The wind turbine is visible from the measurement position. Audible during equipment setup were distant road traffic noise, a motor-boat offshore, birds and gulls and a general distant industrial background sound. This general background may have had a contribution from the generator powering the LiDAR test rig and also the tractors working grading the site. The turbine was not operating and therefore not audible during setup. The weather was bright and sunny with a light onshore (approximately south easterly) wind. The water was flat-calm and was not a source of noise during setup. On other occasions with a non-flat-calm sea this could become a source of noise at this measurement position. It was noted that there now exists a met mast in a new location (336447, 698309) which is at the highest point on the site earth-works. SLM Location: 336299, 698202.

Equipment	Type	Serial Number	Last Calibrated
Sound Level Meter	Rion NL-32	01030553	21/04/2015
Microphone	Rion UC-53A	304789	21/04/2015
Pre-amplifier	Rion NH-21	08179	21/04/2015
Calibrator	Brüel and Kjær 4231	2498799	10/03/2015
SLM Range	20-110		

Data Collected						
File	**Time Start [UTC]**	**Time End [UTC]**	**Cal Start**	**Cal End**	**Drift**	**Notes**
AU2_0000	13/08/2015 11:30	02/09/2015 11:20	94.0	94.0	0.0	No significant drift
AU2_0000	02/09/2015 11:40	25/09/2015 10:50	94.0	93.9	-0.1	No significant drift
AU2_0000	25/09/2015 11:10	18/10/2015 18:40	94.0	94.0	0.0	No significant drift

Table C3 **Information on the measurement location, equipment and noise data at Fife Energy Park Loc. #3.**

Figure C7 **View of the monitoring location at Fife Energy Park Loc. #3 looking approximately south east.**

Figure C8 View of the monitoring location at Fife Energy Park Loc. #3 looking approximately south west.

Figure C9 View of the monitoring location at Fife Energy Park Loc. #3 looking approximately north east.

Figure C10 **View of the monitoring location at Fife Energy Park Loc. #3 looking approximately south.**

Figure C11 **View of the monitoring location at Fife Energy Park Loc. #3 looking approximately south east.**

Annex D – Background Noise and Noise Limits

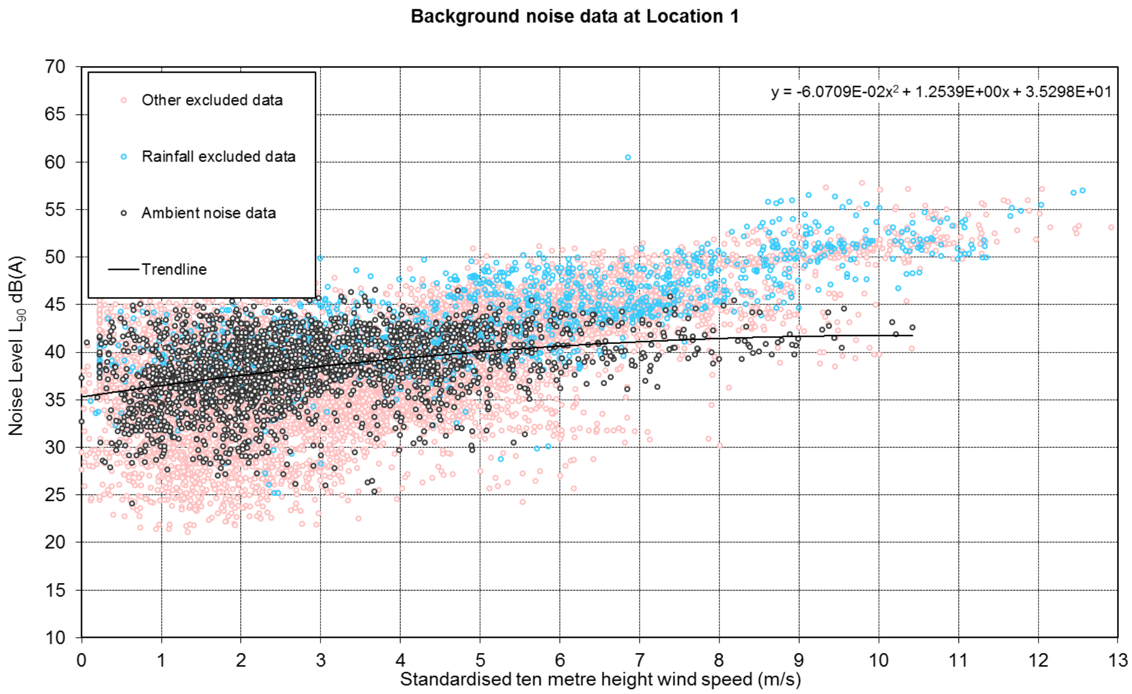


Figure D1 - Location 1 – background noise levels – Daytime – Offshore

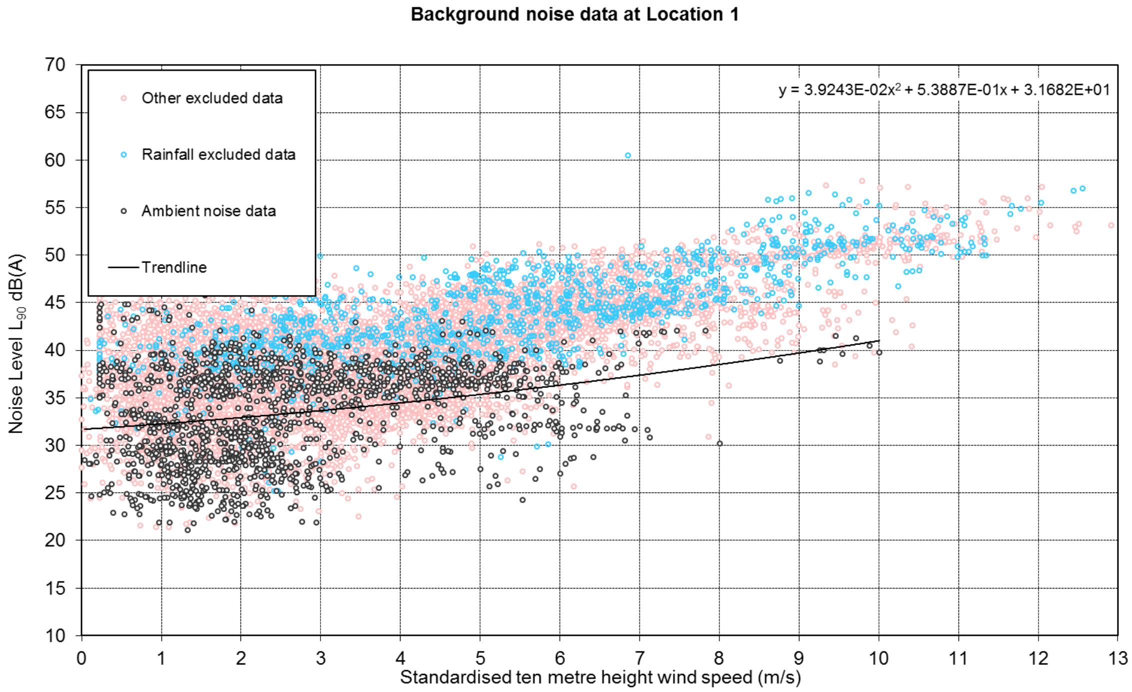


Figure D2 - Location 1 – background noise levels – Night-time – Offshore

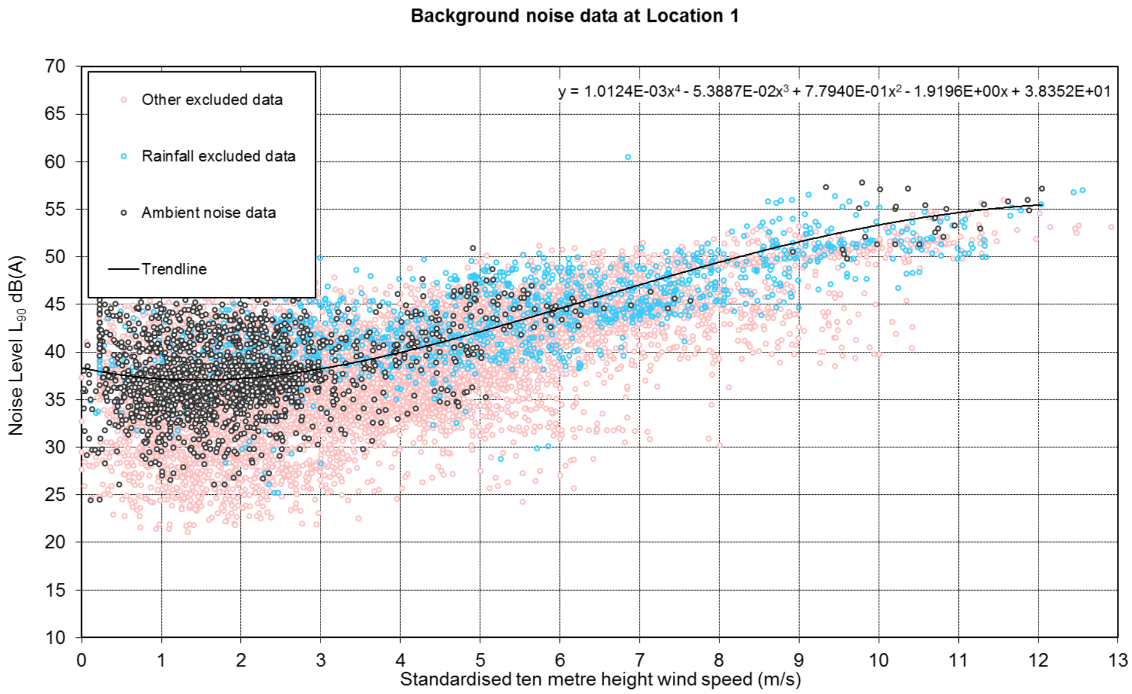


Figure D3 - Location 1 – background noise levels – Day-time – Onshore

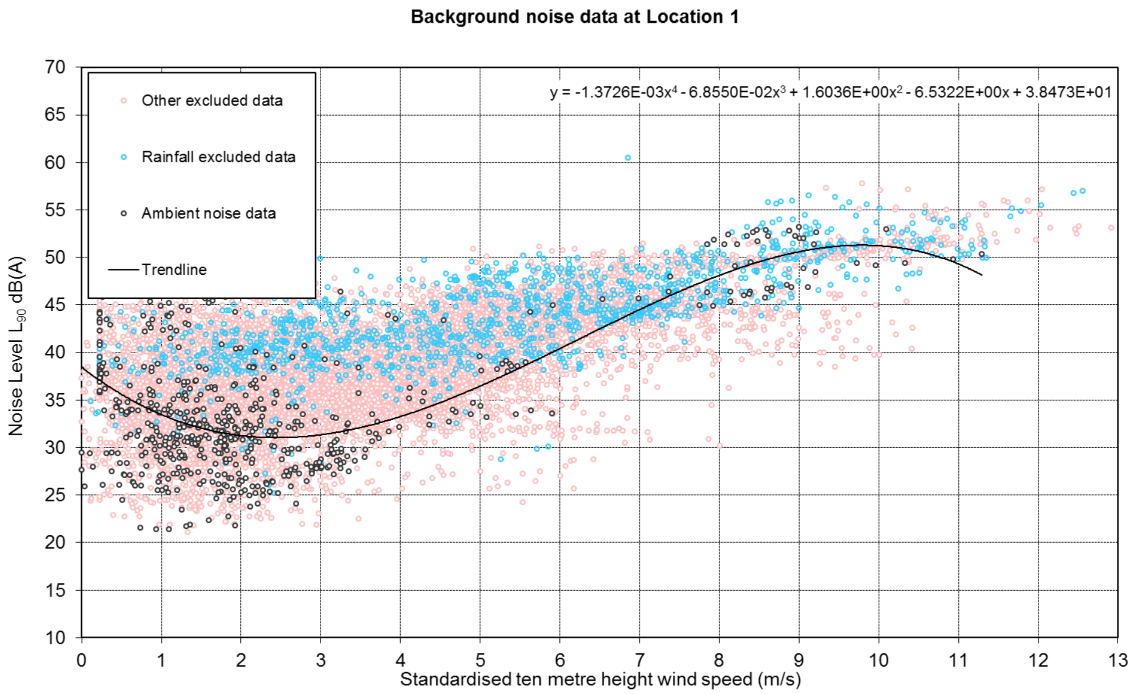


Figure D4 - Location 1 – background noise levels – Night-time – Onshore

Background noise data at Location 2

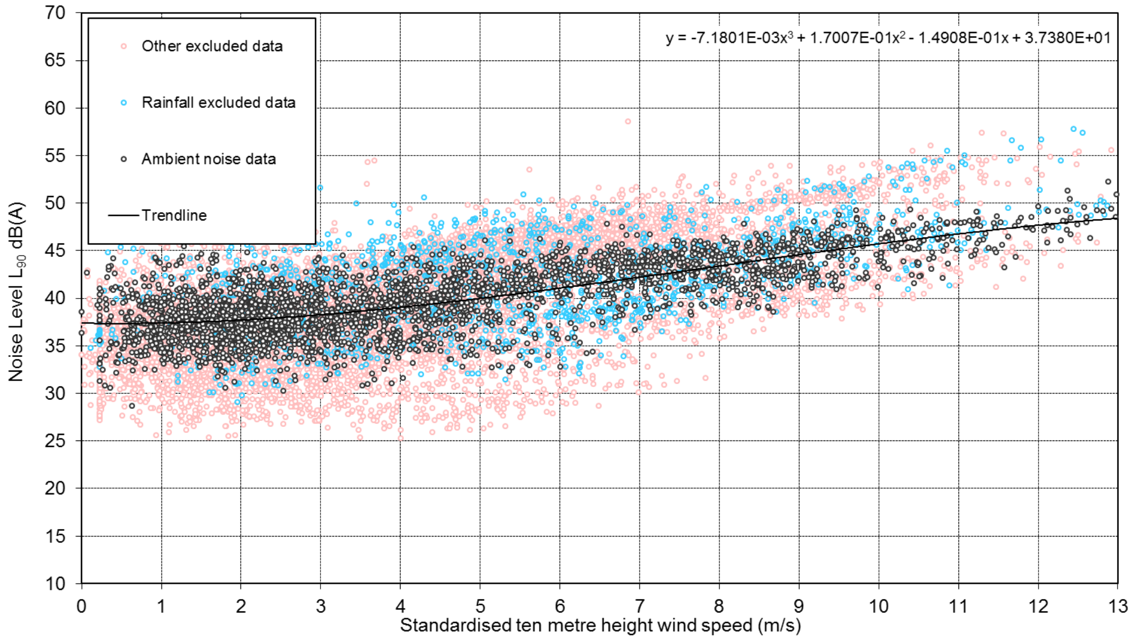


Figure D5 - Location 2 – background noise levels – Day-time – Offshore

Background noise data at Location 2

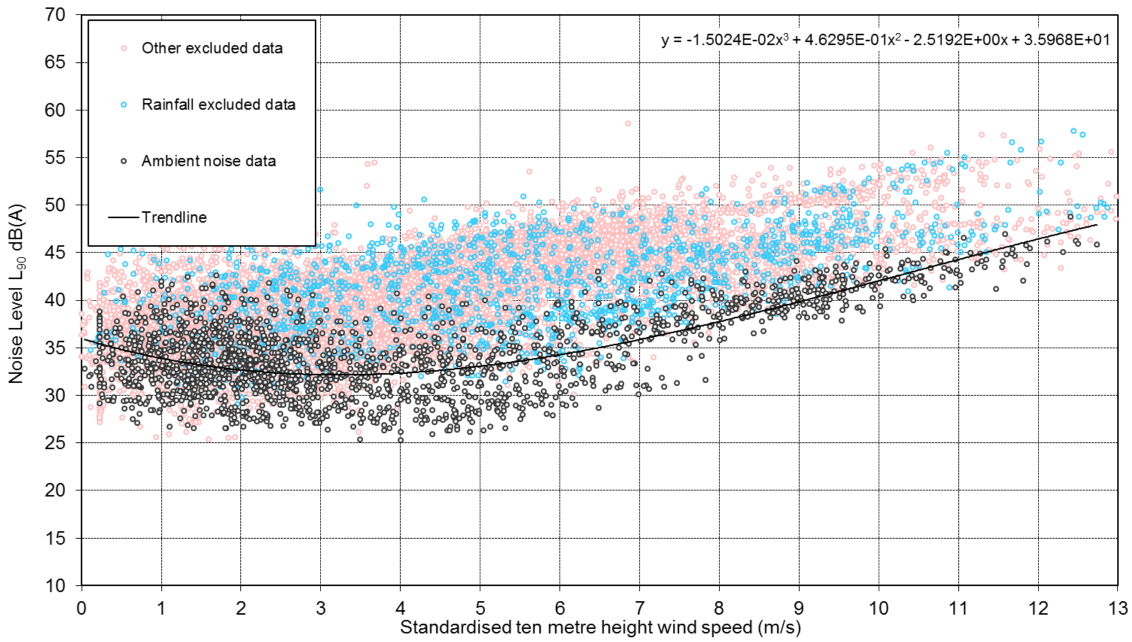


Figure D6 - Location 2 – background noise levels – Night-time – Offshore

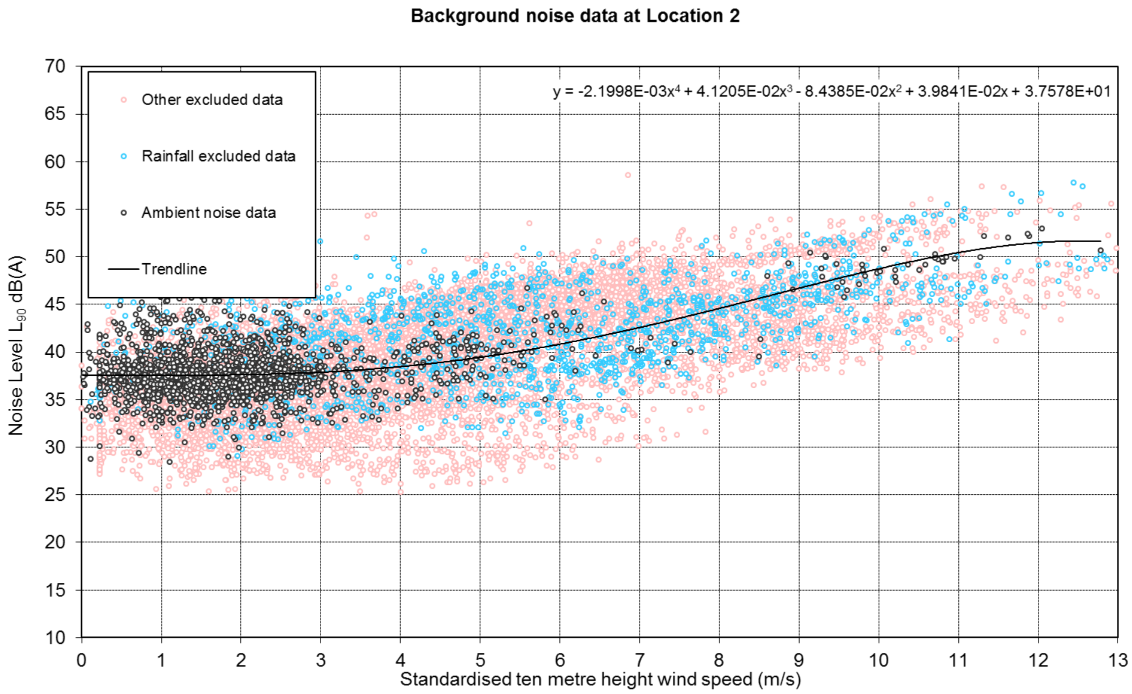


Figure D7 - Location 2 – background noise levels – Day-time – Onshore

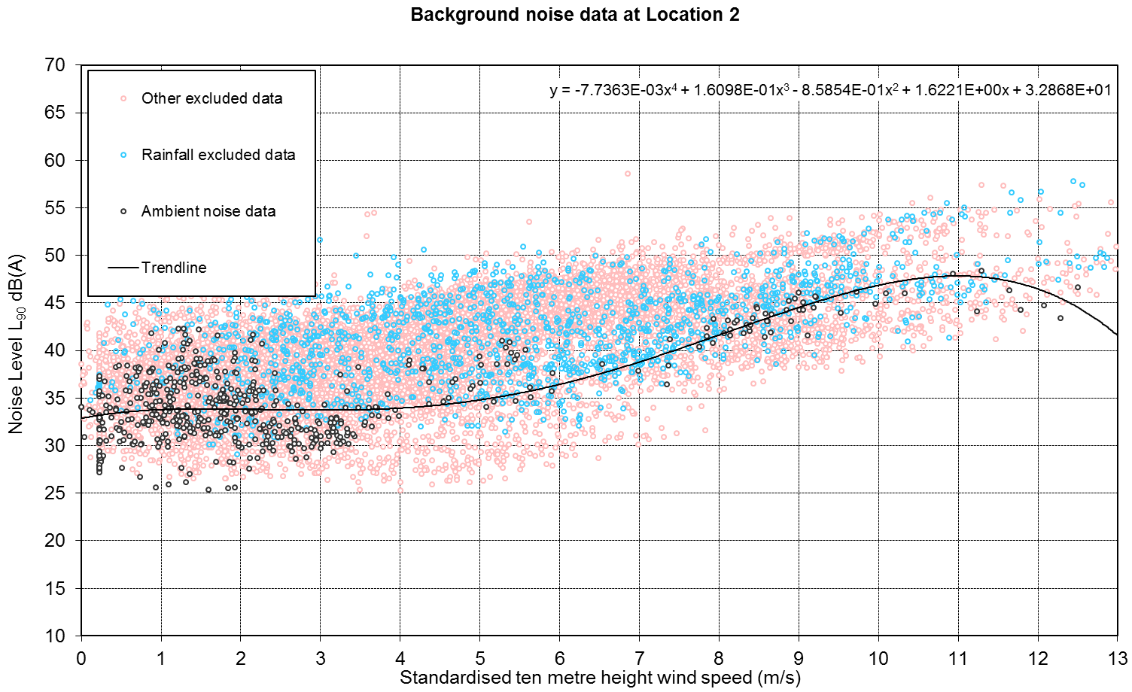


Figure D8 - Location 2 – background noise levels – Night-time – Onshore

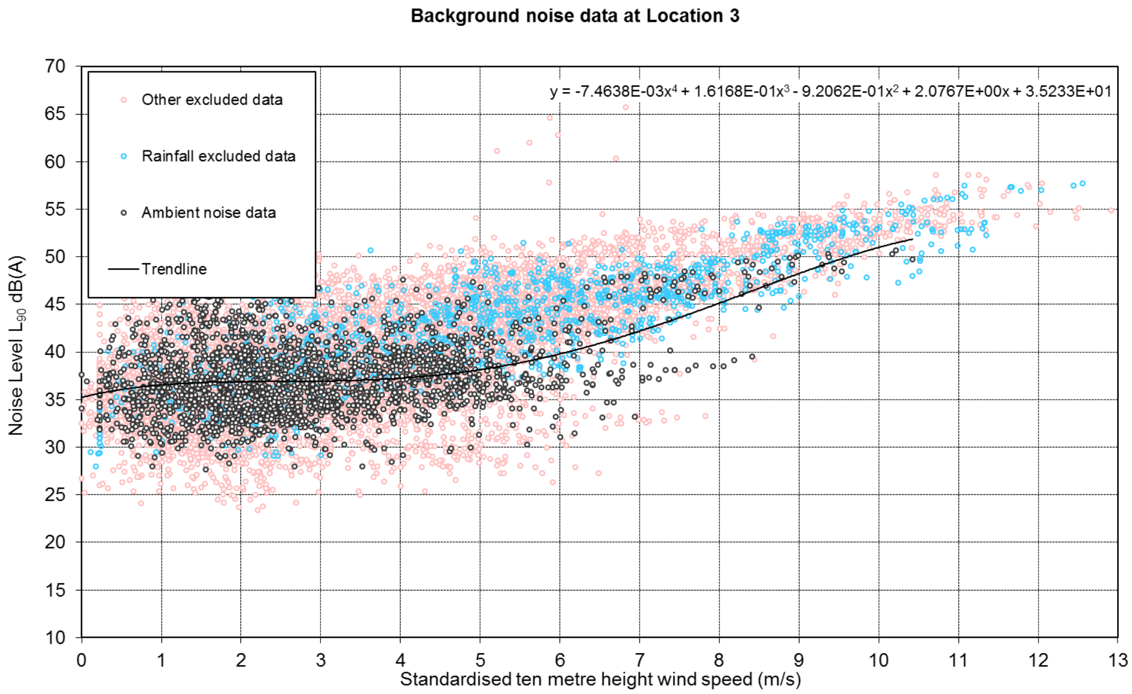


Figure D9 - Location 3 – background noise levels – Day-time – Offshore

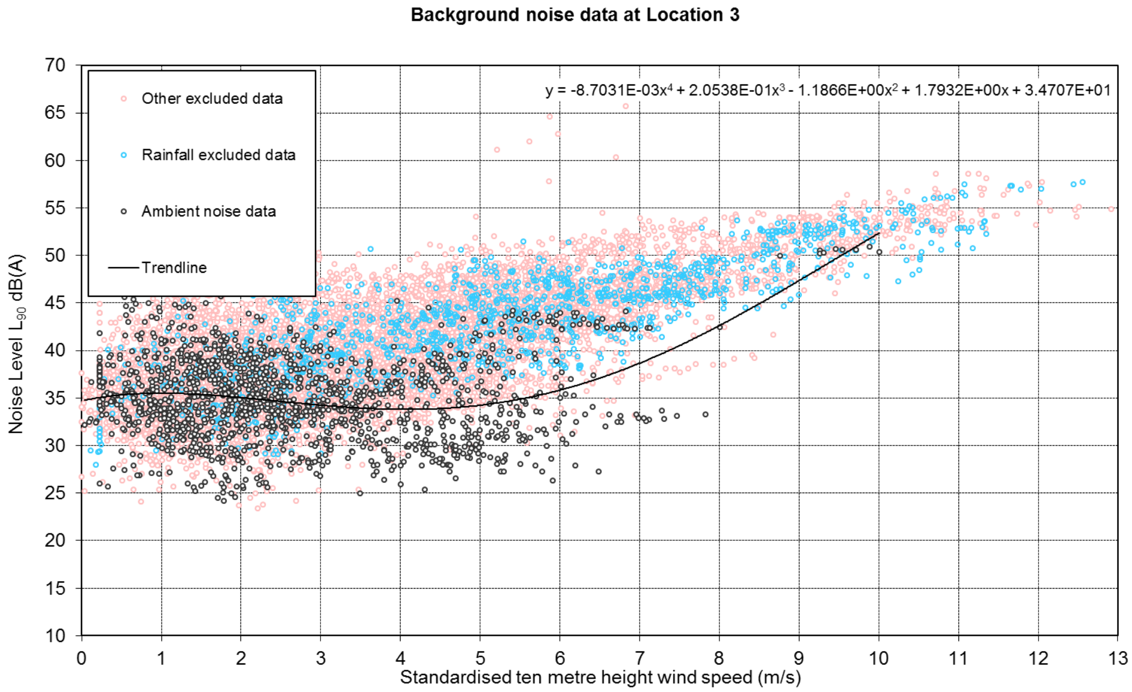


Figure D10 - Location 3 – background noise levels – Night-time – Offshore

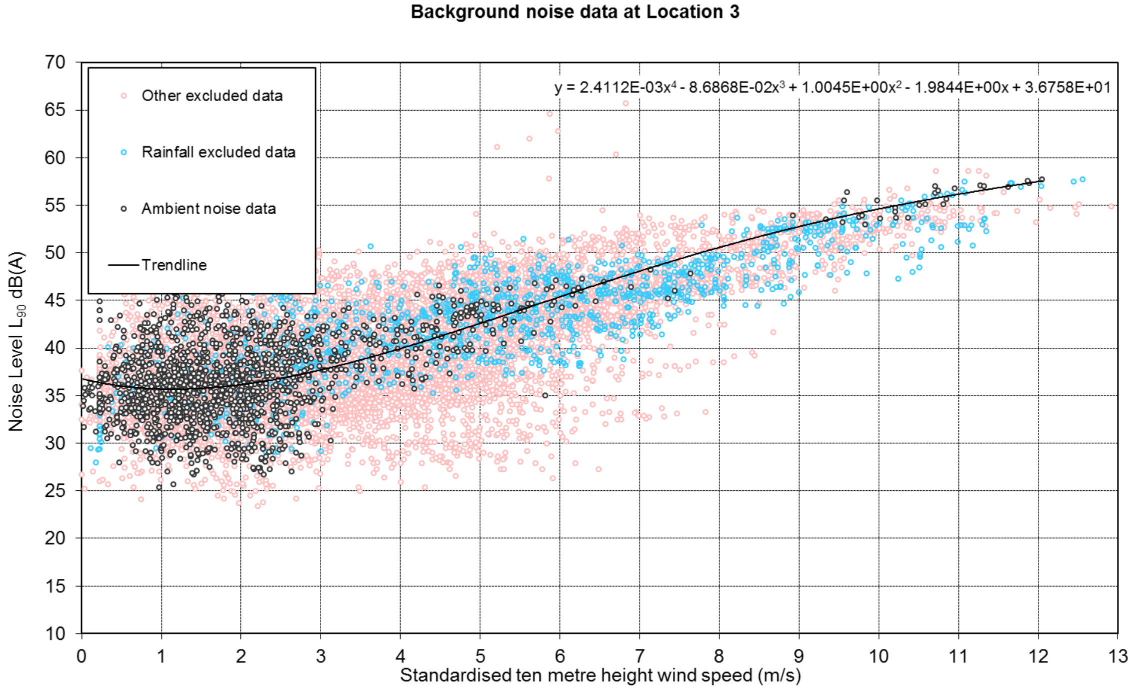


Figure D11- Location 3 – background noise levels – Day-time – Onshore

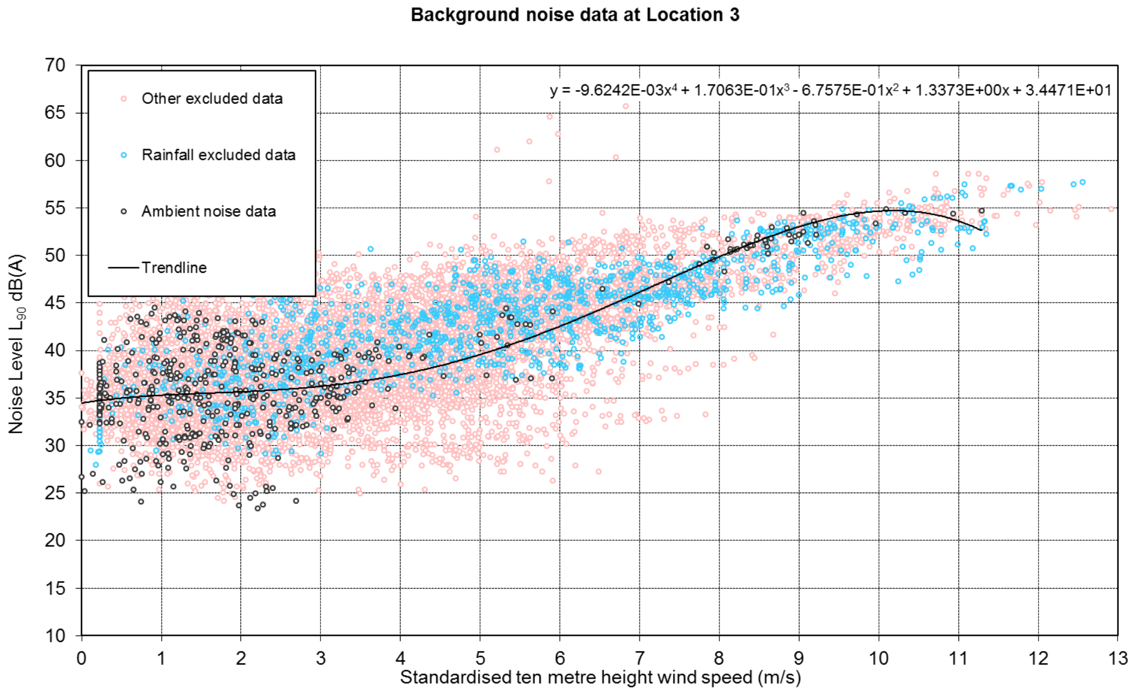


Figure D12 - Location 3 – background noise levels – Night-time – Onshore

Annex E – Operational noise levels

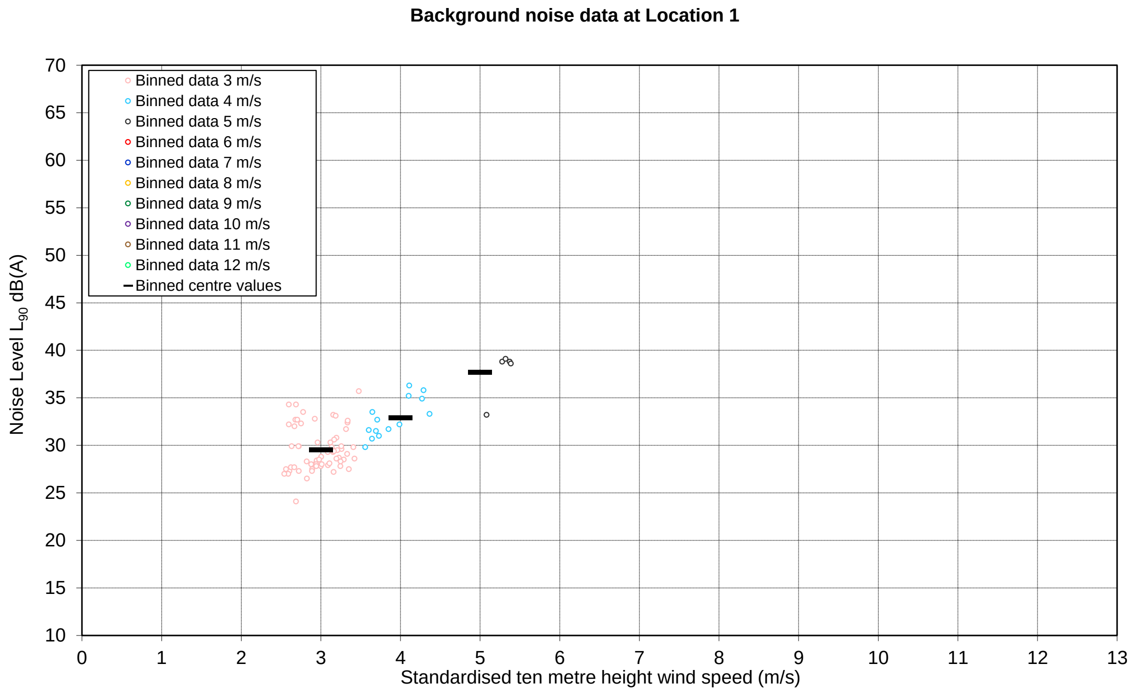


Figure E1: Turbine Off measurements for 90° wind direction sector (onshore) at Location 1

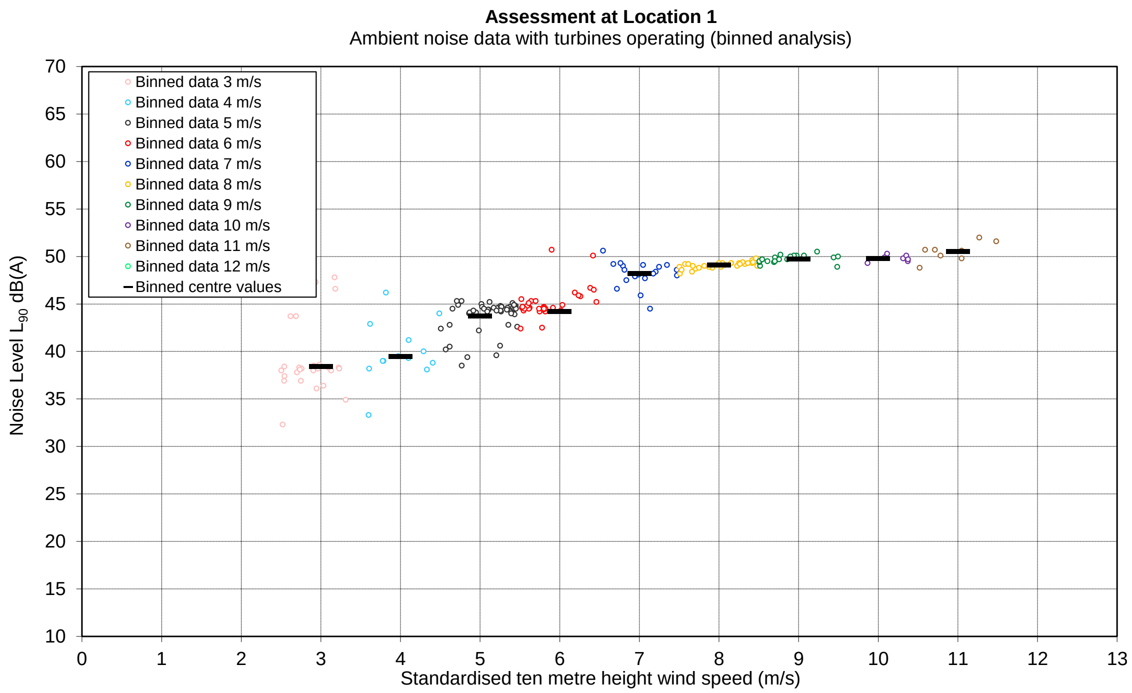


Figure E2: Turbine On measurements for 90° wind direction sector (onshore) at Location 1

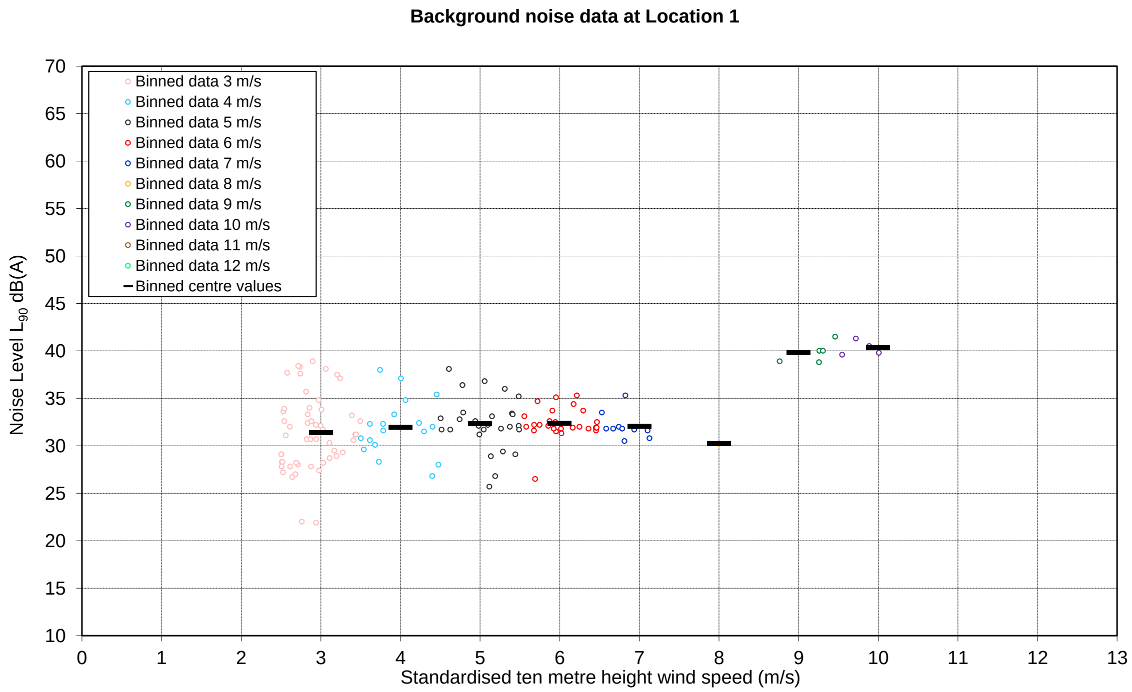


Figure E3: Turbine Off measurements for 240° wind direction sector (offshore) at Location 1

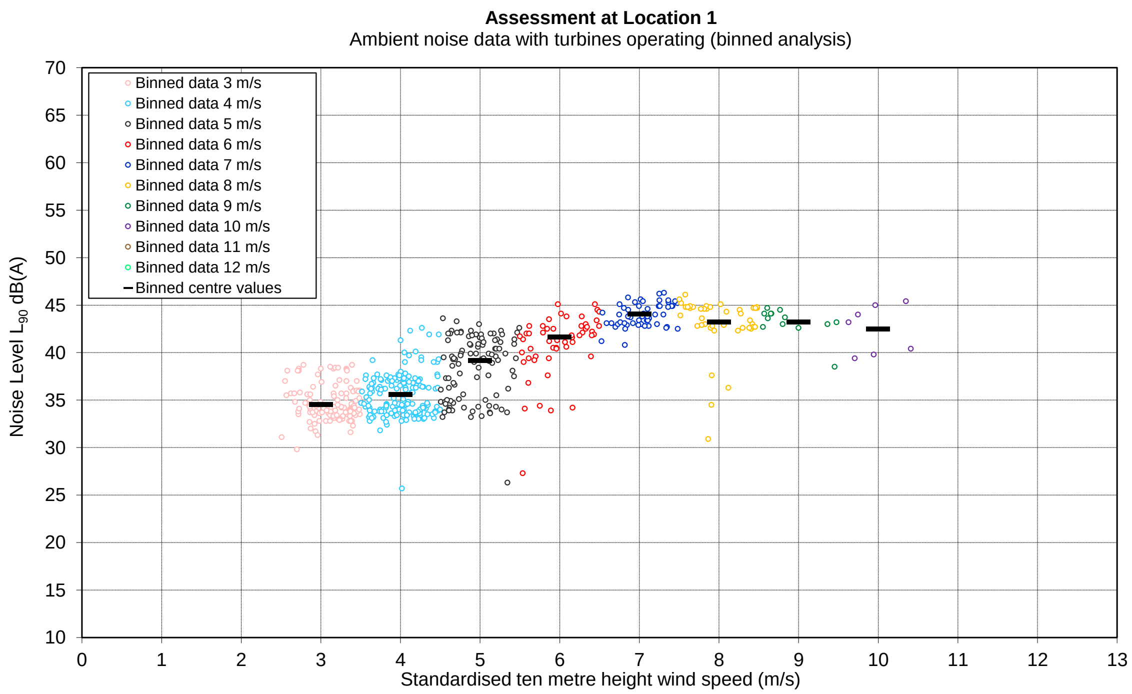


Figure E4: Turbine On measurements for 240° wind direction sector (offshore) at Location 1

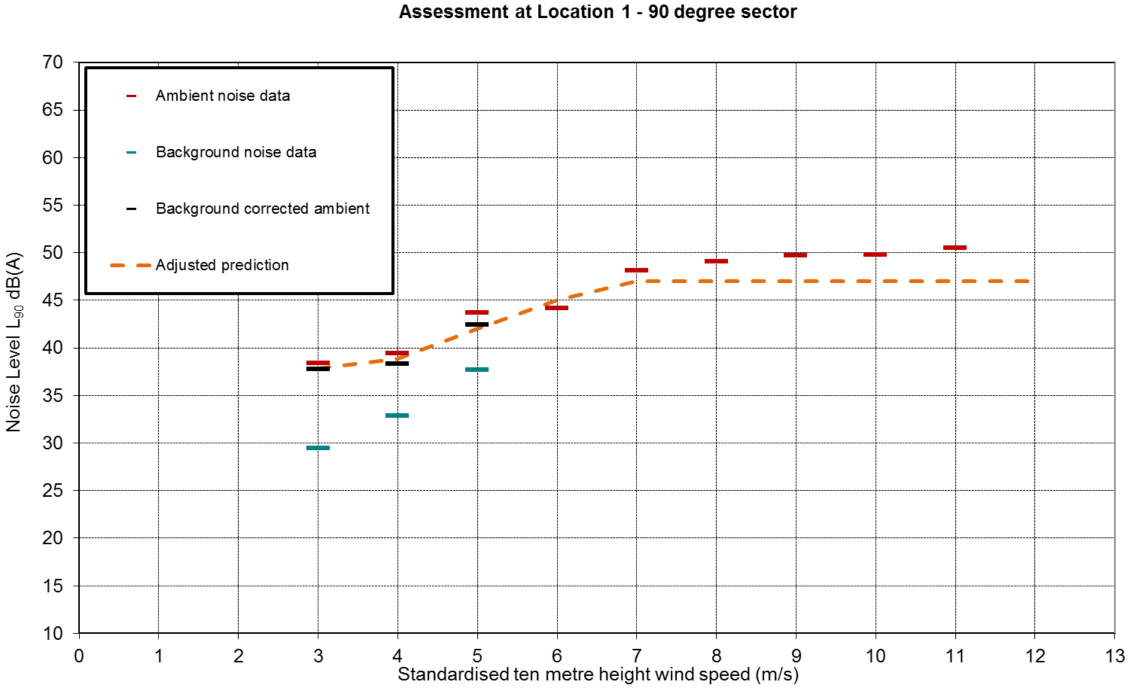


Figure E5 Chart of assessment for 90° wind direction sector at location 1. Ambient noise levels corrected for the influence of background noise levels are shown where this is possible. Adjusted predicted levels are also shown.

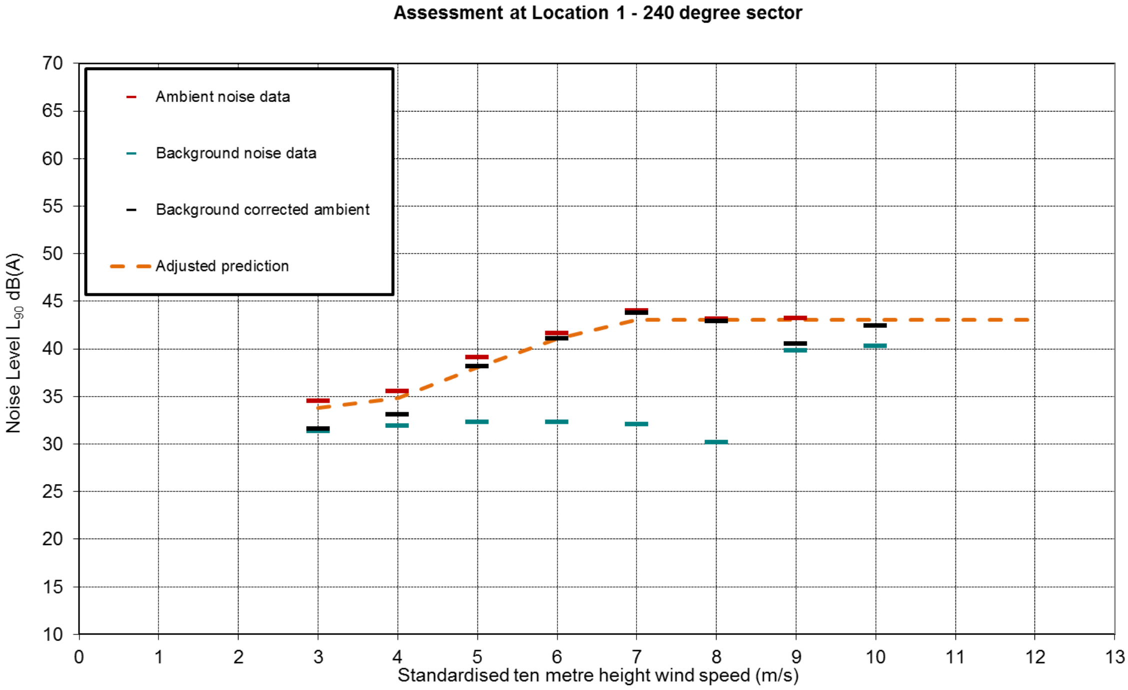


Figure E6 Chart of assessment for 240° wind direction sector at location 1. Ambient noise levels corrected for the influence of background noise levels are shown where this is possible. Adjusted predicted levels are also shown.

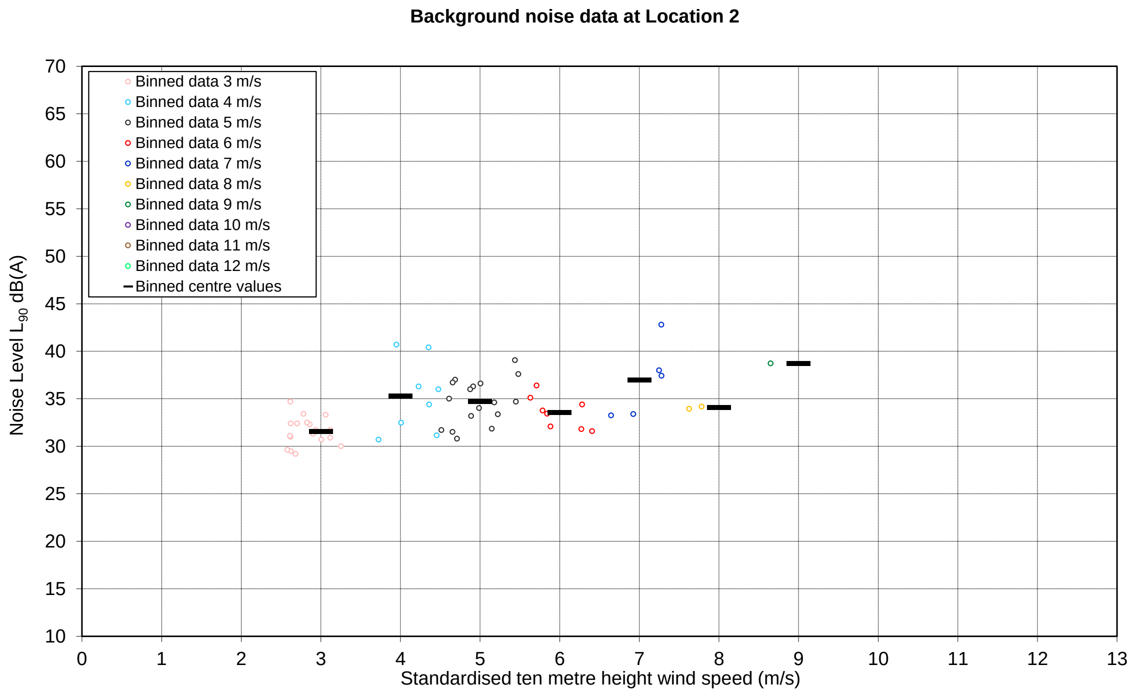


Figure E7: Turbine Off measurements for 0° wind direction sector (offshore) at Location 2

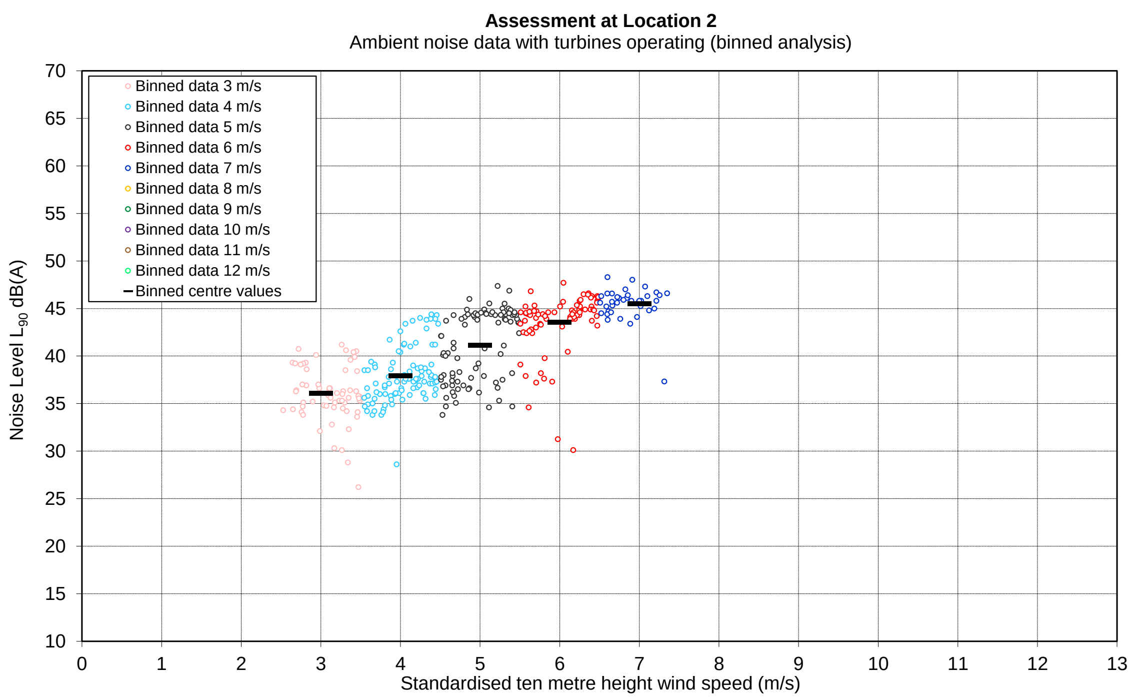


Figure E8: Turbine On measurement for 0° wind direction sector (offshore) at Location 2

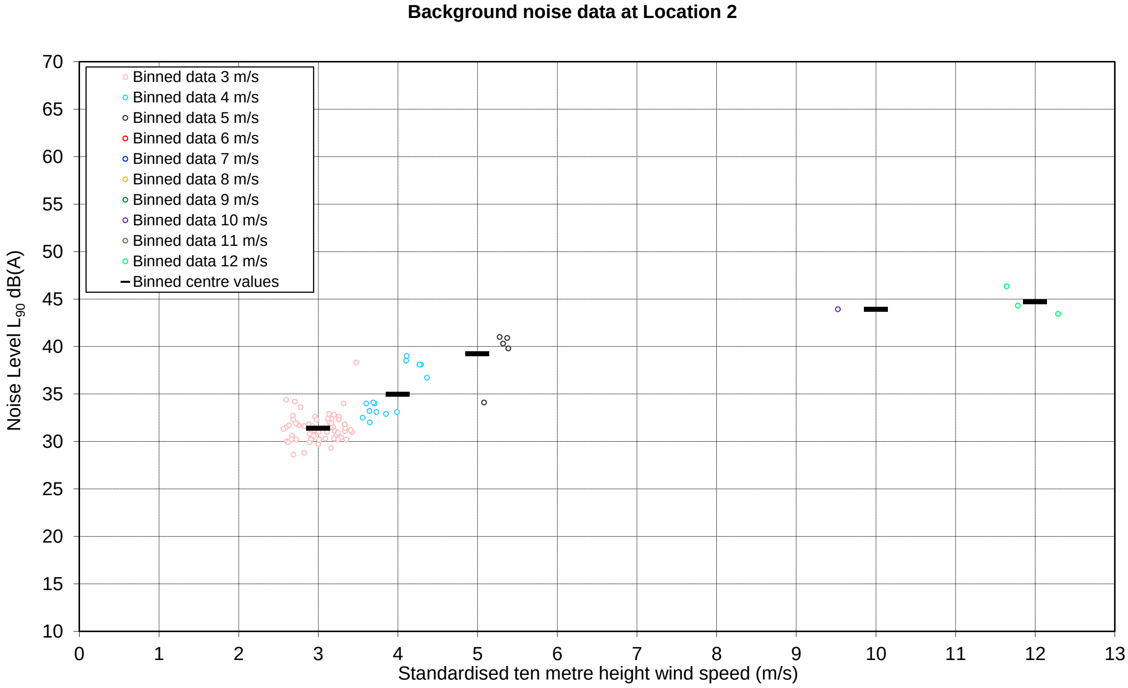


Figure E9: Turbine Off measurements for 90° wind direction sector (onshore) at Location 2

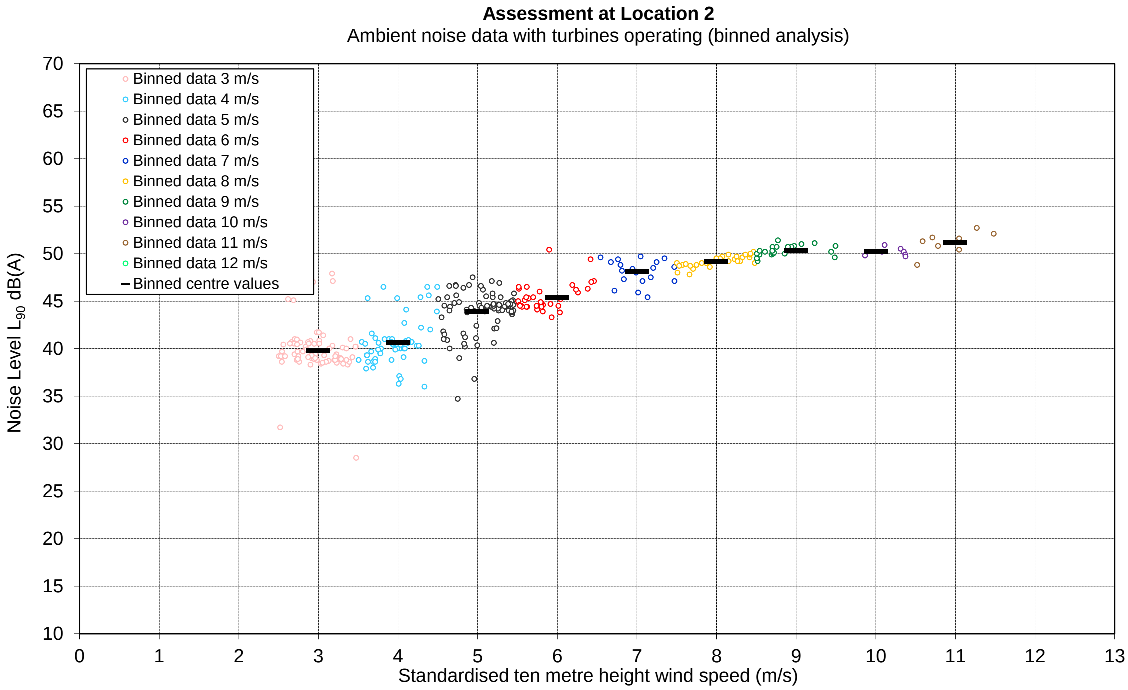


Figure E10: Turbine On measurements for 90° wind direction sector (onshore) at Location 2

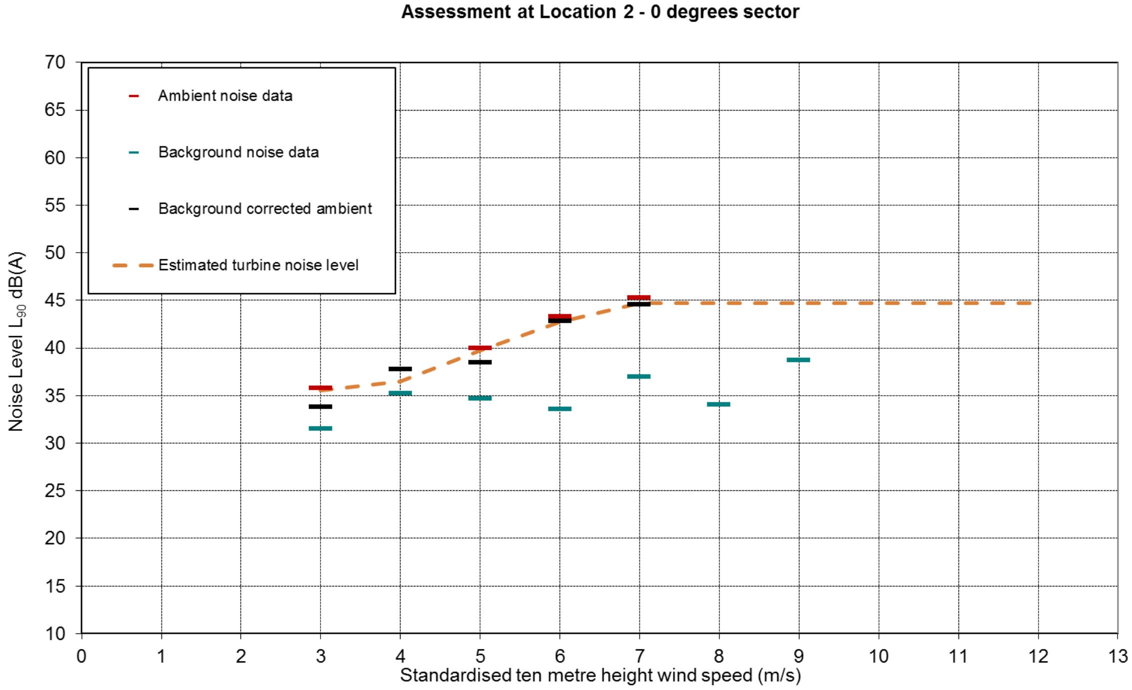


Figure E11 Chart of assessment for 0° wind direction sector at location 1. Ambient noise levels corrected for the influence of background noise levels are shown where this is possible. Adjusted predicted levels are also shown.

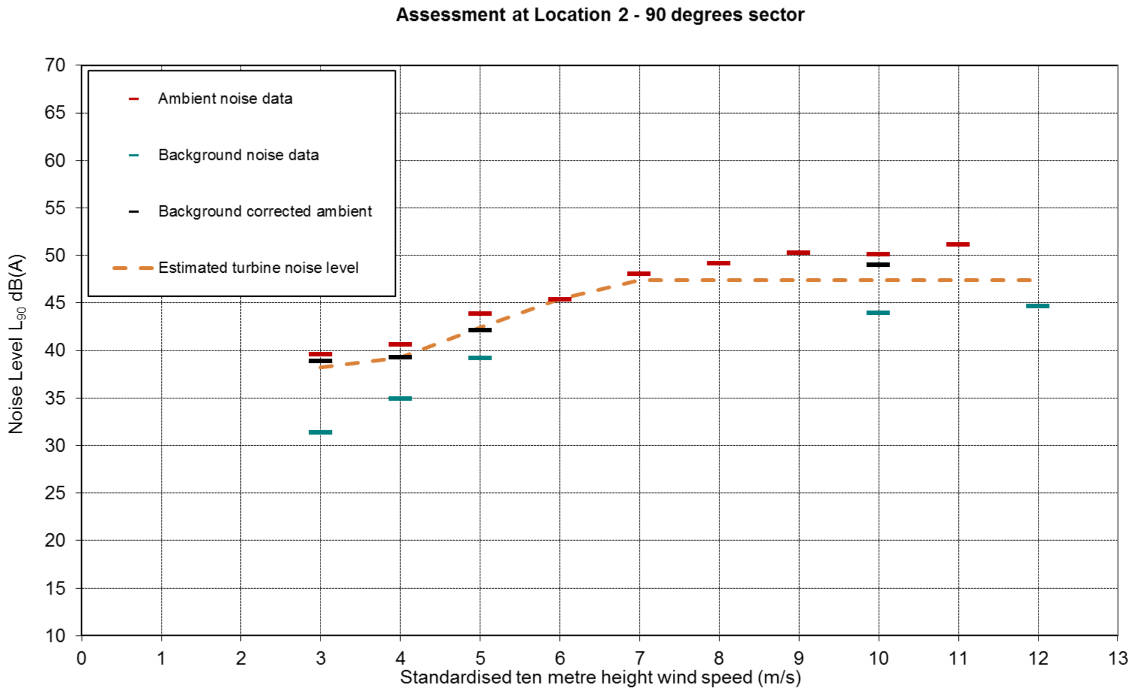


Figure E12 Chart of assessment for 90° wind direction sector at location 2. Ambient noise levels corrected for the influence of background noise levels are shown where this is possible. Adjusted predicted levels are also shown.

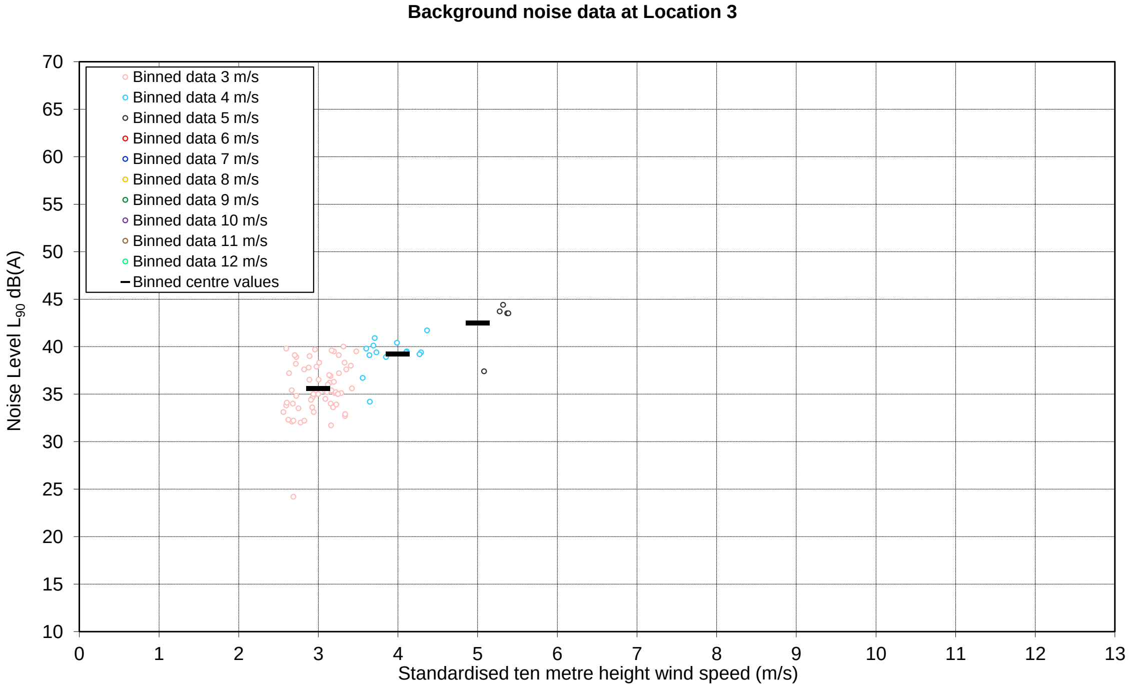


Figure E13: Turbine Off measurements for 90° wind direction sector (onshore) at Location 3

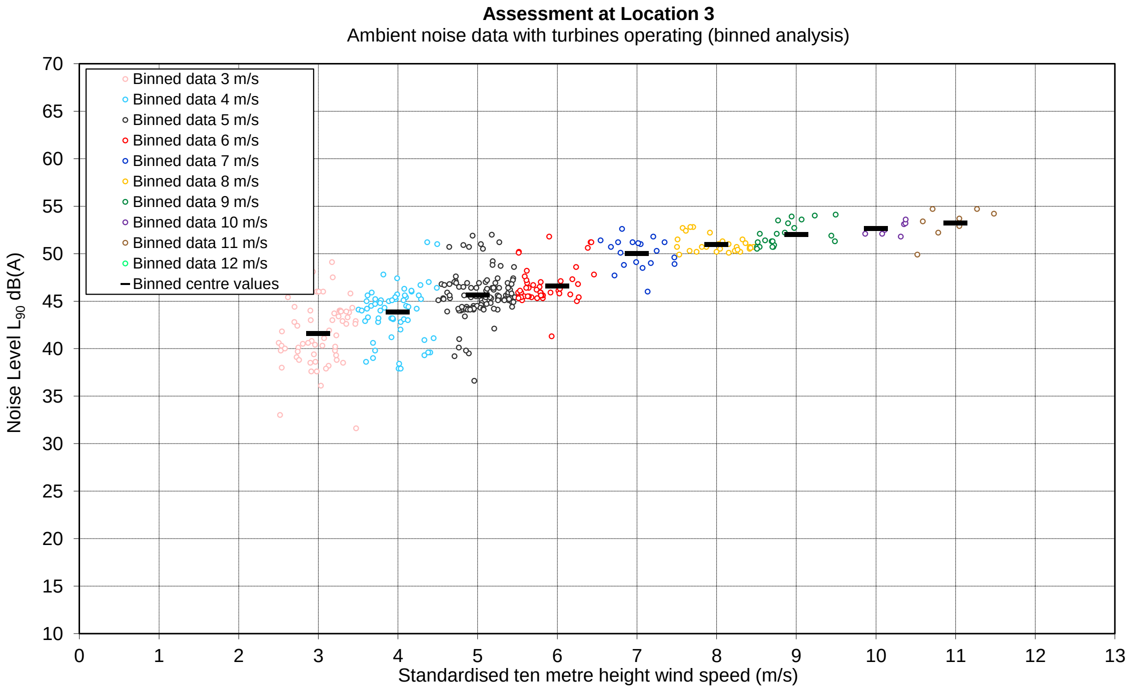


Figure E14: Turbine On measurements for 90° wind direction sector (onshore) at Location 3

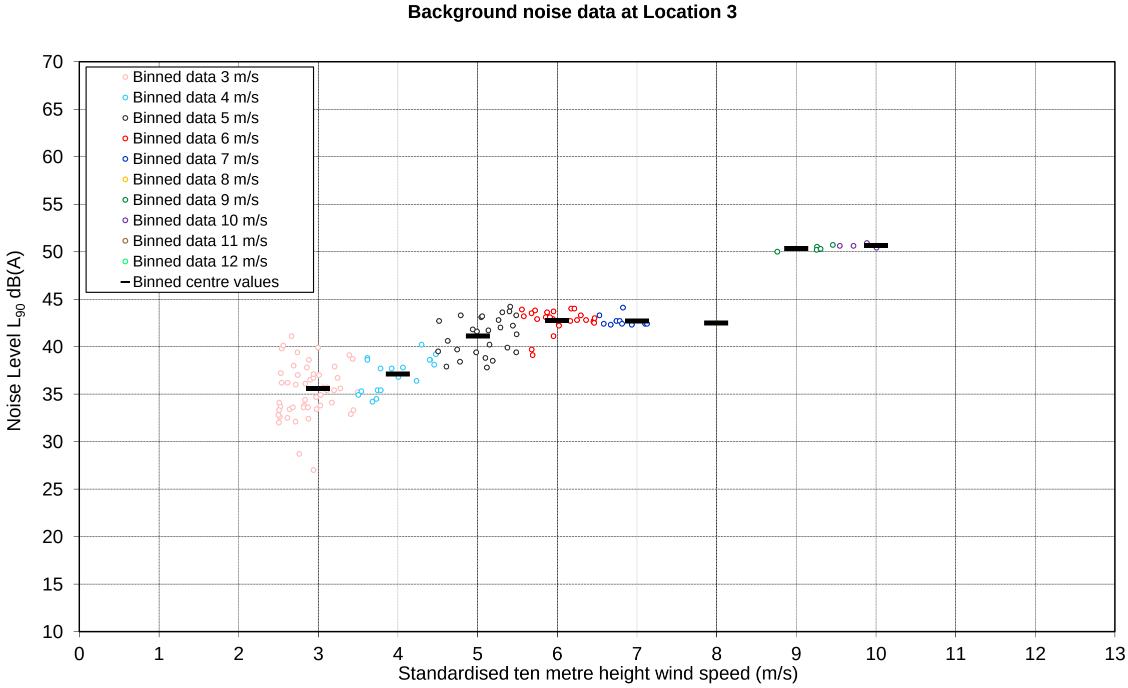


Figure E15: Turbine Off measurements for 240° wind direction sector (offshore) at Location 3

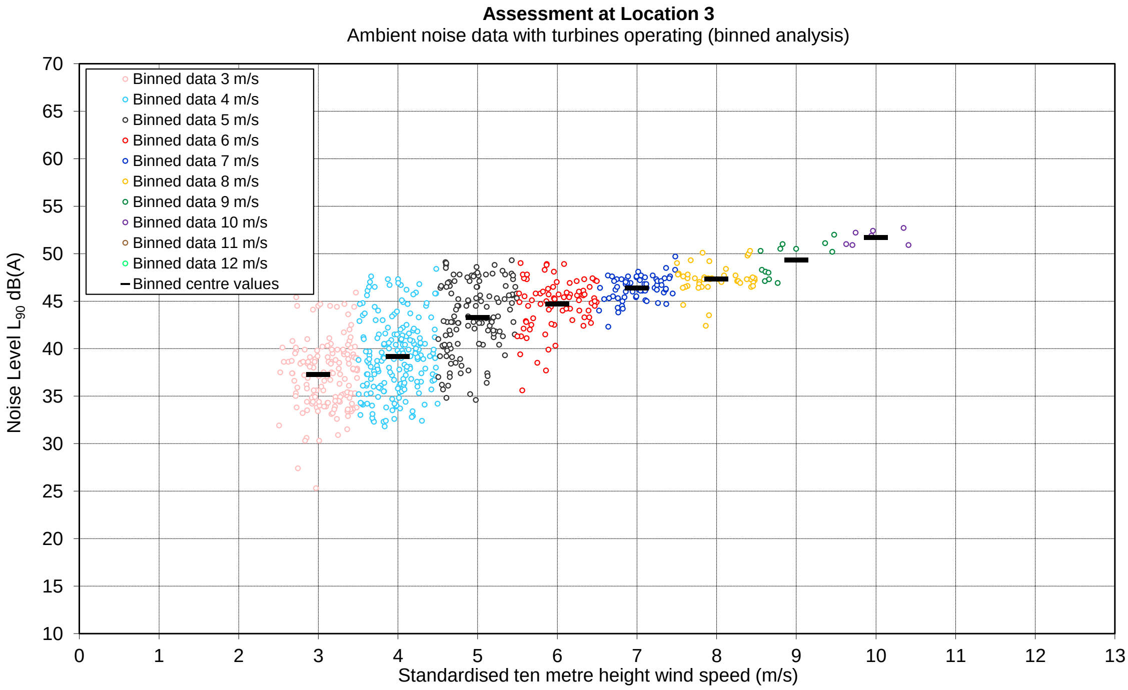


Figure E16: Turbine On measurements for 240° wind direction sector (offshore) at Location 3

Assessment at Location 3 (proxy) - 90 degrees sector

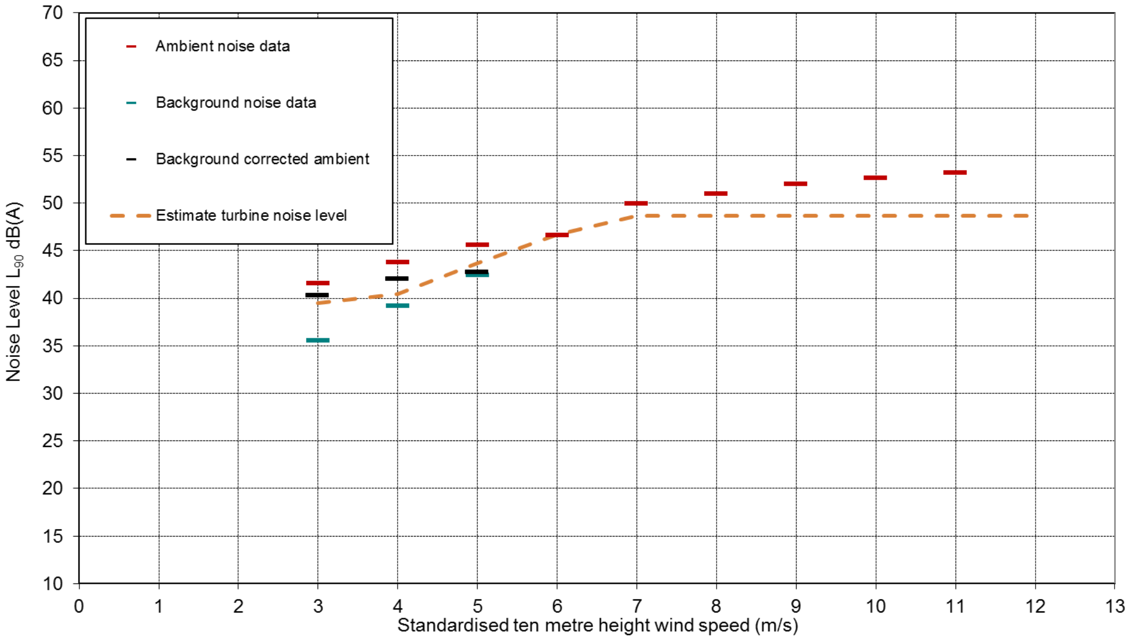


Figure E17 Chart of assessment for 90° wind direction sector at location 3. Ambient noise levels corrected for the influence of background noise levels are shown where this is possible. Adjusted predicted levels are also shown.

Assessment at Location 3 (proxy) - 240 degrees sector

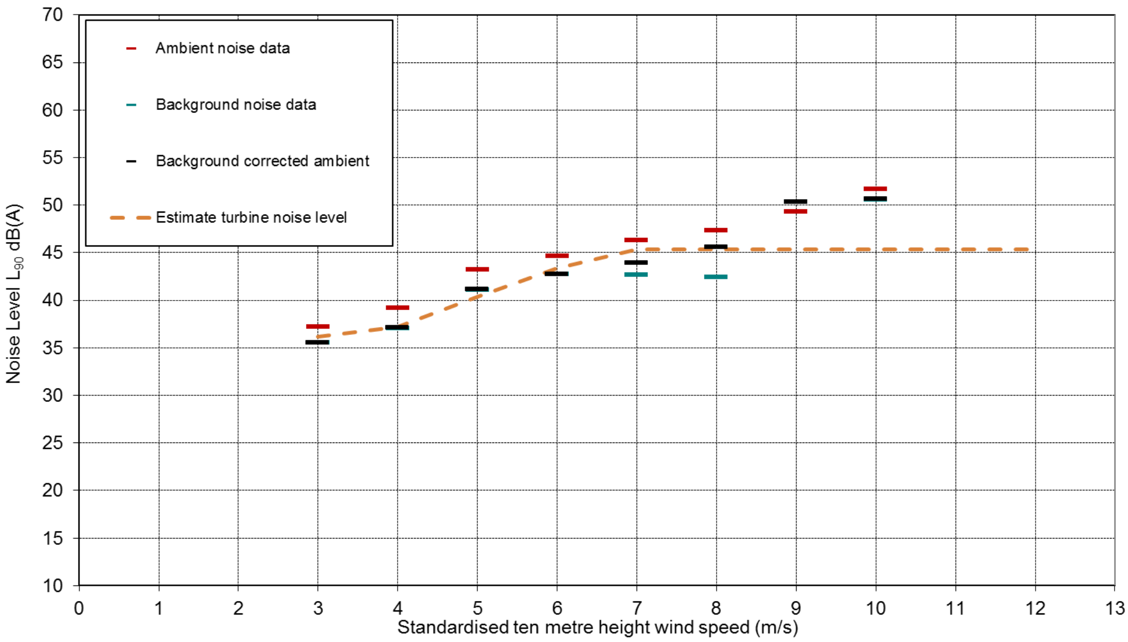


Figure E18 Chart of assessment for 240° wind direction sector at location 3. Ambient noise levels corrected for the influence of background noise levels are shown where this is possible. Adjusted predicted levels are also shown.

Annex F – Wind Speed Calculations

Background

F.1 An important consideration when specifying the sound power outputs of wind turbines is the fact that wind speed varies with height above the ground. This effect is commonly termed 'wind shear'. Therefore, if the wind speed on a site is characterised in terms of, say, the wind speed measured at ten metres above ground level, then some means must be available for converting this ten metre height wind speed to whatever the hub height of the proposed turbine will be. This is important because it is this hub height wind speed (i.e. the wind speed seen by the rotor of the wind turbine) that determines the actual sound power radiated by that turbine.

F.2 The example of a ten metre height wind speed is selected here because this height is frequently adopted as a 'reference'. For example, in ETSU-R-97 [1] the wind speed dependent background noise levels are specified as a function of ten metre height site wind speeds. Likewise, the declared sound power data measured in accordance with the internationally adopted standard for the measurement of wind turbine sound power output, IEC61400-11 [2], is also referenced to a ten metre height wind speed.

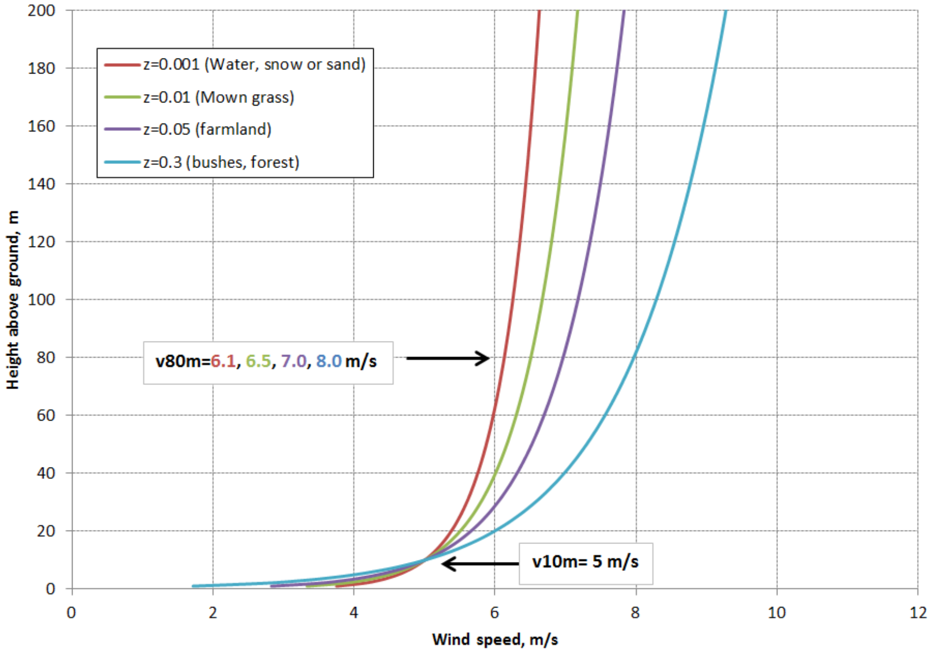
F.3 The ground roughness length, z, indicates the degree to which wind is slowed down by friction as it passes close to the ground: the rougher the ground, the more the wind is slowed down and the larger the roughness length. Table 11 of ETSU-R-97 gives examples of roughness lengths, as repeated here in Table F.1. Figure F.1 shows the wind speed profiles corresponding to the four ground roughness lengths given in Table F1. However, another key factor can be the amount of turbulence in the atmosphere itself.

F.4 Generally speaking, under a typical day time meteorological scenario, the atmosphere lying above the ground will exhibit what is termed 'neutral' characteristics. In such cases the atmosphere itself has little effect on the wind speed profile which is then controlled primarily by ground roughness. However, under certain conditions, typically on a summer's evening following a warm day, the radiative effects of the ground can cool the air lying close to the earth at a rate faster than the convective cooling of the air lying above. This can result in a highly stable atmosphere, one of the characteristics of which is a pronounced wind shear effect. This means that the relative difference between the wind speed at ten metres height and that at hub height during affected evening/night time periods may be significantly greater than the difference which typically exists during day time periods or other 'neutral' conditions.

Table F1 Table 11 of ETSU-R-97 showing the typical roughness lengths associated with different terrain types

Type of Terrain	Roughness Length, z (metres)
Water, snow or sand surfaces	0.0001
Open, flat land, mown grass, bare soil	0.01
Farmland with some vegetation (reference)	0.05
Suburbs, towns, forests, many trees and bushes	0.3

Figure F1 Wind speed profiles calculated for the four different ground roughness lengths listed in Table F.1. The figure adopts a fixed wind speed at ten metres height of v10=5 ms-1 then presents the calculated wind speeds at other heights as the curved lines. The calculated wind speeds at 80 metres height corresponding to the assumed U10=5 ms-1 are also presented as numerical values, ranging from U80=6.1 ms-1 for a ground roughness length of z=0.001 metres to U80=8.0 ms-1 for ground roughness length of z=0.3 metres.



F.5 When undertaking noise certification measurements of wind turbine sound power outputs, the relevant procedure applies a standard means of converting between hub height and ten metres height wind speeds. This involves using a 'standard' roughness length of 0.05 metres in Equation F1, regardless of what the actual roughness length seen on the test site may have been. This 'normalisation' procedure is adopted to ensure direct comparability between test results for different turbines. However, when this standardised data is subsequently used to calculate the sound power radiated from an installed turbine on an actual wind farm site, it is important to convert between ten metres height wind speeds and hub height wind speeds using the actual wind speed differences experienced on the site itself. These hub height wind speeds may well be different from those calculated by assuming the standard 0.05 metres ground roughness length.

F.6 The relevance of this conversion between wind speeds at ten metres height and wind speeds at hub height has come under increasing scrutiny with the acknowledgement that, on some sites, the wind shear (i.e. the increase in wind speed with increasing height above ground level) can vary significantly between day time and evening/night time periods. This difference occurs for the reasons discussed above concerning the radiative cooling effects of the earth on the lower levels of air. When this effect occurs, the wind speed seen by the turbine blades at night can be significantly higher than that derived using either a 'standard' assumed roughness length based on the characteristics of the general terrain, or from using on a roughness length or shear factor based on longer term averaged measurements of the difference in wind speeds measured at two different heights. This issue, and the manner in which it has been accounted for in the case of the Development, is discussed in the following section.

Approach

F.7 Wind speeds are needed at a height of ten metres for correlation with measured noise data as specified in ETSU-R-97. ETSU-R-97 also requires the noise assessment be performed with a wind speed maximum of no more than 12 m/s at ten metres height. Whilst it would be possible to use the direct measurement of wind speeds at a height of ten metres, this approach has been questioned due to potential differences in the wind shear profile during the evenings and night times when compared to the day time.

F.8 In accordance with the preferred methodology set out in the Institute of Acoustic Bulletin Good Practice Guide [3], all ten metre wind speed data is calculated from those which will be directly experienced by the wind turbines. Wind speeds are therefore related directly to those at hub height and calculated to be at ten metres height assuming reference conditions. Reference conditions are those used when reporting the measured and/or warranted sound power levels of the wind turbines and assume a ground roughness length of 0.05 metre. The process used to calculate the ten metres height wind speeds is therefore described below.

Methodology

F.9 ETSU-R-97 specifies that where measurements are not made using a ten metre met mast, measurements at other heights may be used to provide ten metre height wind speeds by calculation. Equation F1 is given in ETSU-R-97 for this purpose. Equation F1 is of the same form as that given in BS EN 61400 11:2003 [2] for calculating ten metre wind speeds related to hub height wind speeds when providing source noise emission data for wind turbines. ETSU-R-97 suggests that the roughness length may be calculated from wind speed measurements at two heights, by inverting equation F1. Alternatively, wind shear can be described by the wind shear exponent according to equation F2 below. In this case as well, the wind shear exponent may be calculated from wind speed measurements at two heights, by inverting equation F2.

$$U_1 = U_2 \cdot \frac{\ln\left(H_1 / z \right)}{\ln\left(H_2 / z \right)} \qquad \text{[F1]}$$

Where:

H_1	The height of the wind speed to be calculated (10 metres)
H_2	The height of the measured wind speed
U_1	The wind speed to be calculated
U_2	The measured wind speed
z	The roughness length (0.05 metres in the case of reference conditions)

$$U = U_{ref} \cdot \left[\frac{H}{H_{ref}} \right]^m \qquad [F2]$$

Where:

U	calculated wind speed.
U_{ref}	measured wind speed
H	height at which the wind speed will be calculated
H_{ref}	height at which the wind speed is measured
M	shear exponent

F.10 For the 2010 survey, wind speeds measured at 70 m and 51 m height were used to extrapolate the 110 m high wind speed. For the 2015 survey, an anemometry mast located on the site (easting/northing 336447, 698309) measured wind directly at 110 m height.

F.11 Equation F1 was then used to calculate a ten metre height wind speed from the hub height wind speed every ten minutes assuming the reference roughness length of 0.05 metres.

Conclusions

F.12 By using this method, measured background noise levels were correlated to ten metre wind speeds calculated from wind speeds at hub height. Any likely difference in the shear profile during the 24 hours of the day will be accounted for within the method and be reflected in the resulting ten metre wind speed data.

F.13 The method used to calculate ten metre wind speeds from those at hub height is the same as that used when deriving noise emission data for the turbines. Because the same method has been used, direct comparison of background noise levels, noise limits and predicted turbine noise immission levels may be undertaken. This method is consistent with guidance published in the Institute of Acoustic Bulletin Good Practice Guide [3].

References for Wind Speed Calculations

[1] ETSU-R-97, The Assessment and Rating of Noise from Wind Farms, Final Report for the Department of Trade & Industry, September 1996. The Working Group on Noise From Wind Turbines.

[2] IEC 61400 11:2003 Wind turbine generator systems - Part 11: Acoustic noise measurement techniques.

[3] A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, M. Cand, R. Davis, C. Jordan, M. Hayes, R. Perkins, Institute of Acoustics, May 2013.

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APPENDIX 7.1

YEAR 1-3 OPERATIONAL BIRD MONITORING COMPARITIVE ANALYSIS

LEVENMOUTH DEMONSTRATION TURBINE

YEAR 1–3 OPERATIONAL BIRD MONITORING

COMPARATIVE ANALYSIS

NOVEMBER 2017

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TABLE OF CONTENTS

1 INTRODUCTION

Arcus Consultancy Services Ltd (Arcus) has carried out operational bird monitoring at the Levenmouth Demonstration Turbine (LDT) before, during and after installation of the turbine between July 2013 and March 2017 [1]. The LDT has previously been known as the 'Fife Energy Park Offshore Demonstration Wind Turbine' and the 'Samsung Heavy Industries Turbine', but for the purposes of this report is referred to as the LDT.

1.1 Project Environmental Monitoring Programme

A Project Environmental Monitoring Programme (PEMP)[2] was produced in 2013 to comply with the requirements set out in Planning Condition 11 of the Development Consent issued under Section 36 of the Electricity Act 1989 (Reference 022/OW/SEM-10). The PEMP is a 'live' document which sets out monitoring and mitigation measures associated with various environmental and ecological aspects, one of which was birds. Operational bird monitoring and reporting objectives set out in the PEMP include:

Operational bird monitoring strategy:

To undertake twice-monthly bird flight activity surveys during years one, two, three and five of the operational life of the Development, to understand the interactions of birds with the Development.

Reporting:

Bird monitoring reports will be submitted within 2 months of the completion of the year one (which will include the pre-construction / construction monitoring results), year two, year three and year five operational monitoring periods. The reports will present the results of the monitoring studies and will draw comparisons with the pre-construction data and any previous years' monitoring data.

In November 2016, The PEMP was updated[3] in accordance with Condition 12 (stated below) of the Development Consent to reflect findings of monitoring results.

Condition 12 states:

"The Project Environmental Monitoring Programme (PEMP) is a living document that is reviewed and updated by the Company as and when data from the demonstrator turbine is analysed. A copy of the updated PEMP must be submitted to, and approved by, the Scottish Ministers, with the first copy being submitted to the Scottish Ministers for approval no later than one year after the final commissioning of the turbine and thereafter on an annual basis, until the Development is decommissioned.

Reason: To ensure that appropriate and effective monitoring of the impacts of the Development is undertaken. "

The objectives of the updated PEMP remained unchanged. Alterations were made to the ornithology methods of data collection following review of results of surveys conducted during the construction period and presented in the Year 1 report[4]. The changes made do not impact the contents of this report or the ability to draw comparisons with previous years' data.

[1] Surveys have been continued during Year 4 of the operational phase of the LDT but are excluded from this report, as the Year 4 data have not yet been collated and analysed.

[2] Arcus (2013) Fife Energy Park Offshore Demonstration Wind Turbine: Project Environmental Monitoring Programme.

[3] Arcus (2016) Fife Energy Park Offshore Demonstration Wind Turbine: Project Environmental Monitoring Programme, v6.2.

[4] Arcus (2015) Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT) Bird Monitoring [Report].

1.2 Aim of Report

Results of the monitoring surveys are presented in three reports, each published at the end of an annual survey period:

- Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT) Bird Monitoring[5] [Year 1 Report]
- Levenmouth Demonstration Turbine Operational Bird Monitoring Year 2 Report[6]
- Levenmouth Demonstration Turbine Operational Bird Monitoring Year 3 Report[7]

The aim of this report is to provide a review and comparison of the first three years of operational monitoring results. Where appropriate, the review includes data from the pre-construction baseline surveys[8] conducted between September 2006 and September 2007 for the EIA of the original application.

Table 1 summarises the surveys conducted at the LDT and included in this review. The review provides quantitative and qualitative comparisons across the years to help establish, if possible, the effects of the construction and operation of the LDT on birds.

Table 1: Summary of bird surveys 2006–2018

Year	Type	Surveys
2006/07	EIA baseline (pre-construction).	Flight Activity Survey (13 months, 122.5 hours). Census of alighted birds in survey area, recorded every half hour ('Activity Summary').
2013	Construction (pre-installation) (reported in Year 1 Report). During this phase, construction of the walkway and other components of the LDT took place, prior to installation of the turbine in mid-October 2013.	Flight Activity Survey (July to mid-October 2013, 36 hours). Census of alighted birds around turbine, recorded every 15 minutes ('Activity Summary').
2013/14	Post-construction/ Pre-commissioning (reported in Year 1 Report). During this phase, the turbine was in place and occasionally operating, but had not been commissioned as operational until early April 2014.	Flight Activity Survey (October 2013 to March 2014, 66 hours). Recorded flights in relation to vertical and horizontal distance bands around the turbine. Census of alighted birds around turbine, recorded every hour ('Activity Summary').
2014/15	Year 1 Operational Monitoring.	Flight Activity Survey (12 months, April to March each year, 144 hours per year). Recorded flights in relation to vertical and horizontal distance bands around the turbine. Census of alighted birds around turbine, recorded every hour ('Activity Summary').
2015/16	Year 2 Operational Monitoring.	
2016/17	Year 3 Operational Monitoring.	
2017/18	Year 4 Operational Monitoring.	Flight Activity and Activity Summary Survey ongoing between April 2017 and March 2018, aiming to repeat the same frequency and type of survey as in Years 1-3. These are not reported herein.

[5] Arcus (2015) *Fife Energy Park Offshore Demonstration Wind Turbine (FEPODWT) Bird Monitoring.* [Report]. October 2015, Arcus Consultancy Services.
[6] Arcus (2016) *Levenmouth Demonstration Turbine Operational Bird Monitoring Year 2 Report.* [Report]. July 2016, Arcus Consultancy Services.
[7] Arcus (2017) *Levenmouth Demonstration Turbine Operational Bird Monitoring Year 3 Report.* [Report]. September 2017, Arcus Consultancy Services.
[8] Ove Arup & Partners Ltd. (2010) *2B Energy Wind Turbine; Ornithological Assessment.* [Report]. February 2010.

In response to comments on a previous draft of this report from Scottish Natural Heritage (SNH) and Marine Scotland Science (MSS), analysis of the data provided in the annual reports has been revised. In doing so, the analyses presented in this report do not necessarily match those presented in the annual reports from Years 1-3. The key differences between this report and the annual reports are summarised below.

- The focus of this report is on the qualifying interest species of the Forth Islands Special Protection Area (SPA), the Forth of Forth SPA and the Outer Firth of Forth and St Andrews Bay Complex Proposed SPA (pSPA), whereas the annual reports simply provide details of all species recorded during the surveys. The reason for this is that the LDT is located partly within the Firth of Forth SPA and partly within the pSPA and has connectivity with the Forth Islands SPA and this report has a dual function in terms of also providing information to aid the assessment of the application to extend the operational phase of the LDT. In contrast, the annual monitoring reports simply fulfil the requirements of the condition to understand the interactions of birds with the turbine.
- The annual reports each provide details of the bird monitoring results across the 12 month time period spanning April of one year to March of the following year; this comparative analysis report examines the activity of birds around the turbine during each season within the three-year period, as defined by SNH[9] (see Table 4).
- The analysis in this report includes a comparison of the monitoring data with the baseline survey data from 2006/07, which are not included in the annual reports.

1.3 European Sites

The LDT is located in the Firth of Forth, which is designated, in part, for its importance to a number of breeding and non-breeding populations of birds. Many of these species were recorded during the baseline and operational monitoring surveys and are considered in this review. Table 2 provides a summary of the qualifying interests of the Firth of Forth SPA, Forth Islands SPA and Outer Firth of Forth and St Andrews Bay Complex pSPA.

Table 2: Qualifying interest species of SPAs and pSPA

Firth of Forth SPA	Forth Islands SPA	Outer Firth of Forth and St Andrew's Bay Complex pSPA
Red-throated diver (wintering) Slavonian grebe (wintering) Golden plover (wintering) Bar-tailed godwit (wintering) Pink-footed goose (wintering) Shelduck (wintering) Knot (wintering) Redshank (wintering) Turnstone(wintering) Sandwich tern (passage) Waterfowl assemblage (wintering): ▪ Great crested grebe ▪ Cormorant ▪ Scaup ▪ Eider ▪ Long-tailed duck ▪ Common scoter	Arctic tern (breeding) Roseate tern (breeding) Common tern (breeding) Sandwich tern (breeding) Gannet (breeding) Shag (breeding) Lesser black-backed gull (breeding) Puffin (breeding) Seabird assemblage (breeding): ▪ Razorbill ▪ Guillemot ▪ Kittiwake ▪ Herring gull ▪ Cormorant ▪ Fulmar ▪ and other breeding species listed above	Red-throated diver (non-breeding) Slavonian grebe (non-breeding) Little gull (non-breeding) Common tern (breeding) Arctic tern (breeding) Eider (non-breeding) Waterfowl assemblage (non-breeding): ▪ Long-tailed duck ▪ Common Scoter ▪ Velvet scoter ▪ Goldeneye ▪ Red-breasted merganser Shag (non-breeding) Gannet (non-breeding) Seabird assemblage (breeding): ▪ Puffin

[9] Available at https://www.snh.scot/sites/default/files/2017-07/A303080%20-%20Bird%20Breeding%20Season%20Dates%20in%20Scotland.pdf, accessed 27/10/2017.

Firth of Forth SPA	Forth Islands SPA	Outer Firth of Forth and St Andrew's Bay Complex pSPA
▪ Velvet scoter ▪ Goldeneye ▪ Red-breasted merganser ▪ Oystercatcher ▪ Ringed plover ▪ Grey plover ▪ Dunlin ▪ Curlew ▪ Wigeon ▪ Mallard ▪ Lapwing		▪ Kittiwake ▪ Manx shearwater ▪ Guillemot ▪ Herring gull Seabird assemblage (non-breeding): ▪ Black-headed gull ▪ Common gull ▪ Herring gull ▪ Guillemot ▪ Shag ▪ Kittiwake ▪ Razorbill

2 SURVEY METHODS

The aim of the monitoring, as defined in the PEMP, was to understand the interactions of birds with the turbine.

Monitoring survey methods were developed to record the spatial distribution of flying and alighted birds (on the water surface) and their avoidance behaviour. All years of operational monitoring followed the same methods for the Flight Activity and Activity Summary Surveys data and have collected the same amount of data following a similar schedule each year. The monitoring survey methods are described in each of the annual monitoring reports[5,6,7]. The avoidance behaviours and the vertical and horizontal recording bands defined in the operational monitoring are provided for reference in Appendix 1 of this report.

The EIA baseline survey methods for the surveys carried out between September 2006 and September 2007 are described in the Technical Appendix[8] to the original application.

2.1 Variation in Survey Methods

Survey effort was consistent between the years of monitoring observations. Wherever possible, the same surveyors carried out surveys throughout the monitoring survey period to increase consistency between the surveys, particularly relevant to the estimation of distances. Surveys were generally evenly spread throughout the year with 12 hours of observation completed in most months.

The methods used for the EIA pre-construction baseline surveys and construction (pre-installation) surveys were broadly similar to the pre-commissioning and operational monitoring surveys, although they differed in some ways:

- Flight paths were mapped during the EIA baseline surveys and construction phase surveys, rather than recorded in a tabular format for the monitoring surveys.
- Flight heights were recorded in four height bands during the EIA baseline surveys that did not correspond directly with the turbine dimensions (1–10 m, 10–30 m, 30–85 m and >85 m). Flight heights were recorded in three height bands during the construction phase surveys, corresponding approximately with the turbine dimensions as: below; at; and above the rotor swept height (RSH) (0-20 m, 20-200 m and >200 m). Height bands were modified for the operational monitoring surveys to provide better understanding of their height distribution and simplify the field survey method (see Appendix 1).

- The survey area for the EIA baseline surveys was smaller than the construction, pre-commissioning and operational monitoring survey area (Figure 1). However, for the purposes of the comparative analyses, the number of birds in the different survey areas is reported. Analysis of the change in *densities* of birds was initially considered, but rejected because there would need to be an assumption that birds are randomly or evenly distributed throughout the survey areas. It is known from the surveys that this is not the case – for example, eider are usually observed close to the shoreline, rather than further out to sea; if their numbers in the baseline survey area were converted to densities and applied to a larger area including more offshore sea to estimate a population in an area similar to the monitoring survey area, the estimated number of birds would be artificially inflated because there are more birds near the shoreline (as represented by the baseline survey area) than further out to sea (more of which is covered by the monitoring survey area).
- Activity Summary data of alighted birds were collected at half-hourly intervals during the EIA baseline surveys, rather than hourly. The distance of birds away from the proposed turbine location was not recorded during the EIA baseline surveys.
- Flight Activity Survey effort was slightly lower during the EIA baseline surveys with an average of ten hours of survey completed during each month, rather than an average of 12 hours per month (Table 3).

These differences preclude detailed quantitative comparisons between the EIA baseline data and subsequent operational monitoring data, and so it is only possible to draw general and qualitative comparisons.

Likewise, the construction phase surveys prior to the installation of the turbine only covered a period of four months during the late summer and early autumn period, which precludes analysis of changes in distribution or activity before and after the installation of the turbine. The construction phase therefore covers only a part of a breeding or non-breeding season and for this reason, detailed presentation and comparison of flight activity or abundance/distribution of birds has been excluded from the analyses.

Table 3: Monthly survey effort during EIA baseline surveys and monitoring surveys

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006									4	12	11	8
2007	8	8	12	11.5	12	8	12	11.3	8			
2008-2012												
2013							6	12	12	6 6	12	12
2014	12	12	12	6	18	12	12	12	12	12	12	12
2015	12	12	12	12	12	12	12	12	12	12	12	12
2016	12	12	12	6	12	12	12	12	12	12	12	12
2017	12	12	18									

	EIA Baseline
	Construction
	Pre-commissioning
	Operational Year 1
	Operational Year 2
	Operational Year 3

3 DATA COMPARISON

3.1 Presentation

This section presents an overview of the occurrence of each of the qualifying interest species of the SPAs/pSPA within the survey area around the LDT, and then provides details and comparison between years for those species which occurred frequently within the survey area.

A broad threshold was set for including more detailed analysis and comparison of occurrence in each season:

- consistently more than ten recorded flights in each season; or
- more than five records in the activity summary survey each season.

Below this threshold, it is considered that the area around the turbine does not provide important resources for the species, or that the species is extremely unlikely to interact with the turbine in a manner that could give rise to detectable effects. Table 5 presents the overview of occurrence for each of the qualifying interest species in each relevant season.

For each species/activity with frequent occurrence in the relevant season, the following are presented to allow comparison between years and identify trends or possible effects of the turbine:

- European site qualification.
- Summary of distribution and trends in the Firth of Forth, using sources such as the Wetland Bird Survey (WeBS), JNCC aerial surveys used for the European site selection of the pSPA[10] and Seabird Monitoring Programme (SMP).
- Flight activity:
  - Summary;
  - Flight distribution: tables are presented to display results, which maintain the format of those presented in the annual monitoring reports. Where applicable, the Rotor Swept Area (RSA) – the combination of horizontal and vertical distances in which the turbine blades rotate – is highlighted in the tables with a bold border; and
  - Avoidance behaviour.
- Activity summary:
  - Summary;
  - Monthly peak-mean number of birds (including chart);
  - Weighted mean distance of the bird/flock from the turbine (including chart)[11].

3.2 Bird Breeding and Non-breeding Seasons

Table 4 shows the breeding and non-breeding seasons for each qualifying interest species of the SPAs/pSPA, as defined by SNH[9].

[10] SNH & JNCC (2016) Outer Firth of Forth and St Andrews Bay Complex Proposed Special Protection Area (pSPA) No. UK9020316. SPA Site Selection Document: Summary of the scientific case for site selection. Final version (7) for submission to Marine Scotland, June 2016. Available at: www.snh.gov.uk/docs/A2020842.pdf, accessed 09/10/2017.

[11] The mean distance was weighted by flock size.

Table 4: Breeding and Non-breeding Seasons

Species	Breeding Season	Non-breeding Season
Pink-footed goose*	n/a	Sep – Apr
Shelduck	n/a	Sep – Mar
Wigeon	n/a	Sep – mid-Apr
Mallard	n/a	Oct – mid-Feb
Scaup*	n/a	mid-Sep – mid-Apr
Eider	n/a	mid-Sep – mid-Apr
Long-tailed duck*	n/a	mid-Sep – mid-Apr
Common scoter	n/a	Sep – mid-Apr
Velvet scoter*	n/a	Sep – mid-Apr
Goldeneye	n/a	mid-Aug – mid-Apr
Red-breasted merganser	n/a	Sep – Mar
Red-throated diver	n/a	mid-Sep – Mar
Great crested grebe	n/a	mid-Oct – mid-Feb
Slavonian grebe	n/a	mid-Sep – Apr
Fulmar	mid-Apr – mid-Sep	n/a
Gannet	mid-Mar – mid-Sep	n/a
Manx shearwater	mid-Apr – mid-Oct	n/a
Cormorant	mid-Feb – mid-Sep	mid-Sep – mid-Feb
Shag	Feb – mid-Sep	mid-Sep – Jan
Oystercatcher	n/a	Sep – mid-Mar
Ringed plover	n/a	Aug – Mar
Golden plover	n/a	Aug – Mar
Grey plover**	n/a	Sep – Apr
Lapwing	n/a	Aug – Feb
Knot**	n/a	Sep – Apr
Dunlin	n/a	Aug – Mar
Bar-tailed godwit**	n/a	Sep – Apr
Curlew	n/a	Aug – Mar
Redshank	n/a	Aug – Mar
Turnstone**	n/a	Sep – Apr
Little gull*	n/a	Sep – Apr
Black-headed gull	n/a	Sep – Mar
Common gull	n/a	Sep – Mar
Lesser black-backed gull	Apr – Aug	n/a
Herring gull	Apr – Aug	Sep – Mar
Kittiwake	mid-Apr – Aug	Sep – mid-Apr
Sandwich tern	mid-Apr – mid-Sep	Passage: mid-Sep – Oct
Roseate tern	mid-May – Aug	n/a
Common tern	May – mid-Sep	n/a
Arctic tern	May – Aug	n/a
Guillemot	Apr – Aug	Sep – Mar
Razorbill	Apr – Aug	Sep – Mar
Puffin	mid-Mar - Aug	n/a

* Waterfowl/gull species without breeding seasons defined in SNH guidance; these have been assigned non-breeding season periods based on similar species and/or observations made during the surveys.

** Wintering wader species without breeding seasons defined in SNH guidance; these have been assigned a non-breeding season period between September and April, reflecting their likely presence throughout the season.

Table 5: Summary of occurrence during baseline and monitoring surveys of qualifying interest species of the Forth Islands SPA, Firth of Forth SPA and Outer Firth of Forth and St Andrews Bay Complex pSPA

Species	Season	Forth Islands SPA	Firth of Forth SPA	pSPA	Survey Type	Occurrence	Comparison Analysis
Pink-footed goose	Non-breeding		✓		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Shelduck	Non-breeding		✓		Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Wigeon	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Mallard	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Scaup	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Eider	Non-breeding		✓*	✓	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Long-tailed duck	Non-breeding		✓*	✓*	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Common scoter	Non-breeding		✓*	✓*	Flight Activity	≤ 10 flights in each season	NO
					Sea / Shoreline Activity	≤ 5 records in each season, except during pre-commissioning phase	NO
Velvet scoter	Non-breeding		✓*	✓*	Flight Activity	≤ 10 flights in each season	NO
					Sea / Shoreline Activity	> 5 records in each season	YES
Goldeneye	Non-breeding		✓*	✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Red-breasted merganser	Non-breeding		✓*	✓*	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Red-throated diver	Non-breeding		✓	✓	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	> 5 records in each season	YES
Great crested grebe	Non-breeding		✓*		Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Slavonian grebe	Non-breeding		✓	✓	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Fulmar	Breeding	Assemblage			Flight Activity	> 5 records in each season	YES
					Sea / Shoreline Activity	None	No

Species	Season	Forth Islands SPA	Firth of Forth SPA	pSPA	Survey Type	Occurrence	Comparison Analysis
Gannet	Breeding	✓		✓	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	≤ 5 records in each season	No
Manx shearwater	Breeding			✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Cormorant	Breeding	✓*			Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Cormorant	Non-breeding		✓*		Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Shag	Breeding	✓		✓	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Shag	Non-breeding			✓*	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Oystercatcher	Non-breeding		✓*		Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	≤ 5 records in each season	No
Ringed plover	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Golden plover	Non-breeding		✓		Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Grey plover	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Lapwing	Non-breeding		✓*		Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Knot	Non-breeding		✓		Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Dunlin	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Bar-tailed godwit	Non-breeding		✓		Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Curlew	Non-breeding		✓*		Flight Activity	≤ 10 flights in each season, except Year 2 (13 flights)	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Redshank	Non-breeding		✓		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No

Species	Season	Forth Islands SPA	Firth of Forth SPA	pSPA	Survey Type	Occurrence	Comparison Analysis
Turnstone	Non-breeding		✓		Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Little gull	Non-breeding			✓	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Black-headed gull	Non-breeding			✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Common gull	Non-breeding			✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Lesser black-backed gull	Breeding	✓			Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	≤ 5 records in each season, except during the baseline season when they were recorded in small numbers during 5/18 surveys	NO
Herring gull	Breeding	✓*		✓*	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Herring gull	Non-breeding			✓*	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	> 5 records in each season	YES
Kittiwake	Breeding	✓*		✓*	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	≤ 5 records in each season	No
Kittiwake	Non-breeding			✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Sandwich tern	Breeding	✓			Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	≤ 5 records in each season	No
Sandwich tern	Passage		✓		Flight Activity	> 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No
Roseate tern	Breeding	✓			Flight Activity	None	No
					Sea / Shoreline Activity	None	No
Common tern	Breeding	✓		✓	Flight Activity	> 10 flights in each season	YES
					Sea / Shoreline Activity	≤ 5 records in each season	No
Arctic tern	Breeding	✓		✓	Flight Activity	> 10 flights in each season	No
					Sea / Shoreline Activity	None	No
Guillemot	Breeding	✓*		✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	> 5 records in each season	YES

Species	Season	Forth Islands SPA	Firth of Forth SPA	pSPA	Survey Type	Occurrence	Comparison Analysis
Guillemot	Non-breeding			✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season, except during the baseline season when they were recorded in very small numbers during 6/18 surveys	No
Razorbill	Breeding	✓*			Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season, except during the baseline season when they were recorded in very small numbers during 3/13 surveys	No
Razorbill	Non-breeding			✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season, except during the baseline season when they were recorded in very small numbers during 5/18 surveys	No
Puffin	Breeding	✓		✓*	Flight Activity	≤ 10 flights in each season	No
					Sea / Shoreline Activity	≤ 5 records in each season	No

3.3 Species Accounts

3.3.1 Eider (non-breeding season)

Table 6: SPA/pSPA qualification relating to eider

Forth Islands SPA	Not a qualifying interest feature
Firth of Forth SPA	Qualifies as part of the wintering assemblage (based on 1992/93-96/97 winter peak mean); nationally important numbers (9,400, 13% of the GB population)
pSPA	Population of European importance: average peak counts recorded during the five year period 2001/02 to 2004/05 (21,546 individuals 2.1% of the biogeographic population and 35.9% of the GB population)

Aerial surveys undertaken by JNCC between 2001 and 2005 identified a relatively high density of wintering eider (50 – 100 birds/km^2) using the inshore waters around Methil.

WeBS data indicate that the peak winter counts in the Forth Estuary were lower during the winter when installation of the turbine took place (2013/14) than during the baseline survey winter (2006/07) but the peak counts in the subsequent two winters when the turbine was operational (2014/15 and 2015/16) were similar to the peak count in the year of the baseline surveys (Table 7).

Table 7: WeBS peak counts of eider in the Forth Estuary

Winter	2006/07	2013/14	2014/15	2015/16	2016/17
Peak Count	5,646	4,310	5,267	5,547	Not available

Eiders were frequently recorded in flight and using the sea particularly near the shoreline during the EIA baseline surveys and all subsequent construction and operational phase monitoring surveys. Eiders were present throughout the year; however, only the non-breeding population is a qualifying interest feature of the Firth of Forth SPA and the Outer Firth of Forth and St Andrews Bay Complex pSPA, therefore the comparative analysis focusses on the non-breeding period (mid-September to mid-April).

3.3.1.1 *Flight Activity*

Table 8 displays the spatial distribution of flying birds recorded during each non-breeding season in the baseline and monitoring surveys.

During the baseline non-breeding season surveys, three flights totalling 11 birds were recorded in the height band of 10-30 m above sea level; the remaining 152 birds observed in the baseline season were very low, between 0-10 m above sea level. The 11 flights in height band 10-30 m were included in the collision risk model in the original assessment because the rotor sweep extends down to 25 m above sea level. Most, if not all, of the 11 flights were likely to have been below the sweep of the rotors, because only the upper 5 m of the 20 m span of the height band would have flights at risk height and the flights of eider are more likely to be distributed in the lower part of the height band.

All observed flight activity during the non-breeding season monitoring surveys was below the sweep of the rotors. The vast majority of flights were also seaward of the sweep of the rotors (97.4%).

Table 8: Flight activity distribution of eider in each non-breeding season (number of birds)

Baseline mid-Sep 06 – mid-Apr 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	0	
	10 – 30	11	
	0 – 10	152	

Pre-commissioning mid-Oct 13 – mid-Apr 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						
	0 – 5		5	63	33	48	12

Year 1 mid-Sep 14 – mid-Apr 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						1
	5 – 12.5				4	2	1
	0 – 5			19	28	59	32

Year 2 mid-Sep 15 – mid-Apr 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25					1	
	5 – 12.5					3	5
	0 – 5		2	13	21	60	92

Year 3 mid-Sep 16 – Mar 17		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25					2	
	5 – 12.5		7			4	31
	0 – 5		3	12	29	3	52

Apparent avoidance behaviour was observed very occasionally during the pre-commissioning period after installation of the turbine but not at all during the subsequent operational monitoring surveys (Table 9). These included lateral movements taking the birds further away from the turbine when at distance from the turbine and one incident of more urgent action close to the turbine.

Table 9: Observed avoidance behaviour of eider in each non-breeding season (number of birds)

Pre-commissioning	1 AVOID @ 20 m; turbine operational 3 HORIZ @ 200 m; turbine static 1 HORIZ @ 150 m; turbine operational
Year 1	No avoidance behaviour observed
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.1.2 *Activity Summary*

The numbers of birds in the survey area during the baseline and pre-commissioning period were relatively high and similar to the modelled surface density as reported in the Site Selection Document for the pSPA (50-100 birds/km^2). The number of birds in the survey area in Year 1 was higher than that in the baseline period (although noting that the survey area during the baseline period was smaller) but lower than that during the pre-commissioning period. The numbers in Year 2 and Year 3 were then lower than in previous monitoring winters and slightly below the number recorded during the baseline winter (Table 10 and Chart 1).

The mean distance that birds were recorded from the turbine increased between the pre-commissioning period and operational Years 1 and 2, but then decreased slightly in Year 3; however, there is a high degree of variance around the mean distance in each season (Table 10 and Chart 2).

Table 10: Monthly peak-mean number of eider in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	mid-Sep 06 - mid-Apr 07	17.63	7.65	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - mid-Apr 14	35.50	11.59	233	133
Year 1	mid-Sep 14 - mid-Apr 15	26.63	11.63	295	170
Year 2	mid-Sep 15 - mid-Apr 16	15.50	9.96	308	149
Year 3	mid-Sep 16 - Mar 17	14.14	6.89	290	115

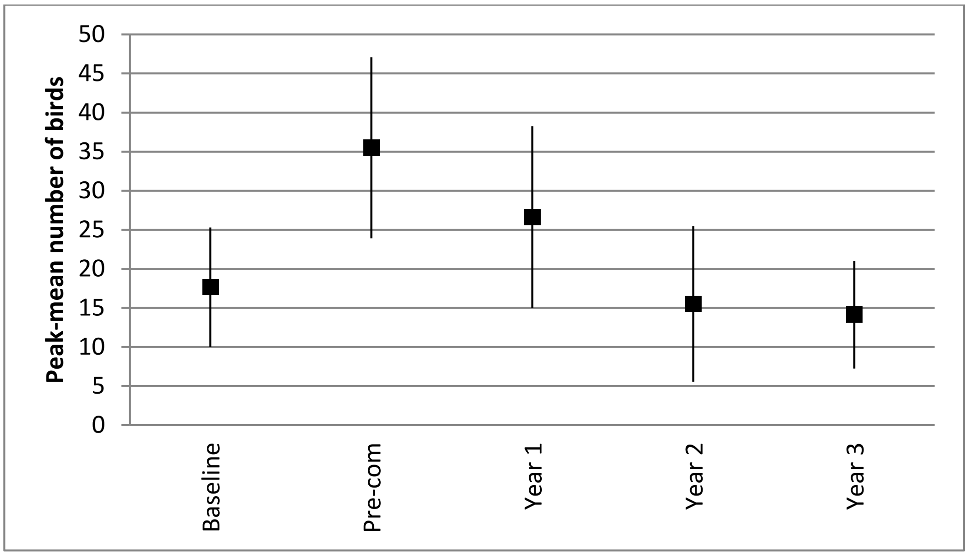

Chart 1: Monthly peak-mean number of eider recorded in the survey area each non-breeding season

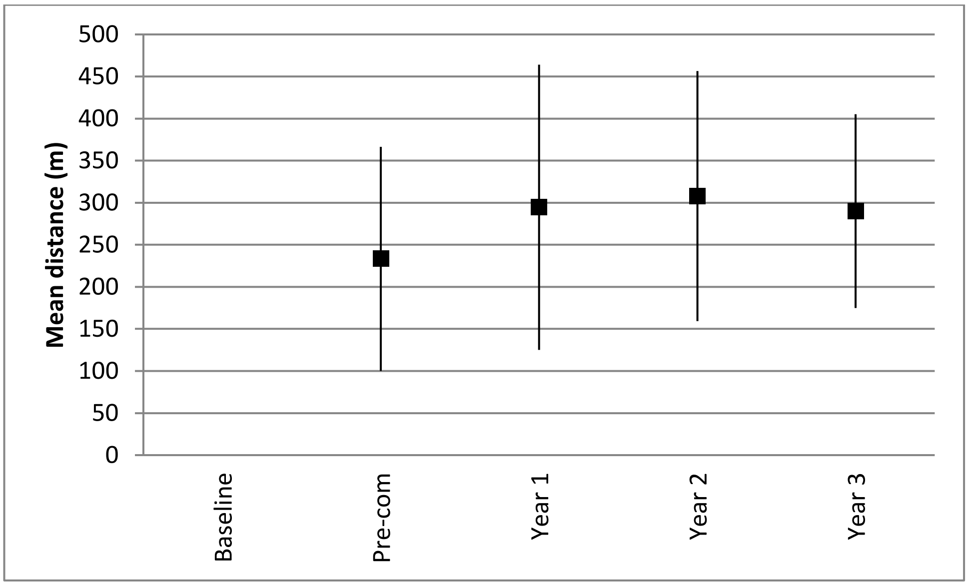

Chart 2: Mean distance of eider from the turbine during each non-breeding season

3.3.2 Long-tailed Duck (non-breeding season)

Table 11: SPA/pSPA qualification relating to long-tailed duck

Forth Islands SPA	Not a qualifying interest feature
Firth of Forth SPA	Qualifies as part of the wintering waterfowl assemblage (based on 1992/93-1996/97 winter peak mean); nationally important numbers (1,045, 4% of the GB population)
pSPA	Qualifies as part of the wintering waterfowl assemblage (based on 2001/02-2004/05 winter peak mean); nationally important numbers (1,948, 17.7% of the GB population)

Aerial surveys undertaken by JNCC between 2001 and 2005 identified a relatively high density of wintering long-tailed duck (2 – 5 birds/km^2) using the inshore waters around Methil.

WeBS data indicate that the peak winter counts in the Forth Estuary were much higher during the pre-commissioning phase (2013/14) than during the baseline surveys (winter 2006/07) and peak counts in the subsequent two winters when the turbine was operational (2014/15 and 2015/16) fluctuated lower and higher than during the baseline winter (Table 12).

Table 12: WeBS peak counts of long-tailed duck in the Forth Estuary

Winter	2006/07	2013/14	2014/15	2015/16	2016/17
Peak Count	220	323	147	259	Not available

Long-tailed ducks were infrequently recorded in flight but small numbers were regularly seen using the sea in the survey area during the EIA baseline surveys and subsequent monitoring surveys. They were typically present from November/December through to March/April.

3.3.2.1 *Flight Activity*

During the baseline surveys, seven flights totalling 15 birds were recorded; all were in the lowest height band of 0-10 m above sea level (Table 13).

All observed flight activity during the monitoring surveys was below the sweep of the rotors in the lowest height bands (all <12.5 m). All of the flights were also seaward of the sweep of the rotors (Table 13).

Table 13: Flight activity distribution of long-tailed duck in each non-breeding season (number of birds)

Baseline mid-Sep 06 – mid-Apr 07		Horizontal Distance Band	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	0	
	10 – 30	0	
	0 – 10	15	

Pre-commissioning mid-Oct 13 – mid-Apr 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						
	0 – 5				3	3	11

Year 1 mid-Sep 14 – mid-Apr 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						
	0 – 5				6	9	19

Year 2 mid-Sep 15 – mid-Apr 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						3
	0 – 5					9	17

Year 3 mid-Sep 16 – Mar 17		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						1
	0 – 5			1		1	12

No apparent avoidance behaviour was observed during any of the monitoring surveys (Table 14)

Table 14: Observed avoidance behaviour of long-tailed duck in each non-breeding season

Pre-commissioning	No avoidance behaviour observed
Year 1	No avoidance behaviour observed
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.2.2 *Activity Summary*

The density of birds in the survey area during the baseline and pre-commissioning period (monthly peak-mean of 4.75 birds in a minimum survey area of 0.08 km^2) was much higher than the modelled surface density as reported in the pSPA site selection document (2-5 birds/km^2). The mean number of birds in the survey area in Year 1 was much lower than during the baseline and previous (pre-commissioning) winter, although mean bird numbers increased in the subsequent two winters and were similar to the number of birds reported in the baseline surveys (although noting there is a difference in the survey areas) (Table 15 and Chart 3). There is no clear evidence of an influence of the turbine on numbers of long-tailed duck in the survey area.

There was an increasing trend in the distance of birds within the survey area from the turbine, although variance in the mean distance was high (Table 15 and Chart 4).

Table 15: Monthly peak-mean number of long-tailed duck in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	mid-Sep 06 - mid-Apr 07	4.75	5.39	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - mid-Apr 14	16.50	31.22	273	117
Year 1	mid-Sep 14 - mid-Apr 15	2.38	3.78	334	106
Year 2	mid-Sep 15 - mid-Apr 16	4.13	4.70	328	138
Year 3	mid-Sep 16 - Mar 17	4.57	8.73	362	74

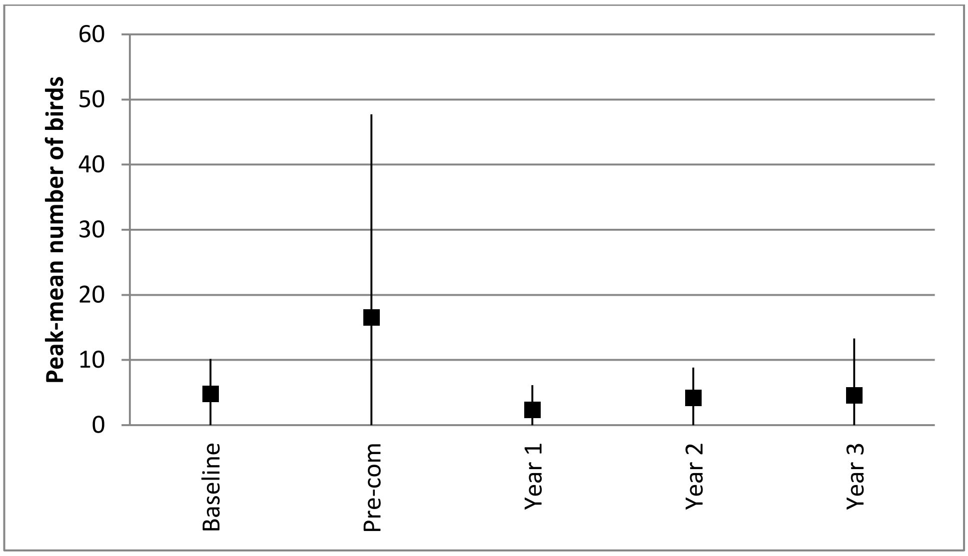

Chart 3: Monthly peak-mean number of long-tailed duck recorded in the survey area each non-breeding season

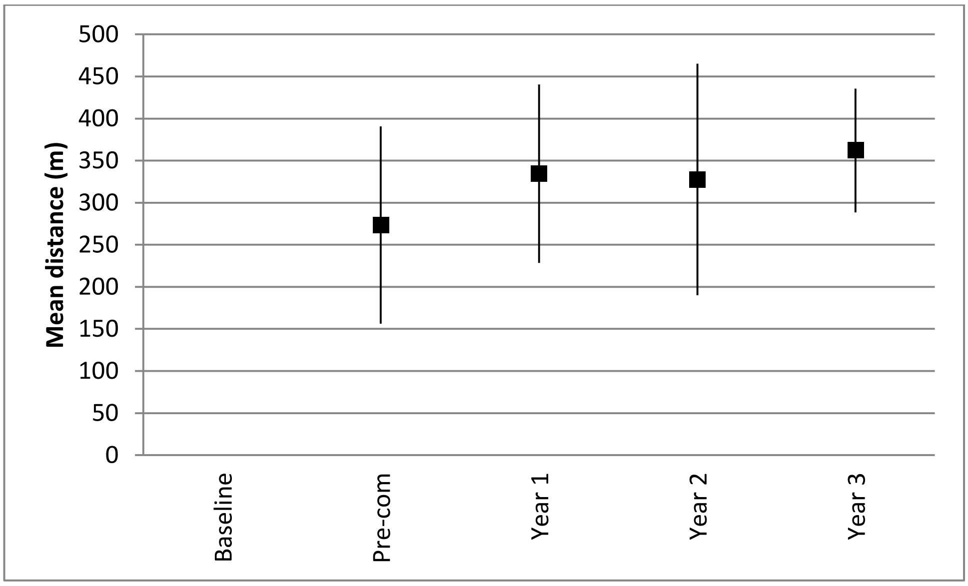

Chart 4: Mean distance of long-tailed duck from the turbine during each non-breeding season

3.3.3 Velvet Scoter (non-breeding season)

Table 16: SPA/pSPA qualification relating to velvet scoter

Forth Islands SPA	Not a qualifying interest feature
Firth of Forth SPA	Qualifies as part of the wintering waterfowl assemblage (based on 1992/93-96/97 winter peak mean); nationally important numbers (635, 21% of the GB population)
pSPA	Qualifies as part of the wintering waterfowl assemblage (based on a combination of 2001/02-2004/05 and 2006/07-2010/11 winter peak means in St Andrews Bay and the Forth of Forth respectively); nationally important numbers (775, 31% of the GB population)

Wetland Bird Survey counts identified a relatively low density of wintering velvet scoter using the inshore waters around Methil (<50 birds in the count sector), with the main hotspot in the Forth being further east in Largo Bay near Ruddon's Point (>150 birds in the count sector).

WeBS data for the whole Forth Estuary show that the peak winter counts in operational years 1 and 2 have been the highest recorded since the baseline survey winter 2006/07, but were very low during the winter (2013/14) immediately after construction of the turbine took place (Table 17).

Table 17: WeBS peak counts of velvet scoter in the Forth Estuary

Winter	**2006/07**	**2013/14**	**2014/15**	**2015/16**	**2016/17**
Peak Count	928	473	1,284	1,650	Not available

Velvet scoters were infrequently recorded on the sea surface within the survey area during the EIA baseline surveys, but were more frequently recorded during some of the subsequent monitoring surveys. Flight activity was only rarely recorded.

3.3.3.1 *Activity Summary*

The number of velvet scoters in the survey area during the baseline period was very low, with just three birds recorded on one survey. Birds were more frequently observed in small numbers (maximum of nine birds) in the survey area during the pre-commissioning period after installation of the turbine. Birds were recorded very infrequently in the survey area in the first two winters of operation; however. In winter of Year 3, there were up to 15 velvet scoters frequently present in the survey area between January and March (Table 18 and Chart 5).

The sample size is small; however, there is some indication that in the longer term, birds have moved further away from the turbine – in Years 2 and 3, the distance from the turbine was much larger than during the pre-commissioning period (Table 18 and Chart 6), although more birds were present in the survey area in Year 3.

Table 18: Monthly peak-mean number of velvet scoter in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	**Date range**	**Monthly-peak-mean number of birds**	**Standard Deviation of peak-mean number of birds**	**Weighted mean distance (m)**	**Standard Deviation of weighted mean distance (m)**
Baseline	Sep 06 - mid-Apr 07	0.38	1.06	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - mid-Apr 14	2.63	3.78	250	113

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Year 1	Sep 14 - mid-Apr 15	0.13	0.35	200	-
Year 2	Sep 15 - mid-Apr 16	0.50	1.07	490	35
Year 3	Sep 16 - Mar 17	5.43	7.16	349	113

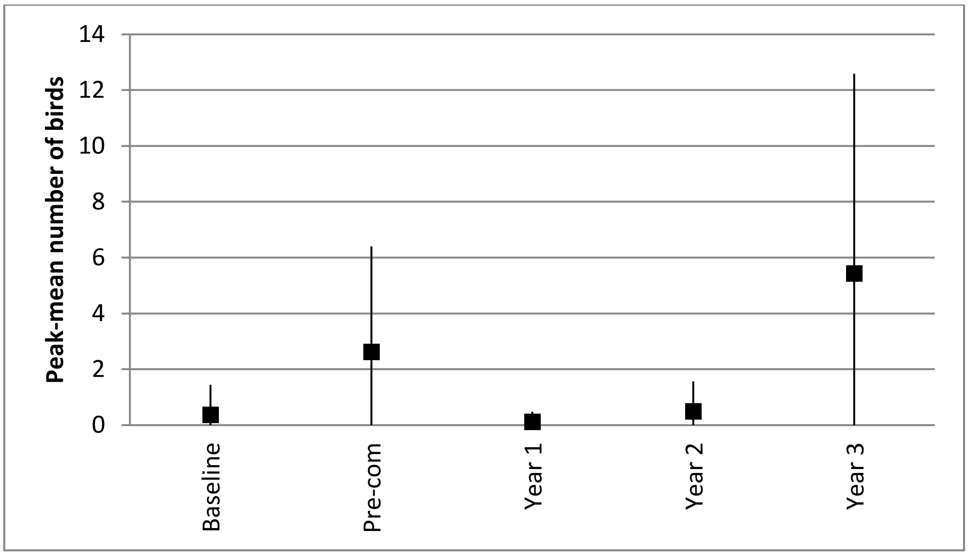

Chart 5: Monthly peak-mean number of velvet scoter recorded in the survey area each non-breeding season

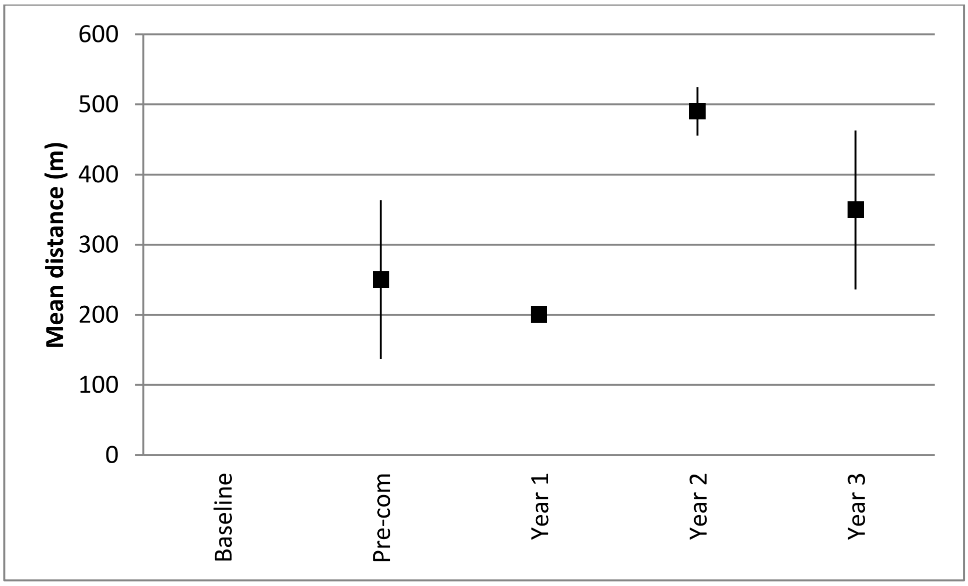

Chart 6: Mean distance of velvet scoter from the turbine during each non-breeding season

3.3.4 Red-breasted Merganser (non-breeding season)

Table 19: SPA/pSPA qualification relating to red-breasted merganser

Forth Islands SPA	Not a qualifying interest feature
Firth of Forth SPA	Qualifies as part of the wintering waterfowl assemblage (based on 1992/93-96/97 winter peak mean); nationally important numbers (670, 7% of the GB population)
pSPA	Qualifies as part of the wintering waterfowl assemblage (based on a combination of 2001/02-2004/05 and 2006/07-2010/11 winter peak means in St Andrews Bay and the Forth of Forth respectively); nationally important numbers (369, 4.4% of the GB population)

Wetland Bird Survey counts identified a typical density of wintering red-breasted mergansers using the inshore waters around Methil (15-30 birds in the count sector), with similar numbers in other count sectors along the northern shoreline of the Firth of Forth.

WeBS data for the whole Forth Estuary show that the peak winter counts in operational years 1 and 2 have been slightly lower (c. 5%) than in the baseline survey winter 2006/07, but were c. 20% lower during the pre-commissioning winter immediately after construction of the turbine took place (Table 20).

Table 20: WeBS peak counts of red-breasted merganser in the Forth Estuary

Winter	2006/07	2013/14	2014/15	2015/16	2016/17
Peak Count	347	276	328	328	Not available

Red-breasted mergansers were infrequently recorded in very small numbers on the sea surface within the survey area during the EIA baseline surveys and subsequent monitoring surveys.

3.3.4.1 *Flight Activity*

During the baseline surveys, a total of 14 birds were recorded in the non-breeding season; 12 were in the lowest height band of 0-10 m above sea level and two were at 10-30 m above sea level (Table 21).

All observed flight activity during the non-breeding season monitoring surveys was below the sweep of the rotors in the lowest height bands (all <12.5 m). All of the flights were also seaward of the sweep of the rotors (Table 21).

Table 21: Flight activity distribution of red-breasted merganser in each non-breeding season (number of birds)

Baseline mid-Sep 06 – mid-Apr 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	0	
	10 – 30	2	
	0 – 10	12	

Pre-Commissioning mid-Oct 13 – mid-Apr 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						2
	0 – 5				1	1	

Year 1 mid-Sep 14 – mid-Apr 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						3
	0 – 5					6	2

Year 2 mid-Sep 15 – mid-Apr 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						1
	5 – 12.5						3
	0 – 5				3		10

Year 3 mid-Sep 16 – Mar 17		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5						8
	0 – 5					1	

No apparent avoidance behaviour was observed during any of the monitoring surveys (Table 22).

Table 22: Observed avoidance behaviour of red-breasted merganser in each non-breeding season

Pre-commissioning	No avoidance behaviour observed
Year 1	No avoidance behaviour observed
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.4.2 *Activity Summary*

Red-breasted mergansers were recorded in the survey area during nearly half of the surveys in the baseline period, although numbers were very low with a peak of three birds. Birds were less frequently observed and in smaller numbers in the survey area during the pre-commissioning period and three years of operational monitoring – a maximum of three out of 14 survey days (Table 23 and Chart 7).

There is a possible downward trend in the monthly peak-mean number of birds in the survey area, as well as an increasing trend in the distance of birds within the survey area from the turbine (Table 23 and Chart 8).

Table 23: Monthly peak-mean number of red-breasted merganser in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	Sep 06 - Mar 07	1.71	1.50	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - Mar 14	0.43	0.53	175	104
Year 1	Sep 14 - Mar 15	1.14	2.27	264	33
Year 2	Sep 15 - Mar 16	0.86	1.07	216	153
Year 3	Sep 16 - Mar 17	0.43	0.79	275	54

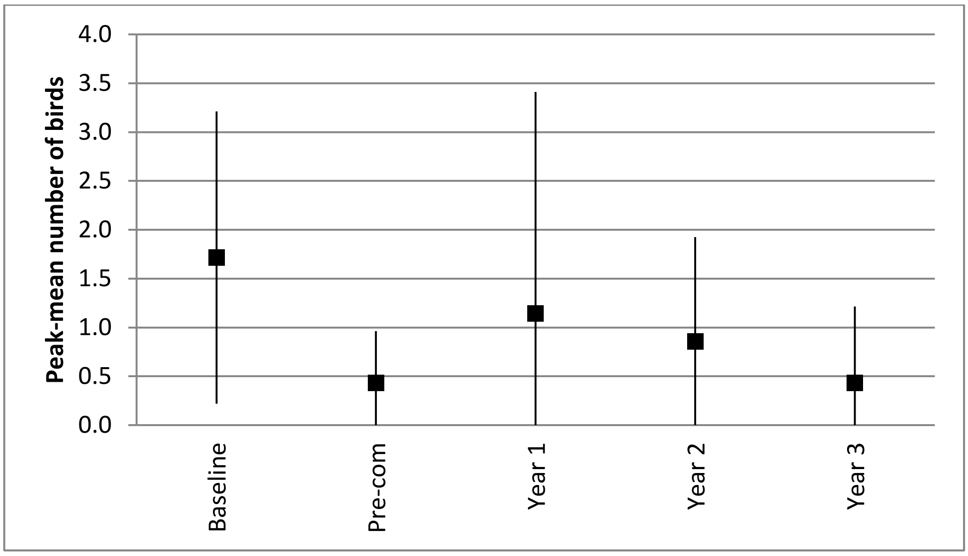

Chart 7: Monthly peak-mean number of red-breasted merganser recorded in the survey area each non-breeding season

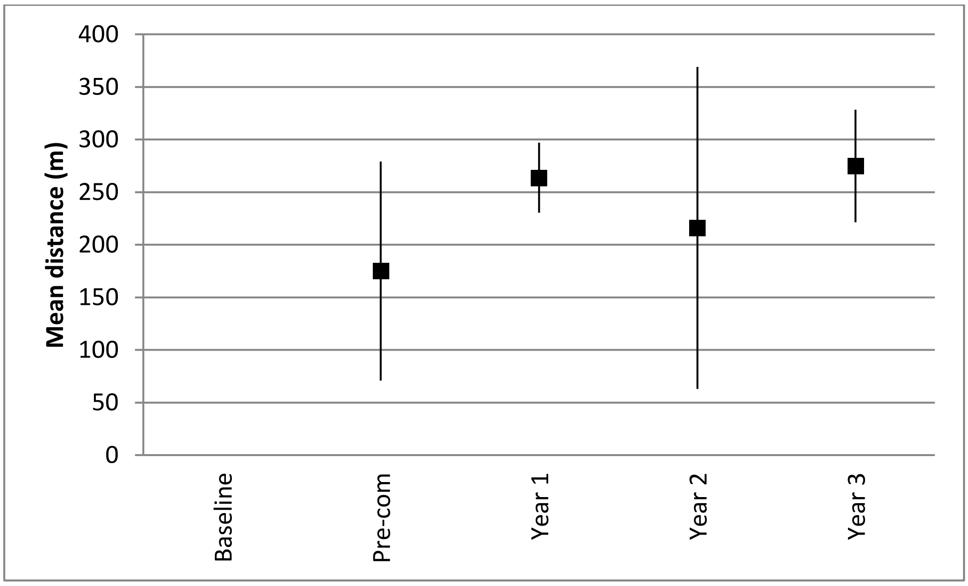

Chart 8: Mean distance of red-breasted merganser from the turbine during each non-breeding season

3.3.5 Red-throated Diver (non-breeding season)

Table 24: SPA/pSPA qualification relating to red-throated diver

Forth Islands SPA	Not a qualifying interest feature
Firth of Forth SPA	Wintering population of European importance (based on 1993/94-1997/98 winter peak means) (90 individuals; 2% of GB population)
pSPA	Non-breeding population of European importance during the period 2001/02 to 2004/05 (a mean peak estimate of 851 individuals; 5.0% of the GB population)

Aerial surveys undertaken by JNCC between 2001 and 2005 identified a moderate density of wintering red-throated divers (0.75 birds/km^2) using the inshore waters around Methil, with densities in the Firth of Forth as a whole ranging from 0.1 – 1.3 birds/km^2.

WeBS data indicate that the peak winter counts in the Forth Estuary have fluctuated from year to year. Counts in the Forth during the winters of the LDT monitoring surveys have been both higher and lower than the count during the baseline winter (Table 25). However, this species is not well represented by WeBS shore-based counts as many of the birds use offshore waters not viewable from the coastline.

Table 25: WeBS peak counts of red-throated diver in the Forth Estuary

Winter	2006/07	2013/14	2014/15	2015/16	2016/17
Peak Count	53	42	74	38	Not available

Red-throated divers were infrequently recorded in very small numbers on the sea surface within the survey area during the EIA baseline surveys and subsequent monitoring surveys.

3.3.5.1 *Activity Summary*

Red-throated divers were recorded in the survey area during approximately 40% of the surveys in the baseline period, although numbers were very low with a peak of three birds during one of the surveys. Birds were less frequently observed and in smaller numbers in the survey area during the pre-commissioning period and three years of operational monitoring – ranging from one to three out of 13 survey days in each winter season (Table 26 and Chart 9).

There was a notable decrease in the frequency of occurrence in the survey area following installation of the turbine, although there has been a slight increase in Years 2 and 3. There is no clear trend in the distance of birds within the survey area from the turbine (Table 26 and Chart 10).

Table 26: Monthly peak-mean number of red-throated diver in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	mid-Sep 06 - Mar 07	1.29	0.95	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - Mar 14	0.29	0.49	300	180
Year 1	mid-Sep 14 - Mar 15	0.14	0.38	275	35

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Year 2	mid-Sep 15 - Mar 16	0.29	0.49	420	115
Year 3	mid-Sep 16 - Mar 17	0.57	0.79	350	89

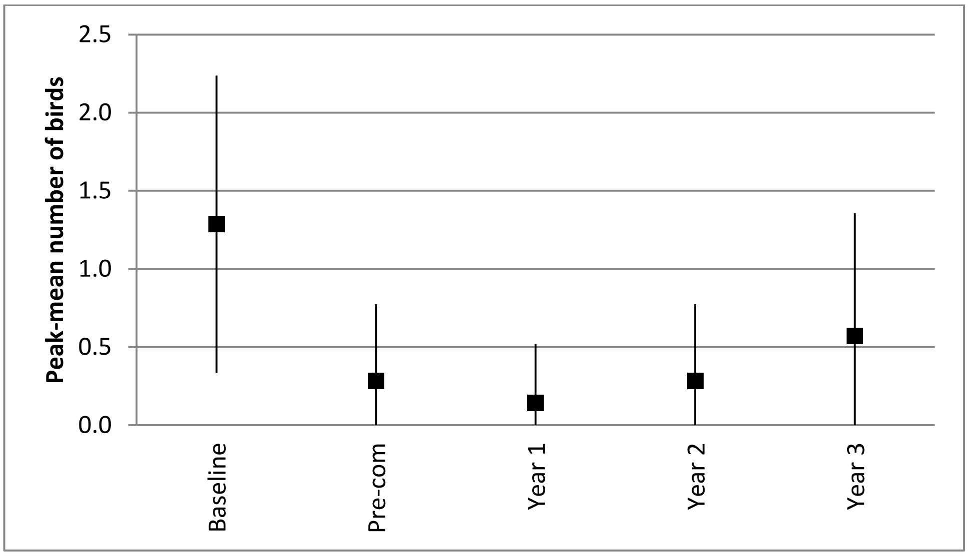

Chart 9: Monthly peak-mean number of red-throated diver recorded in the survey area each non-breeding season

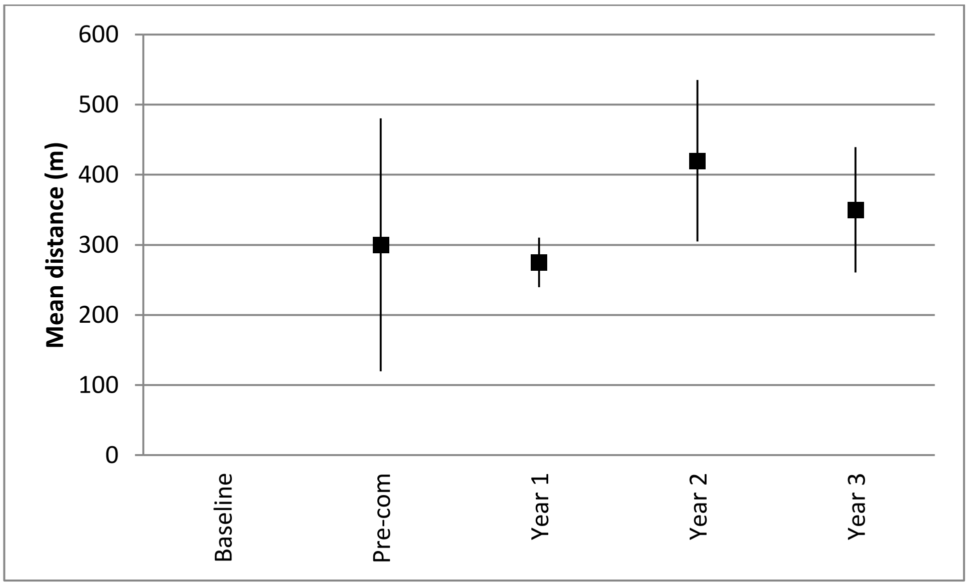

Chart 10: Mean distance of red-throated diver from the turbine during each non-breeding season

3.3.6 Fulmar (breeding season)

Table 27: SPA/pSPA qualification relating to fulmar

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (798 pairs)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Not a qualifying interest feature

The most recent data from the Seabird Monitoring Programme between 2015 and 2017 indicates that there have been between approximately 600-700 occupied fulmar nests on the Forth Islands SPA. Several hundred more pairs nest at other locations in and around the Firth of Forth that are not part of the Forth Islands SPA (e.g. the islands of Inchgarvie, Inchcolm and Inchkeith).

Fulmars were infrequently recorded in flight between February and September during the EIA baseline surveys and all subsequent construction and operational phase monitoring surveys. Fulmar was not recorded on the sea surface during the activity summary surveys. The comparative analysis focusses on the flight activity in the breeding season, defined as mid-April to mid-September for this species.

3.3.6.1 *Flight Activity*

During the baseline surveys a total of eight birds were recorded in various height bands above sea level during the breeding season. Only two flights were certainly within the rotor swept height (Table 28).

Only five flights were recorded at rotor swept height during three breeding seasons of operational monitoring, although none of those were geographically located within the rotor sweep of the turbine. The majority of flights (72.3%) were seaward of the sweep of the rotors (Table 28).

Table 28: Flight activity distribution of fulmar in each breeding season (number of birds)

Baseline mid-Apr 07 – mid-Sep 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	2	
	10 – 30	4	
	0 – 10	2	

Year 1 mid-Apr 14 – mid-Sep 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110			1		1	
	12.5 – 25	5			2	2	
	5 – 12.5					1	
	0 – 5		1		1		

Year 2 mid-Apr 15 – mid-Sep 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25				3	1	1
	5 – 12.5						1
	0 – 5			1		3	1

Year 3 mid-Apr 16 – mid-Sep 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	2			1		
	12.5 – 25	1	3	2	1		1
	5 – 12.5		1		2		
	0 – 5				3	2	3

Apparent avoidance behaviour was observed very occasionally during the monitoring surveys. Two avoiding actions when the turbine was operating involved horizontal movements at distance from the turbine to take the birds around the perimeter of turbine; one action was sudden change in flight direction close to the turbine (Table 29).

Table 29: Observed avoidance behaviour of fulmar in each breeding season (number of birds)

Year 1	2 HORIZ; turbine static 1 HORIZ @ 150 m; turbine operational
Year 2	No avoidance behaviour observed
Year 3	1 HORIZ @ 200 m; turbine operational 1 AVOID @ 10 m; turbine operational

3.3.7 Gannet (breeding season)

Table 30: SPA/pSPA qualification relating to gannet

Forth Islands SPA	Breeding population of European importance (21,600 pairs; 8.2% of world biogeographic population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Supports a population of European importance of foraging birds (1980-2006) (10,945 individuals, 1.4% of biogeographical population and 2% of GB population)

There has been a substantial increase in the population since the Forth Islands SPA was designated. The most recent data from the Seabird Monitoring Programme in 2014 provides a count of 75,259 occupied sites in the Forth Islands SPA on Bass Rock.

Gannets were frequently recorded in flight during the breeding season during the EIA baseline surveys and all subsequent monitoring surveys. They were very infrequently observed during the non-breeding season, with the exception of one survey in October 2006 when 238 birds were observed. Gannets were very infrequently recorded on the sea surface during the activity summary surveys. The comparative analysis focusses on the flight activity in the breeding season, defined as mid-March to September for this species.

3.3.7.1 *Flight Activity*

During the baseline surveys a total of 15 birds were recorded in various height bands above sea level during the breeding season. Only three flights were certainly within the rotor swept height (Table 31).

Flight activity of gannets was observed more frequently in the three breeding seasons of operational monitoring, probably because flights were recorded further out to sea than during the baseline surveys. The frequency of observed flight activity appears to have increased each year. Flight activity at rotor swept height was recorded relatively frequently during monitoring surveys; however, only one bird was seen flying through the rotor swept area, with most flights being further seaward of the turbine (Table 31).

Table 31: Flight activity distribution of gannet in each breeding season (number of birds)

Baseline mid-Mar 07 – Sep 07		Horizontal Distance Band	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	3	
	10 – 30	8	
	0 – 10	4	

Year 1 mid-Mar 14 – Sep 14		Horizontal Distance Band					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110				2	1	
	12.5 – 25			6	2	1	
	5 – 12.5					3	20
	0 – 5					2	2

Year 2 mid-Mar 15 – Sep 15		Horizontal Distance Band					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110			2	6		2
	12.5 – 25			1	7	7	10
	5 – 12.5				1	4	5
	0 – 5				1		5

Year 3 mid-Mar 16 – Sep 16		Horizontal Distance Band					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110		1	3	4	10	23
	12.5 – 25		1	1	2	4	34
	5 – 12.5		1	2	2	25	30
	0 – 5			2	3	17	22

Apparent avoidance behaviour was rarely observed during the monitoring surveys. There were two avoiding actions when the turbine was operating involving movements at distance from the turbine (Table 32). The bird that flew through the rotor swept area (Table 31) did not need to take avoiding action because the turbine was static at the time.

Table 32: Observed avoidance behaviour of gannet in each breeding season (number of birds)

Year 1	1 HORIZ @ 200 m; turbine operational
Year 2	No avoidance behaviour observed
Year 3	1 OTHER @ 250 m; turbine operational

3.3.8 Cormorant (breeding season)

Table 33: SPA/pSPA qualification relating to cormorant

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (200 pairs; 2.8% of the GB population)
Firth of Forth SPA	Qualifies as part of the wintering assemblage (based on 1992/93-96/97 winter peak mean); nationally important numbers (682; 5% of the GB population)
pSPA	Not a qualifying interest feature

There has been a substantial decrease in the breeding cormorant population since the Forth Islands SPA counts at designation and the SPA population is currently assessed as 'favourable declining'. The most recent data from the Seabird Monitoring Programme between 2015-2017 indicates numbers are in the region of 82 to 123 occupied sites on Craigleith and The Lamb; however, there are other breeding colonies outside the SPA within the Firth of Forth.

Cormorants were frequently recorded in flight in the breeding season during the EIA baseline surveys and all subsequent monitoring surveys. Cormorants were also recorded relatively frequently but in small numbers on the sea surface during the activity summary surveys.

3.3.8.1 *Flight Activity*

During the baseline surveys, a total of 129 birds were recorded in flight in the survey area in the breeding season. The vast majority (90%) were very low (0-10 m above sea level); only three birds were certainly at rotor swept height (30-85 m above sea level) (Table 34).

Flight activity of cormorants was observed less frequently in the Year 1 operational breeding season monitoring, but the frequency of observed flight activity appears to have increased in the subsequent two breeding seasons. Flight activity at rotor swept height was recorded very infrequently during monitoring surveys and no birds were seen flying through the rotor swept area. Most flights were observed further seaward of the turbine (>98%) (Table 34).

Table 34: Flight activity distribution of cormorant in each breeding season (number of birds)

Baseline mid-Feb 07 – mid-Sep 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	3	
	10 – 30	10	
	0 – 10	116	

Year 1 mid-Feb 14 – mid-Sep 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110				5		
	12.5 – 25	1		3	5		1
	5 – 12.5			1	4	2	1
	0 – 5			3	22	9	8

Year 2 mid-Feb 15 – mid-Sep 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			1	1		3
	5 – 12.5				1	7	1
	0 – 5		1	10	28	48	36

Year 3 mid-Feb 16 – mid-Sep 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110				1	3	4
	12.5 – 25			3	1	7	
	5 – 12.5	1		1	5		1
	0 – 5	1	16	46	76	43	49

Apparent avoidance behaviour was observed very occasionally during the operational monitoring surveys, all of which involved horizontal movements at distance from the turbine to take the birds around the perimeter of turbine (Table 35).

Table 35: Observed avoidance behaviour of cormorant in each breeding season (number of birds)

Year 1	1 HORIZ @ 250 m; turbine operational
Year 2	No avoidance behaviour observed
Year 3	1 HORIZ @ 300 m; turbine static 2 HORIZ @ 100 m; turbine operational 1 HORIZ @ 250 m; turbine operational

3.3.8.2 *Activity Summary*

Cormorants were recorded in the survey area during nearly half of the surveys in the baseline breeding season period (mid-February to mid-September 2007), although numbers were very low with a peak of six birds. Birds were less frequently observed but in similar numbers in the survey area during the first breeding season of operation. They were then observed more frequently in the survey area during the following two breeding seasons (Table 36 and Chart 11).

There is no clear evidence of a change in the number of birds or frequency of use of the survey area around the turbine. Birds tended to be recorded further away from the turbine in Year 2 and Year 3 than in Year 1 (Table 36 and Chart 12).

Table 36: Monthly peak-mean number of cormorant in the survey area and mean distance of flocks from the turbine during each breeding season

Period	**Date range**	**Monthly-peak-mean number of birds**	**Standard Deviation of peak-mean number of birds**	**Weighted mean distance (m)**	**Standard Deviation of weighted mean distance (m)**
Baseline	mid-Feb 07 - mid-Sep 07	1.75	2.12	Not recorded	Not recorded
Construction	mid-Feb 13 - mid-Sep 13	Period not fully surveyed			
Year 1	mid-Feb 14 - mid-Sep 14	1.50	2.14	189	92
Year 2	mid-Feb 15 - mid-Sep 15	1.25	1.16	348	147
Year 3	mid-Feb 16 - mid-Sep 16	2.38	0.92	309	153

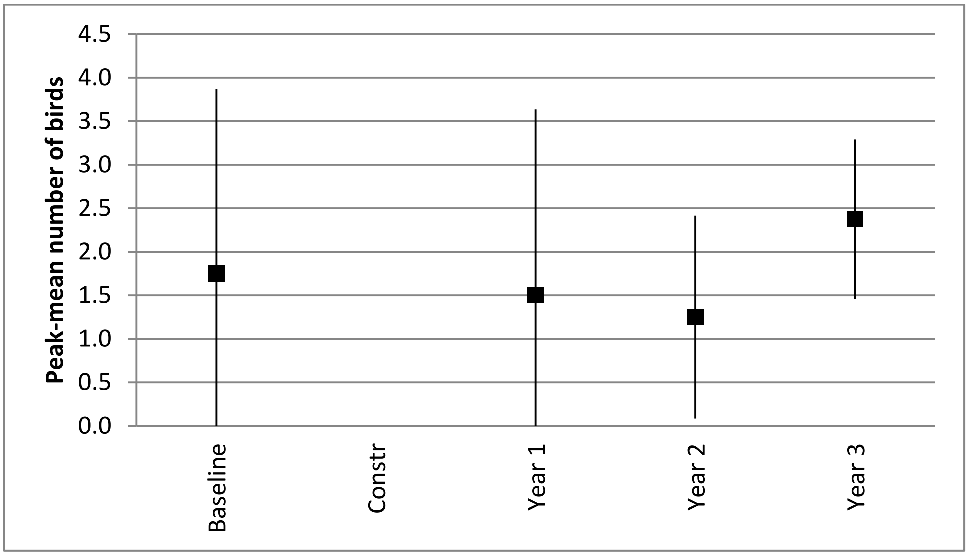

Chart 11: Monthly peak-mean number of cormorant recorded in the survey area each breeding season

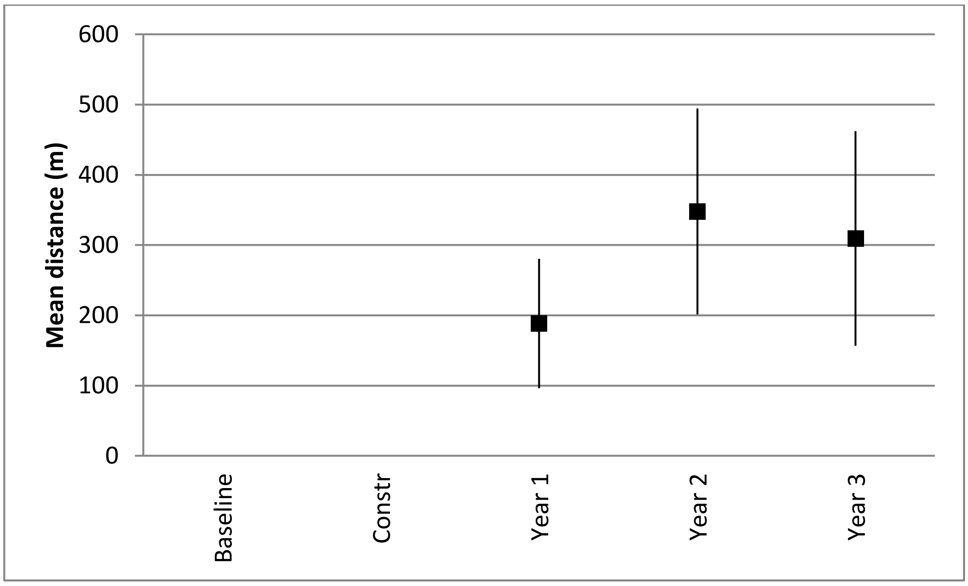

Chart 12: Mean distance of cormorant from the turbine during each breeding season

3.3.9 Cormorant (non-breeding season)

Table 37: SPA/pSPA qualification relating to cormorant

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (200 pairs; 2.8% of the GB population)
Firth of Forth SPA	Qualifies as part of the wintering assemblage (based on 1992/93-96/97 winter peak mean); nationally important numbers (682; 5% of the GB population)
pSPA	Not a qualifying interest feature

WeBS data indicate that the peak winter counts in the Forth Estuary have fluctuated and in the most recent three winters that data are available (2013/14 to 2015/16), peak counts have been both slightly higher and lower than in the baseline winter (2006/07) (Table 38).

Table 38: WeBS peak counts of cormorant in the Forth Estuary

Winter	2006/07	2013/14	2014/15	2015/16	2016/17
Peak Count	653	364	670	544	Not available

Cormorants were frequently recorded in flight and using the sea during the EIA baseline surveys and subsequent operational phase monitoring surveys, but were much less frequently observed during the pre-commissioning winter following installation of the turbine.

3.3.9.1 *Flight Activity*

During the baseline surveys, a total of 271 birds were recorded in flight in the survey area in the non-breeding season. The vast majority (91%) were very low (0-10 m above sea level); only one bird was certainly at rotor swept height (30-85 m above sea level) (Table 39).

Flight activity of cormorants was observed much less frequently during the pre-commissioning phase, but the frequency of observed flight activity increased in the subsequent three winter seasons. During the third winter of operational monitoring, there was much higher incidence of birds recorded flying below the sweep of the rotors. Flight activity at rotor swept height was recorded infrequently including a total of four birds seen flying through the rotor swept area. Most flights were observed further seaward of the turbine (>88%) (Table 39).

Table 39: Flight activity distribution of cormorant in each non-breeding season (number of birds)

Baseline mid-Sep 06 – mid-Feb 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	1	
	10 – 30	24	
	0 – 10	246	

Pre-commissioning mid-Oct 13 – mid-Feb 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	1	2	2	2		
	12.5 – 25				2		
	5 – 12.5						
	0 – 5			4	2	2	1

Year 1 mid-Sep 14 – mid-Feb 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110			1	2	1	6
	12.5 – 25			1	3	3	1
	5 – 12.5			1	10	4	2
	0 – 5	3		15	26	28	38

Year 2 mid-Sep 15 – mid-Feb 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	1				1	
	12.5 – 25	1		1		3	4
	5 – 12.5			1		1	2
	0 – 5		2	6	13	19	56

Year 3 mid-Sep 16 – mid-Feb 17		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196					1	
	25 – 110		2	5	5		
	12.5 – 25		7	6	5	7	2
	5 – 12.5		2	2	2	1	3
	0 – 5		41	26	39	26	59

Apparent avoidance behaviour was observed occasionally during the operational monitoring surveys, all of which involved horizontal or vertical movements at distance from the turbine to take the birds under or around the perimeter of turbine (Table 40). The birds that flew through the rotor swept area (Table 39: two birds during the pre-commissioning phase and two birds in Year 3 non-breeding season) did not need to take avoiding action because the turbine was static at the time.

Table 40: Observed avoidance behaviour of cormorant in each non-breeding season (number of birds)

Pre-commissioning	1 VERT @ 50 m; turbine static 1 HORIZ @ 50 m; turbine static
Year 1	1 HORIZ @ 150 m; turbine static 1 HORIZ @ 200 m; turbine operational 1 HORIZ @ 150 m; turbine operational
Year 2	No avoidance behaviour observed
Year 3	1 VERT @ 100m; turbine operational 1 HORIZ @ 50 m; turbine operational 5 HORIZ @ 100 m; turbine operational 2 HORIZ @ 150 m; turbine operational 1 HORIZ @ 200 m; turbine operational 2 HORIZ @ 250 m; turbine operational

3.3.9.2 *Activity Summary*

Cormorants were recorded in the survey area during most of the surveys in the baseline non-breeding season period (mid-September 2006 to mid-February 2007), with a peak of ten birds observed. Birds were less frequently observed and in lower numbers in the survey area during the monitoring surveys, particularly during the pre-commissioning period, when there was only one bird observed in the survey area during one survey (Table 41 and Chart 13).

The number of birds using the survey area appears to be much lower since the installation and operation of the turbine; however, caution is needed in interpretation because the survey methodologies were different – birds were also recorded on the shoreline during the baseline surveys, whereas birds were only recorded on the sea during the monitoring surveys. Birds tended to be recorded further away from the turbine in successive monitoring winters, although the sample sizes are very small and this does not indicate any clear effect of the turbine (Table 41 and Chart 14).

Table 41: Monthly peak-mean number of cormorant in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	mid-Sep 06 - mid-Feb 07	4.83	2.79	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - mid-Feb 14	0.17	0.41	250	-

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Year 1	mid-Sep 14 - mid-Feb 15	1.00	1.10	278	117
Year 2	mid-Sep 15 - mid-Feb 16	1.50	1.76	282	110
Year 3	mid-Sep 16 - mid-Feb 17	1.83	1.83	391	131

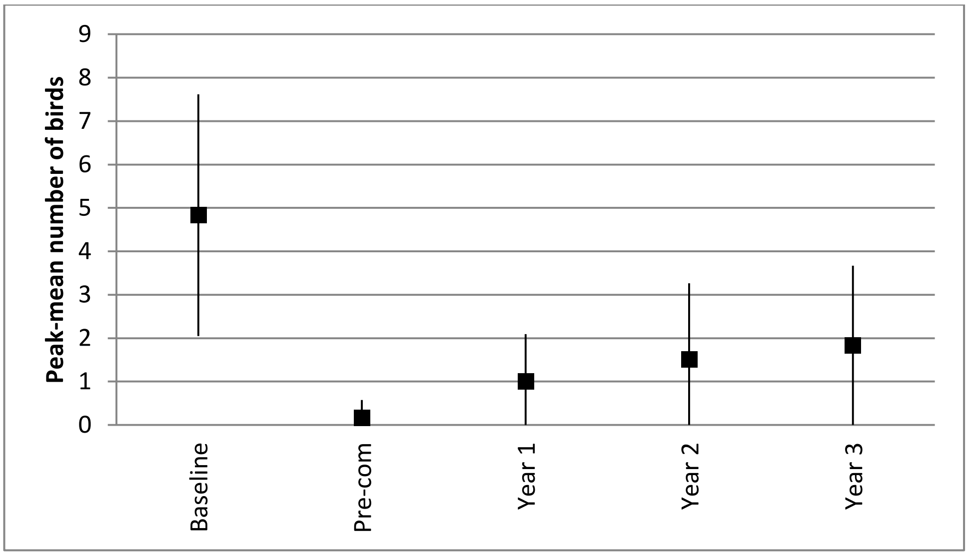

Chart 13: Monthly peak-mean number of cormorant recorded in the survey area each non-breeding season

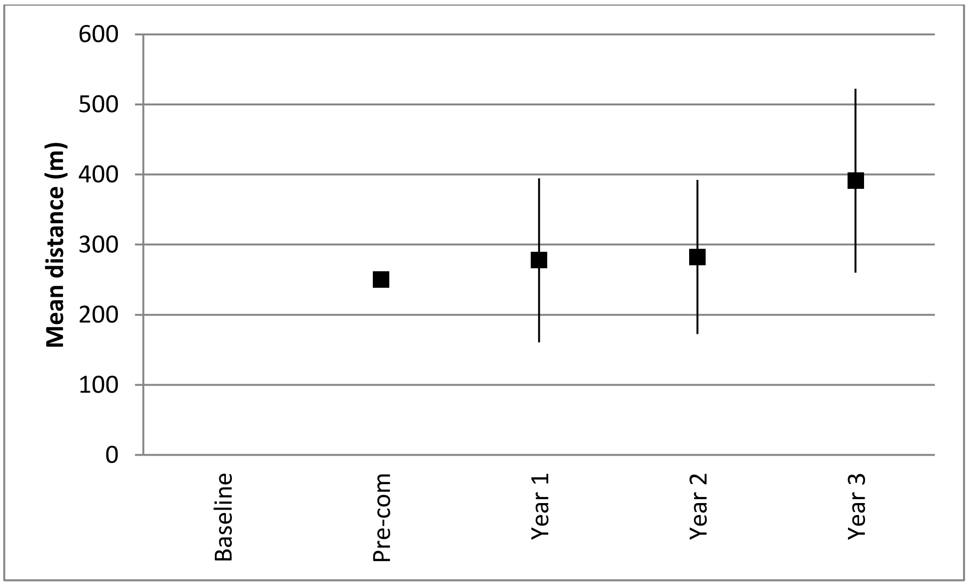

Chart 14: Mean distance of cormorant from the turbine during each non-breeding season

3.3.10 Shag (breeding season)

Table 42: SPA/pSPA qualification relating to shag

Forth Islands SPA	Breeding population of European importance (2,400 pairs; 1.9% of N Europe biogeographic population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Supports a population of European importance of foraging birds (1980-2006) from nearby breeding colonies Qualifies as part of the wintering assemblage (1980-2006); nationally important numbers (2,826 individuals; 2.2% of the GB population)

There has been a substantial decrease in the breeding shag population since the Forth Islands SPA counts at designation and the SPA population is currently assessed as 'unfavourable recovering'. The most recent data from the Seabird Monitoring Programme between 2014-2015 suggests that there are fewer than 1,000 occupied sites on the islands.

Shags were frequently recorded in flight in the breeding season during the EIA baseline surveys and all subsequent monitoring surveys. Shags were also recorded relatively frequently but in small numbers on the sea surface during the activity summary surveys.

3.3.10.1 *Flight Activity*

During the baseline surveys, a total of 95 birds were recorded in flight in the survey area during the breeding season. The majority (75%) were very low (0-10 m above sea level); only two birds were certainly at rotor swept height (30-85 m above sea level) (Table 43).

Flight activity of shags was observed more frequently during the three years of operational phase breeding season monitoring. Flight activity at rotor swept height was recorded just once in three breeding seasons of monitoring and no birds were seen flying through the rotor swept area. Most flights were observed further seaward of the turbine (>98.5%) (Table 43).

Table 43: Flight activity distribution of shag in each breeding season (number of birds)

Baseline Feb 07 – mid-Sep 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	2	
	10 – 30	22	
	0 – 10	71	

Year 1 Feb 14 – mid-Sep 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			2	1		
	5 – 12.5			1	5	4	3
	0 – 5			18	41	36	26

Year 2 Feb 15 – mid-Sep 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110					1	
	12.5 – 25			1	3	1	2
	5 – 12.5				1	1	3
	0 – 5		1	22	53	73	147

Year 3 Feb 16 – mid-Sep 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25						
	5 – 12.5				2	1	1
	0 – 5	1	6	20	25	31	69

Apparent avoidance behaviour was observed occasionally during the operational monitoring breeding season surveys, all of which involved horizontal movements at distance from the turbine to take the birds around the perimeter of turbine (Table 44).

Table 44: Observed avoidance behaviour of shag in each breeding season (number of birds)

Year 1	1 HORIZ @ 150 m; turbine operational 1 HORIZ @ 250 m; turbine operational 1 HORIZ @ 300 m; turbine operational
Year 2	1 HORIZ @ 100 m; turbine operational 2 HORIZ @ 150 m; turbine operational 2 HORIZ @ 250 m; turbine operational 1 HORIZ @ 250 m; turbine static 1 HORIZ @ 300 m; turbine operational
Year 3	3 HORIZ @ 50 m; turbine operational 9 HORIZ @ 100 m; turbine operational 2 HORIZ @ 250 m; turbine operational

3.3.10.2 *Activity Summary*

Shags were recorded in the survey area during approximately one third of the surveys in the baseline breeding season period (February to mid-September 2007); numbers were typically low, with a peak of seven birds in August. Birds were less frequently observed in smaller numbers in Year 1, but had recovered in Years 2 and 3 (Table 45 and Chart 15).

There is no clear trend in the number of birds or frequency of use of the survey area around the turbine. The distance away from the turbine that birds were recorded was very similar throughout the monitoring period (Table 45 and Chart 16).

Table 45: Monthly peak-mean number of shag in the survey area and mean distance of flocks from the turbine during each breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	Feb 07 - mid-Sep 07	1.25	2.43	Not recorded	Not recorded
Construction	Feb 13 - mid-Sep 13	Period not fully surveyed			
Year 1	Feb 14 - mid-Sep 14	0.63	0.74	300	113
Year 2	Feb 15 - mid-Sep 15	3.25	1.98	298	145
Year 3	Feb 16 - mid-Sep 16	1.88	1.46	288	104

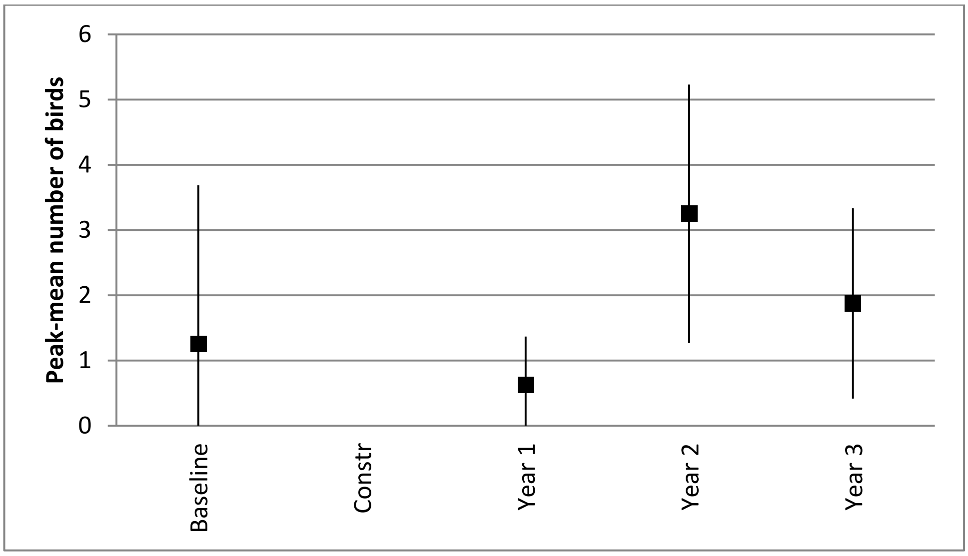

Chart 15: Monthly peak-mean number of shag recorded in the survey area each breeding season

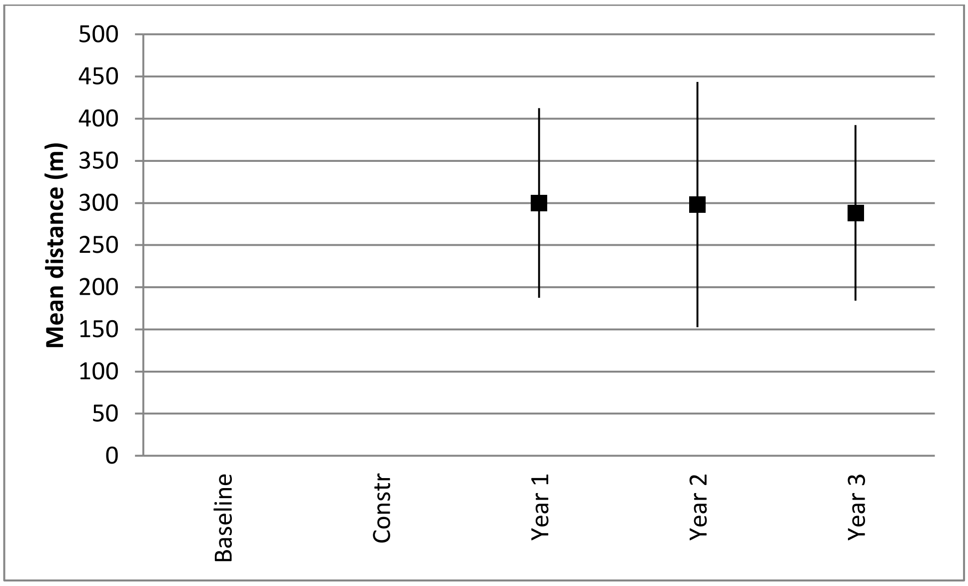

Chart 16: Mean distance of shag from the turbine during each breeding season

3.3.11 Shag (non-breeding season)

Table 46: SPA/pSPA qualification relating to shag

Forth Islands SPA	Breeding population of European importance (2,400 pairs; 1.9% of N Europe biogeographic population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Supports a population of European importance of foraging birds (1980-2006) from nearby breeding colonies Qualifies as part of the wintering assemblage (1980-2006); nationally important numbers (2,826 individuals; 2.2% of the GB population)

WeBS data indicate that the peak winter counts in the Forth Estuary have decreased considerably since the baseline winter (2006/07) (Table 47).

Table 47: WeBS peak counts of shag in the Forth Estuary

Winter	**2006/07**	**2013/14**	**2014/15**	**2015/16**	**2016/17**
Peak Count	719	426	463	292	Not available

Shags were frequently recorded in flight and using the sea during the EIA baseline surveys in the non-breeding season and subsequent operational phase monitoring surveys.

3.3.11.1 *Flight Activity*

During the baseline surveys, a total of 174 birds were recorded in flight in the survey area in the non-breeding season. The vast majority (95%) were very low (0-10 m above sea level); no birds were recorded in the height band spanning most of the rotor swept height (30-85 m above sea level) (Table 48).

The frequency of flight activity of shags in the non-breeding season was similar or higher in the monitoring seasons than in the baseline winter season. There was no flight activity recorded at rotor swept height during monitoring surveys. Most flights were observed further seaward of the turbine (>96%) (Table 48).

Table 48: Flight activity distribution of shag in each non-breeding season (number of birds)

Baseline mid-Sep 06 – Feb 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	0	
	10 – 30	8	
	0 – 10	166	

Pre-Commissioning mid-Oct 13 – Feb 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			4	2		2
	5 – 12.5			3	1	5	
	0 – 5	2	5	52	49	35	9

Year 1 mid-Sep 14 – Feb 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25				1	4	
	5 – 12.5	1		5	8	12	3
	0 – 5	1		37	44	62	101

Year 2 mid-Sep 15 – Feb 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			1		1	3
	5 – 12.5		1	1	1	2	12
	0 – 5		9	31	57	62	135

Year 3 mid-Sep 16 – Feb 17		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25		1	1		1	3
	5 – 12.5			1	1	2	2
	0 – 5		18	17	26	40	62

Apparent avoidance behaviour was observed occasionally during the operational monitoring surveys, most of which involved horizontal movements at distance from the turbine to take the birds around the perimeter of turbine; two avoiding actions were also weaving flights around the turbine (Table 49).

Table 49: Observed avoidance behaviour of shag in each non-breeding season (number of birds)

Pre-commissioning	1 WEAVE @ 50 m; turbine operational 1 HORIZ @ 50 m; turbine operational 1 HORIZ @ 200 m; turbine static
Year 1	2 HORIZ @ 150 m; turbine static 1 HORIZ @ 300 m; turbine operational
Year 2	1 WEAVE @ 20 m; turbine operational 1 HORIZ @ 50 m; turbine operational
Year 3	4 HORIZ @ 100 m; turbine operational 3 HORIZ @ 150 m; turbine operational

3.3.11.2 *Activity Summary*

Shags were recorded in small numbers in the survey area during most of the surveys in the baseline non-breeding season period (mid-September 2006 to February 2007), with a peak of six birds observed. Similar numbers were recorded in the survey area during all of the monitoring surveys (Table 50 and Chart 17).

The number of birds using the survey area does not appear to have changed significantly since the installation and operation of the turbine and there does not appear to be any significant change in the distance that birds were recorded away from the turbine (Table 50 and Chart 18).

Table 50: Monthly peak-mean number of shag in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	mid-Sep 06 - Feb 07	2.80	1.79	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - Feb 14	2.00	1.73	235	104
Year 1	mid-Sep 14 - Feb 15	2.80	1.79	284	112
Year 2	mid-Sep 15 - Feb 16	4.00	1.87	250	119
Year 3	mid-Sep 16 - Feb 17	2.20	0.84	272	165

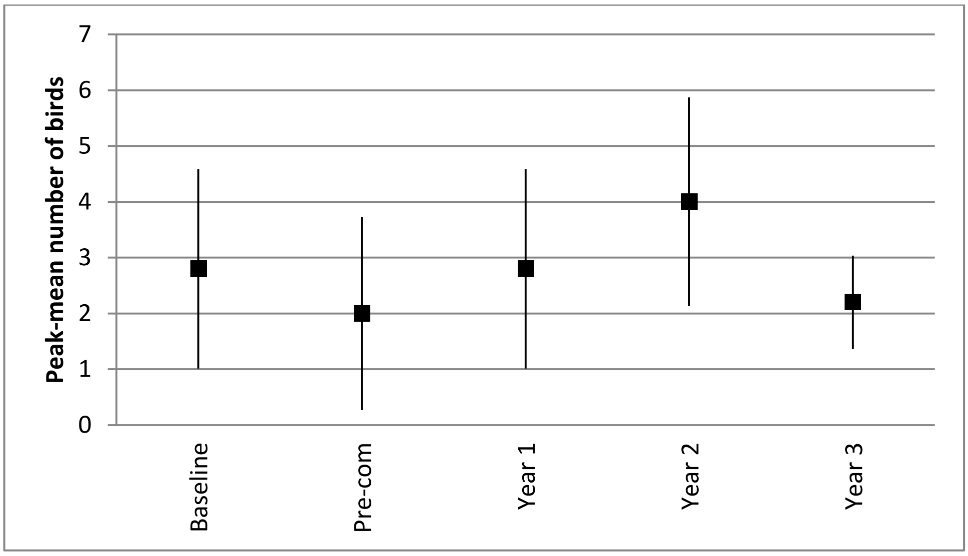

Chart 17: Monthly peak-mean number of shag recorded in the survey area each non-breeding season

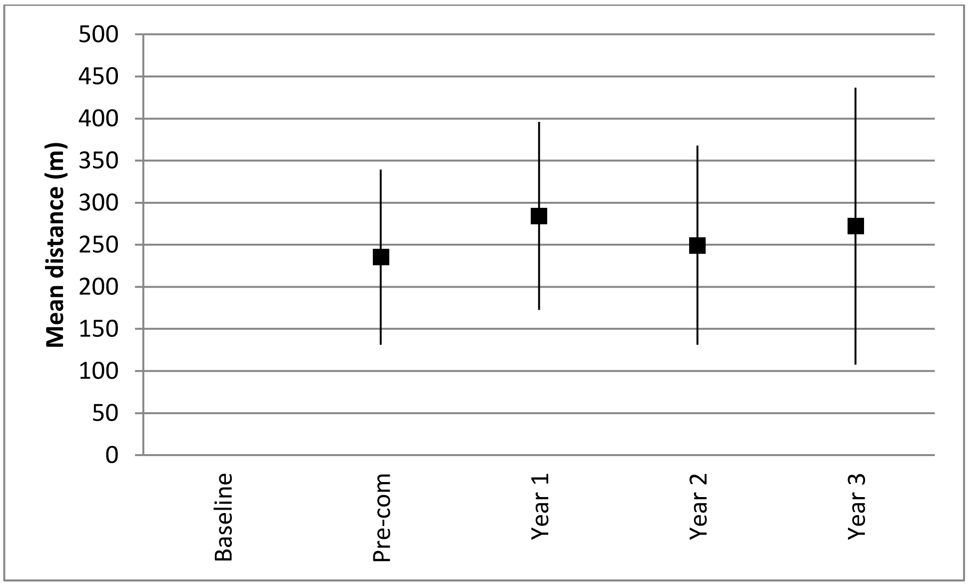

Chart 18: Mean distance of shag from the turbine during each non-breeding season

3.3.12 Oystercatcher (non-breeding)

Table 51: SPA/pSPA qualification relating to oystercatcher

Forth Islands SPA	Not a qualifying interest feature
Firth of Forth SPA	Qualifies as part of the wintering waterfowl assemblage (based on 1992/93-96/97 winter peak mean); nationally important numbers (7,846; 2% of the GB population)
pSPA	Not a qualifying interest feature

The most recent near-complete Wetland Bird Survey low-tide counts in winter 2003/04 showed that oystercatchers were one of the most widespread and common birds in the Forth Estuary, occurring at an average density of approximately one bird per hectare. Since the WeBS Low Tide Count in 2003/04, the habitats around the Fife Energy Park have changed and intertidal mudflats no longer occur at the location of the LDT, so oystercatchers and other wading birds are less abundant now in the that location.

WeBS core count data for the whole Forth Estuary show that the peak winter counts of oystercatcher in the estuary have been considerably lower (c. -30%) than during the baseline winter (Table 52).

Table 52: WeBS peak counts of oystercatcher in the Forth Estuary

Winter	2006/07	2013/14	2014/15	2015/16	2016/17
Peak Count	9,279	6,213	6,481	6,548	Not available

During the EIA baseline surveys and subsequent monitoring surveys, oystercatchers were recorded very rarely using the shoreline or intertidal habitats in the survey area, but birds were frequently recorded in flight moving between other parts of the coastline. The comparative analysis focusses on the flight activity in the non-breeding season, defined as September to mid-March for this species.

3.3.12.1 *Flight Activity*

During the baseline surveys, a total of 309 birds were recorded in flight during the non-breeding season; almost all the flights were in the lowest height bands of 0-10 m and 10-30 m above sea level, with just one flight that was certainly at rotor swept height between 30-85 m above sea level (Table 53).

Most observed flight activity during the non-breeding season monitoring surveys was below or seaward of the sweep of the rotors. No birds were seen flying through the rotor swept area (Table 53).

Table 53: Flight activity distribution of oystercatcher in each non-breeding season (number of birds)

Baseline Sep 06 – mid-Mar 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	1	
	10 – 30	61	
	0 – 10	247	

Pre-commissioning mid-Oct 13 – mid-Mar 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110			3	10		
	12.5 – 25			1	7		
	5 – 12.5			3	4		
	0 – 5			25	14	7	

Year 1 Sep 14 – mid-Mar 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	2			1		
	12.5 – 25				2	5	
	5 – 12.5	1		1		3	5
	0 – 5	2		6	9	12	5

Year 2 Sep 15 – mid-Mar 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110			1		20	
	12.5 – 25				1		2
	5 – 12.5						1
	0 – 5		2	3	23	7	17

Year 3 Sep 16 – mid-Mar 17		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110					1	6
	12.5 – 25	1			1	1	
	5 – 12.5			3			2
	0 – 5		6	25	17	19	18

Apparent avoidance behaviour was observed three times during the winter monitoring surveys; two demonstrated avoiding action at least 150 m away from the turbine, the other was closer, at 20 m away from the turbine.

Table 54: Observed avoidance behaviour of oystercatcher in each non-breeding season (number of birds)

Pre-commissioning	4 HORIZ @ 250 m; turbine operational 1 AVOID @ 150 m; turbine operational
Year 1	1 HORIZ @ 20 m; turbine operational
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.13 Lesser Black-backed Gull

Table 55: SPA/pSPA qualification relating to lesser black-backed gull

Forth Islands SPA	Breeding population of European importance (1,500 pairs; 1.2% of total *Larus fuscus graellsii* biogeographic population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Not a qualifying interest feature

Seabird Monitoring Programme counts of lesser back-backed gulls on the Forth Islands SPA have been inconsistent in their completeness. The largest colony occurs on the Isle of May, where there was a 25% increase from 1,665 to 2,047 occupied sites between 2006 and 2014. At other smaller colonies such as on Inchmickery and Fidra, numbers have fluctuated but appear to be broadly stable. Other substantial breeding colonies occur on non-SPA islands in the Forth, such as Inchcolm and Inchkeith.

Lesser black-backed gulls were frequently observed in flight in the breeding and non-breeding seasons during the EIA baseline surveys and all subsequent monitoring surveys; however, their numbers and activity were not surveyed as a target species during the baseline surveys in 2007. They were very infrequently recorded on the sea surface during activity summary surveys. As this species is a qualifying interest of the Forth Islands SPA only during the breeding season, the comparative analysis focusses on the flight activity in breeding season, defined as April to August.

3.3.13.1 *Flight Activity*

Lesser black-backed gull was not surveyed as a target species during the baseline surveys (Table 56).

Flight activity of lesser black-backed gulls was observed mostly (87%) below rotor swept height throughout the monitoring surveys during the three breeding seasons. Birds were frequently recorded in the near-shore distance bands (A/B) corresponding with the shoreline and rotor swept zone; however, there were only three birds recorded flying through the rotor swept area (Distance Band RSA, Height Band 25-110 m and 110-196 m) (Table 56).

Table 56: Flight activity distribution of lesser black-backed gull in each breeding season (number of birds)

Baseline Apr 07 – Aug 07		Horizontal Distance Band	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	Not recorded as target species	
	30 – 85		
	10 – 30		
	0 – 10		

Year 1 Apr 14 – Aug 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	1	2		2	3	
	12.5 – 25	4	8	3	4	5	3
	5 – 12.5	1		2	4	6	
	0 – 5				2	1	

Year 2 Apr 15 – Aug 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110		1	1	2	2	
	12.5 – 25	4	1	4	4	1	1
	5 – 12.5	1			3		3
	0 – 5					5	4

Year 3 Apr 16 – Aug 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110			1	1	1	2
	12.5 – 25	3	3	1	4	5	3
	5 – 12.5	1		1	6		4
	0 – 5	2	2	9	8	2	4

Apparent avoidance behaviour was observed occasionally during the breeding season operational monitoring surveys, all of which involved horizontal movements at distance from the turbine to take the birds around the perimeter of turbine (Table 57). The birds that flew through the airspace potentially swept by the rotors (Table 56: two birds in Year 1 and one bird in Year 2) did not take avoiding action; the turbine was static during two of the flights and operational during one of the flights.

Table 57: Observed avoidance behaviour of lesser black-backed gull in each breeding season (number of birds)

Year 1	1 HORIZ @ 100 m; turbine operational 1 HORIZ @ 100 m; turbine static 1 HORIZ @ 250 m; turbine operational
Year 2	1 HORIZ @ 100 m; turbine static 1 HORIZ @ 150 m; turbine static
Year 3	1 HORIZ @ 250 m; turbine operational

3.3.14 Herring Gull (breeding season)

Table 58: SPA/pSPA qualification relating to herring gull

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (6,600 pairs; 4.1% of the GB population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Qualifies as part of the breeding seabird assemblage (1980-2006); nationally important numbers (3,044; 1.1% of the GB population) Further qualification as part of the non-breeding seabird assemblage (2003/04-2005/06); nationally important population (12,313; 1.7% of the GB population)

Seabird Monitoring Programme counts of herring gulls in the Forth Islands SPA have been inconsistent in their completeness, so comparison between the populations present during the baseline and monitoring seasons is difficult. The largest colony on a SPA island occurs on the Isle of May, where there was nearly a 50% increase from 2,854 to 4,200 occupied sites between 2006 and 2014. At other smaller colonies such as on Inchmickery and Fidra, numbers have fluctuated but appear to be broadly stable. Other substantial breeding colonies occur on non-SPA islands in the Forth, such as Inchcolm and Inchkeith.

Herring gulls were very frequently observed in flight and within the survey area in the breeding season during the EIA baseline surveys and all subsequent monitoring surveys; however, their flights were not surveyed as a target species during the baseline surveys in 2006/07. They were frequently recorded on the sea surface during activity summary surveys during the baseline and monitoring surveys and were also counted on the hardstandings and other structures within the terrestrial part of the survey area during the baseline surveys (they were not counted on terrestrial parts of the survey area during monitoring surveys). The comparative analysis in this section focusses on the flight activity and abundance in the breeding season, defined as April to August.

3.3.14.1 *Flight Activity*

Herring gull was not surveyed as a target species during the baseline surveys.

Flight activity of herring gulls was observed mostly (84%) below rotor swept height throughout the monitoring surveys during the three breeding seasons. Birds were frequently recorded in the near-shore distance bands (A/B) corresponding with the shoreline and rotor swept area (RSA); however, there were only nine birds recorded flying through the rotor swept area (Distance Band RSA, Height Band 25-110 m and 110-196 m) (Table 59).

Table 59: Flight activity distribution of herring gull in each breeding season (number of birds)

Baseline Apr 07 – Aug 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	Not recorded as target species	
	30 – 85		
	10 – 30		
	0 – 10		

Year 1 Apr 14 – Aug 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	2	2	3	4	4	
	12.5 – 25	32	8	17	17	16	2
	5 – 12.5	3	2	17	30	11	1
	0 – 5		3	9	19	11	5

Year 2 Apr 15 – Aug 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110	3	2	2	4	4	8
	12.5 – 25	6	3	13	15	16	9
	5 – 12.5	5	2	19	6	8	
	0 – 5		4	2	2	1	1

Year 3 Apr 16 – Aug 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196		2				
	25 – 110	3	3	2	12	16	6
	12.5 – 25	7		10	8	13	15
	5 – 12.5	7	7	6	9	5	
	0 – 5	1	5	12	7	3	4

Apparent avoidance behaviour was observed occasionally during the breeding season operational monitoring surveys, most of which involved horizontal movements (HORIZ) at distance from the turbine to take the birds around the perimeter of turbine (while it was either static or operational). Two birds were also witnessed taking more urgent or decisive action (AVOID) to avoid the turbine at closer range when it was operational (Table 60).

Table 60: Observed avoidance behaviour of herring gull in each breeding season (number of birds)

Year 1	1 AVOID @ 50 m; turbine operational 3 HORIZ @ 50 m; turbine static 4 HORIZ @ 100 m; turbine operational 1 HORIZ @ 150 m; turbine static 1 HORIZ @ 200 m; turbine operational
Year 2	1 AVOID @ 50 m; turbine operational 1 HORIZ @ 50 m; turbine static 1 HORIZ @ 100 m; turbine static
Year 3	1 AVOID @ 10 m; turbine operational 1 HORIZ @ 50 m; turbine operational 1 HORIZ @ 150 m; turbine operational

3.3.14.2 *Activity Summary*

Herring gulls were recorded in the survey area during all but one of the survey days during the baseline breeding season period (2007), with a peak of 211 birds noted in August. Birds were also frequently observed in the survey area during the monitoring surveys, but in smaller numbers, mainly because birds using terrestrial parts of the shoreline and Fife Energy Park were not counted.

The number of birds and frequency of use of the survey area was much lower in the Year 3 breeding season than during the previous two breeding seasons of operational monitoring. However, there did not appear to be any substantive difference in the distance that birds were recorded away from the turbine during the three breeding seasons of monitoring (Table 61, Chart 19 and Chart 20).

Table 61: Monthly peak-mean number of herring gull in the survey area and mean distance of flocks from the turbine during each breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	Apr 07 - Aug 07	80.60	82.20	Not recorded	Not recorded
Construction	Apr 13 - Aug 13	Period not fully surveyed			
Year 1	Apr 14 - Aug 14	9.80	7.26	240	130
Year 2	Apr 15 - Aug 15	10.00	6.63	239	157
Year 3	Apr 16 - Aug 16	2.00	1.00	249	151

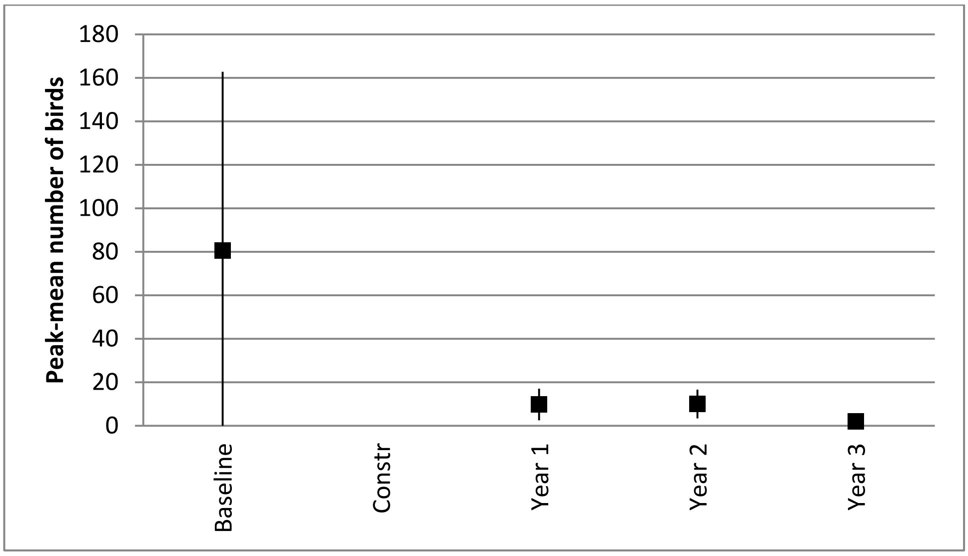

Chart 19: Monthly peak-mean number of herring gull recorded in the survey area each breeding season

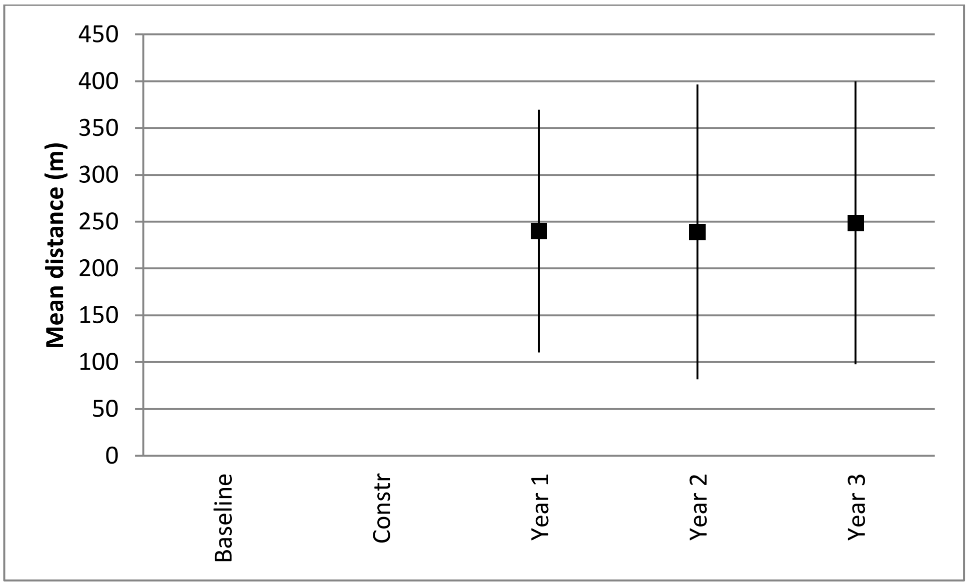

Chart 20: Mean distance of herring gull from the turbine during each breeding season

3.3.15 Herring Gull (non-breeding season)

Table 62: SPA/pSPA qualification relating to herring gull

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (6,600 pairs; 4.1% of the GB population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Qualifies as part of the breeding seabird assemblage (1980-2006); nationally important numbers (3,044; 1.1% of the GB population) Further qualification as part of the non-breeding seabird assemblage (2003/04-2005/06); nationally important population (12,313; 1.7% of the GB population)

One of the largest coastal roosting concentrations of herring gulls in Scotland occurs in the Forth of Forth. In January 2004 the population of non-breeding herring gull in the Firth of Forth, based on counts of birds flying in to roost, was estimated at 12,313 birds.

WeBS core counts are not designed to provide accurate or complete counts of gulls at count sites. The data indicate that the peak winter counts in the Forth Estuary have fluctuated and in the most recent two winters that data are available (2014/15 and 2015/16), peak counts have been both slightly lower than in the baseline winter (2006/07) (Table 63).

Table 63: WeBS peak counts of herring gull in the Forth Estuary

Winter	**2006/07**	**2013/14**	**2014/15**	**2015/16**	**2016/17**
Peak Count	2,814	1,445	2,532	2,556	Not available

Herring gulls were frequently observed in flight and within the survey area in the non-breeding season during the EIA baseline surveys and all subsequent monitoring surveys; however, their flights were not surveyed as a target species during the baseline surveys in 2006/07. They were frequently recorded on the sea surface during activity summary surveys during the baseline and monitoring surveys and were also counted on the hardstandings and other structures within the terrestrial part of the survey area during the baseline surveys (they were not counted on terrestrial parts of the survey area during monitoring surveys). The comparative analysis in this section focusses on the flight activity and abundance in the non-breeding season, defined as September to March.

3.3.15.1 *Flight Activity*

Herring gull was not surveyed as a target species during the baseline surveys.

Flight activity of herring gulls was observed mostly (88%) below rotor swept height throughout the monitoring surveys during the four non-breeding seasons. Birds were frequently recorded in the near-shore distance bands corresponding with the shoreline and rotor swept area (RSA) and there were 19 birds recorded flying through the rotor swept area (Distance Band RSA, Height Band 25-110 m and 110-196 m) (Table 64).

Table 64: Flight activity distribution of herring gull in each non-breeding season (number of birds)

Baseline Sep 06 – Mar 07	Horizontal Distance Band	
Vertical Height Band (m)	**0 – 165 m**	**>165m**
>85	Not recorded as target species	
30 – 85		
10 – 30		
0 – 10		

Pre-Commissioning mid-Oct 13 – Mar 14	**Horizontal Distance Band**					
Vertical Height Band (m)	**Shore – RSA**	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
>196						
110 – 196		1			1	
25 – 110	7	12	9	17	16	5
12.5 – 25	20	26	37	40	6	3
5 – 12.5	28	12	33	19	4	4
0 – 5	5		18	18	6	24

Year 1 Sep 14 – Mar 15	**Horizontal Distance Band**					
Vertical Height Band (m)	**Shore – RSA**	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
>196						
110 – 196						
25 – 110	1	2	2	1	3	6
12.5 – 25	12	2	11	25	15	4
5 – 12.5	11	2	25	32	28	16
0 – 5	3	2	30	41	19	7

Year 2 Sep 15 – Mar 16	**Horizontal Distance Band**					
Vertical Height Band (m)	**Shore – RSA**	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
>196						
110 – 196			1			
25 – 110	1	1	1	3	14	11
12.5 – 25	15	21	18	13	18	20
5 – 12.5	8	9	6	9	21	15
0 – 5	3	19	25	18	14	17

Year 3 Sep 16 – Mar 17	**Horizontal Distance Band**					
Vertical Height Band (m)	**Shore – RSA**	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
>196						
110 – 196						2
25 – 110	1	3	8	9	5	11
12.5 – 25	25	11	5	13	19	19
5 – 12.5	3	24	13	16	14	18
0 – 5		20	7	3	5	14

Apparent avoidance behaviour was observed frequently during the pre-commissioning phase in winter 2013/14, but much less frequently in subsequent winters. The majority of avoiding actions were horizontal or vertical movements (HORIZ or VERT) at distance from the turbine to take the birds above or around the perimeter of turbine (while it was either static or operational). Seven flights were also witnessed of birds taking more urgent or decisive action (AVOID) to avoid the turbine at closer range when it was static or operational. Eight flights were also weaving action to avoid the turbine (Table 65).

Of the 19 flights through the rotor swept area in Distance Band B and Height Bands 4/5 (Table 64), only two demonstrated avoiding action. The remaining 17 flights did not exhibit any avoiding action; although it is possible that those birds flew harmlessly through the space between the rotors, it is quite likely that the turbine was not aligned across the whole distance band at that time and birds did not need to take action to avoid being struck by the rotors.

Table 65: Observed avoidance behaviour of herring gull in each non-breeding season (number of birds)

Pre-commissioning	7 AVOID @ 0-100 m; turbine static 1 AVOID @ 50 m; turbine operational 2 VERT @ 100 m; turbine operational 5 WEAVE @ 50 m; turbine static 4 WEAVE @ 100 m; turbine operational 42 HORIZ @ 50-300 m; turbine static 13 HORIZ @ 20-250 m; turbine operational
Year 1	1 AVOID @ 200 m; turbine static 6 HORIZ @ 50-150 m; turbine operational
Year 2	1 AVOID @ 100 m; turbine operational 2 VERT @ 50 m; turbine operational 6 HORIZ @ 75-250 m; turbine operational 1 HORIZ @ 20 m; turbine static
Year 3	4 HORIZ @ 100-150 m; turbine operational

3.3.15.2 *Activity Summary*

Herring gulls were recorded in the survey area during all survey days during the baseline non-breeding season period (2006/07), with a peak of 93 birds noted in November. Birds were also frequently observed in the survey area during the monitoring surveys, but in much smaller numbers (peaks of 3 to 22 birds), mainly because birds using terrestrial parts of the shoreline and Fife Energy Park were not counted, only those on the sea surface.

The number of birds and frequency of use of the survey area remained consistently low throughout each operational winter season (Table 66 and Chart 21). There did not appear to be any substantive difference in the distance that birds were recorded away from the turbine, although birds appeared to be closer to the turbine during the Year 3 operational winter season (Table 66 and Chart 22).

Table 66: Monthly peak-mean number of herring gull in the survey area and mean distance of flocks from the turbine during each non-breeding season

Period	Date range	Monthly-peak-mean numbers	Standard Deviation of peak-mean number	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	Sep 06 - Mar 07	85.86	146.77	Not recorded	Not recorded
Pre-commissioning	mid-Oct 13 - Mar 14	2.71	0.95	287	126
Year 1	Sep 14 – Mar 15	5.43	7.39	299	163
Year 2	Sep 15 – Mar 16	4.43	2.82	290	127
Year 3	Sep 16 – Mar 17	1.71	0.76	220	122

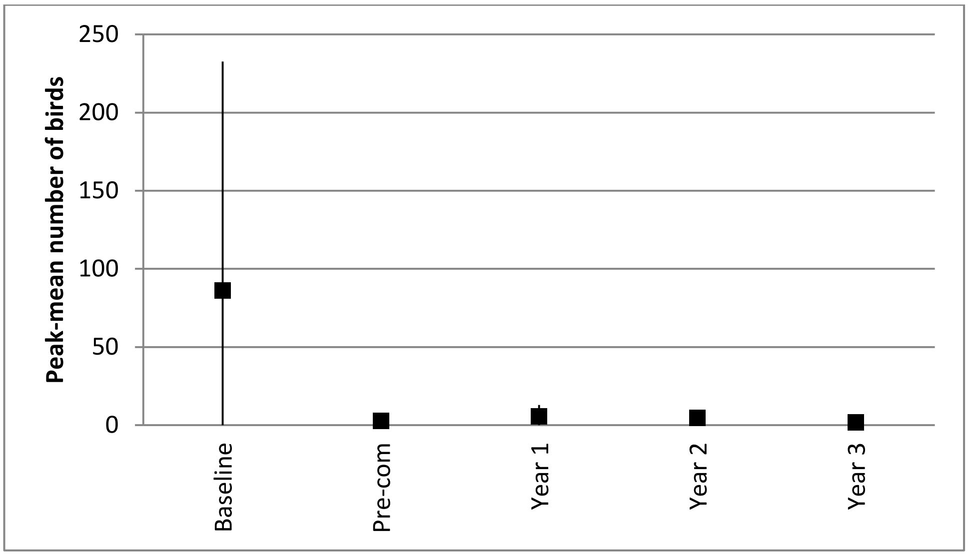

Chart 21: Monthly peak-mean number of herring gull recorded in the survey area each non-breeding season

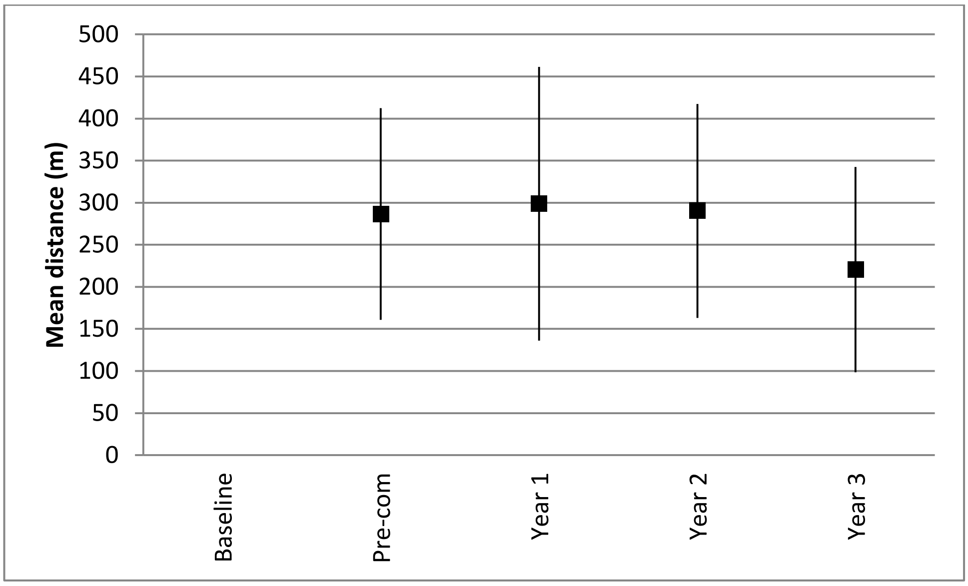

Chart 22: Mean distance of herring gull from the turbine during each non-breeding season

3.3.16 Kittiwake (breeding season)

Table 67: SPA/pSPA qualification relating to kittiwake

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (8,400 pairs; 1.7% of the GB population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Qualifies as part of the breeding seabird assemblage (1980-2006); nationally important numbers (12,020 individuals; 1.6% of the GB population) Further qualification as part of the non-breeding seabird assemblage (1980-2006); nationally important population (3,191 individuals; >2,000 individuals)

The largest colony in the Forth Islands SPA occurs on the Isle of May. Complete counts undertaken for the Seabird Monitoring Programme in 2014 and 2015 show that numbers were much lower in 2014 (3,339) than in 2007 (4,649) but slightly higher in 2015 (4,785). There are several hundred more pairs nesting at other locations in and around the Firth of Forth that are not part of the Forth Islands SPA (e.g. the islands of Inchcolm and Inchkeith).

Kittiwakes were frequently recorded in flight during the EIA baseline breeding season surveys and the subsequent operational phase monitoring surveys in the breeding season. They were very infrequently recorded on the sea surface during the activity summary surveys and their activity and abundance in the non-breeding season was also very infrequent, therefore the comparative analysis focusses on the flight activity in the breeding season, defined as mid-April to August for this species.

3.3.16.1 *Flight Activity*

During the baseline surveys a total of 88 birds were recorded in various height bands above sea level during the breeding season. Six flights were certainly within the rotor swept height (Table 68).

No flights were recorded at rotor swept height during three breeding seasons of operational monitoring and all except one bird was flying seaward of the sweep of the rotors. The frequency of recorded flight activity of kittiwakes within 500 m of the turbine has been much lower during the monitoring surveys than in the baseline breeding season (Table 68).

Table 68: Flight activity distribution of kittiwake in each breeding season (number of birds)

Baseline mid-Apr 07 – Aug 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	6	
	10 – 30	62	
	0 – 10	20	

Year 1 mid-Apr 14 – Aug 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			2	2	4	1
	5 – 12.5				4	7	8
	0 – 5		1	2	7	4	37

Year 2 mid-Apr 15 – Aug 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			1	2	1	
	5 – 12.5						
	0 – 5						30

Year 3 mid-Apr 16 – Aug 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25			1		2	1
	5 – 12.5				1	1	7
	0 – 5				5		4

There was no apparent avoidance behaviour observed during the monitoring surveys in the breeding season.

Table 69: Observed avoidance behaviour of kittiwake in each breeding season (number of birds)

Year 1	No avoidance behaviour observed
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.17Sandwich Tern (breeding season)

Table 70: SPA/pSPA qualification relating to Sandwich tern

Forth Islands SPA	Breeding population of European importance (average of 440 pairs; 3% of GB population)
Firth of Forth SPA	Post-breeding (passage) population of European importance (1,617 individuals; 6% of the GB population, 1% of the East Atlantic population)
pSPA	Not a qualifying interest feature

Seabird Monitoring Programme data show that a colony of several hundred regularly nesting pairs used to occur on Inchmickery in the 1970s and 1980s but were entirely absent after 1995. Other transient colonies sometimes numbering several hundred pairs have historically come and gone over a period of a few years on Long Craig, Fidra and the Isle of May, but not within the last 15 years.

WeBS core counts may not provide accurate or complete counts of terns at count sites; however, the WeBS data indicate that the peak counts in the Forth Estuary typically occur during the post-breeding passage period and peak numbers have fluctuated between the baseline year (2006) and operational monitoring years (2014-2016) (Table 71).

Table 71: WeBS peak counts of Sandwich tern in the Forth Estuary

Period	**2006/07**	**2013/14**	**2014/15**	**2015/16**	**2016/17**
Peak Count	1,037	700	2,914	1,138	Not available

Sandwich terns were frequently recorded in flight during the EIA baseline breeding season surveys and the subsequent operational phase monitoring surveys in the breeding season. They were very rarely recorded on the sea surface during the activity summary surveys and their activity and abundance in the passage and non-breeding seasons was also very infrequent within the survey area, therefore the comparative analysis focusses on the flight activity in the breeding season, defined as mid-April to mid-September for this species.

3.3.17.1 *Flight Activity*

During the baseline surveys a total of 172 birds were recorded in various height bands above sea level during the breeding season. Eleven flights were certainly within the rotor swept height (Table 72).

Only five flights were recorded at rotor swept height during three breeding seasons of operational monitoring, although none of those were geographically located within the rotor sweep of the turbine. The majority of flights (>98%) were seaward of the sweep of the rotors. The frequency of flight activity between the three years of operational monitoring has fluctuated, with no clear trend in activity or location (Table 72).

Table 72: Flight activity distribution of Sandwich tern in each breeding season (number of birds)

Baseline mid-Apr 07 – mid-Sep 07		**Horizontal Distance Band**	
		0 – 165 m	**>165m**
Vertical Height Band (m)	**>85**	0	
	30 – 85	11	
	10 – 30	110	
	0 – 10	51	

Year 1 mid-Apr 14 – mid-Sep 14		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110					4	
	12.5 – 25			1	1	13	15
	5 – 12.5	1		1	3	42	17
	0 – 5						1

Year 2 mid-Apr 15 – mid-Sep 15		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110						
	12.5 – 25				2	8	22
	5 – 12.5				7	11	12
	0 – 5					3	2

Year 3 mid-Apr 16 – mid-Sep 16		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**						
	110 – 196						
	25 – 110				1		
	12.5 – 25		3	5	9	16	9
	5 – 12.5		3	3	11	8	9
	0 – 5			42	23	13	5

Apparent avoidance behaviour was observed on just one occasion during the monitoring surveys, when a bird flying near the shoreline took action to avoid the turbine when the rotors were static (Table 73).

Table 73: Observed avoidance behaviour of Sandwich tern in each breeding season (number of birds)

Year 1	1 OTHER @ unknown distance; turbine static
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.18 Common Tern (breeding season)

Table 74: SPA/pSPA qualification relating to common tern

Forth Islands SPA	Breeding population of European importance (1997-2001 average of 334 pairs; 3% of GB population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Qualifies by supporting feeding birds from adjacent breeding colonies

Seabird Monitoring Programme data show that there have historically been more common terns nesting on the Forth Islands SPA than in recent years; however, there is also a breeding colony at Leith Docks (Imperial Dock Lock, Leith SPA) where numbers have increased since the sites were designated. The breeding numbers accounted for at both SPAs therefore appear to be stable (averaging 769 pairs between 2009 and 2013).

The Site Selection Document for the pSPA (quoting two sources) states that foraging birds feed relatively close to the breeding colonies, rarely moving to feed more than 13 km from the colony and more usually around 10 km. The location of the LDT is more than 13 km from the breeding colonies and there is therefore predicted to be very low relative usage of the area around the turbine by common terns associated with the SPA breeding colonies.

Common terns were frequently recorded in flight during the EIA baseline breeding season surveys and the subsequent operational phase monitoring surveys in the breeding season. They were very rarely recorded on the sea surface during the activity summary surveys and their activity and abundance in the passage and non-breeding seasons was also very infrequent within the survey area, therefore the comparative analysis focusses on the flight activity in the breeding season, defined as May to mid-September for this species.

3.3.18.1 *Flight Activity*

During the baseline surveys a total of 44 birds were recorded in various height bands above sea level during the breeding season. Five flights were within the rotor swept height (Table 75).

Only one flight of two birds was recorded at rotor swept height during three breeding seasons of operational monitoring, which was close to the shoreline outside the rotor swept area. The majority of flights (>98%) were seaward of the sweep of the rotors. The frequency of flight activity between the three years of operational monitoring has decreased each year (Table 75).

Table 75: Flight activity distribution of common tern in each breeding season (number of birds)

Baseline May 07 – mid-Sep 07		Horizontal Distance Band	
		0 – 165 m	>165m
Vertical Height Band (m)	>85	1	
	30 – 85	4	
	10 – 30	32	
	0 – 10	7	

Year 1 May 14 – mid-Sep 14		Horizontal Distance Band					
		Shore – RSA	RSA	RSA – 25 m	25 – 100 m	100 – 200 m	>200 m
Vertical Height Band (m)	>196						
	110 – 196	2					
	25 – 110						
	12.5 – 25			1	15	2	1
	5 – 12.5			7	11	37	6
	0 – 5			2			

Year 2 May 15 – mid-Sep 15		Horizontal Distance Band					
		Shore – RSA	RSA	RSA – 25 m	25 – 100 m	100 – 200 m	>200 m
Vertical Height Band (m)	>196						
	110 – 196						
	25 – 110						
	12.5 – 25				7	2	2
	5 – 12.5			2	4	6	8
	0 – 5			2	1	4	3

Year 3 May 16 – mid-Sep 16		Horizontal Distance Band					
		Shore – RSA	RSA	RSA – 25 m	25 – 100 m	100 – 200 m	>200 m
Vertical Height Band (m)	>196						
	110 – 196						
	25 – 110						
	12.5 – 25				1	2	4
	5 – 12.5				2	2	5
	0 – 5				2		

Apparent avoidance behaviour was observed on just one occasion during the monitoring surveys, when a bird moved horizontally away from the turbine when the rotors were static (Table 76).

Table 76: Observed avoidance behaviour of common tern in each breeding season (number of birds)

Year 1	1 HORIZ @ 100 m; turbine static
Year 2	No avoidance behaviour observed
Year 3	No avoidance behaviour observed

3.3.19Guillemot (breeding season)

Table 77: SPA/pSPA qualification relating to guillemot

Forth Islands SPA	Qualifies as part of the breeding seabird assemblage (based on 1986-1988 three year mean); nationally important population (16,000 pairs; 2.2% of the GB population)
Firth of Forth SPA	Not a qualifying interest feature
pSPA	Qualifies as part of the breeding seabird assemblage (1980-2006); more than 2,000 individuals (28,123 individuals) Further qualification as part of the non-breeding seabird assemblage (1980-2006); more than 2,000 individuals (21,968 individuals)

The largest colony in the Forth Islands SPA occurs on the Isle of May. The most recently reported count on the Isle of May in 2015 was of 21,598 individuals on land. Several thousand birds also occur on the other islands in the Forth and the Forth Islands SPA is classified as 'Favourable Maintained' condition.

Aerial surveys undertaken and reported in the Site Selection Document for the Outer Firth of Forth and St Andrews Bay pSPA show that there are wintering concentrations of guillemots in the inner estuary seaward of the Forth Road Bridge and in the waters of the outer Firth surrounding the Isle of May.

Guillemots were recorded relatively frequently using the sea surface in the survey area during the breeding season surveys during the EIA baseline surveys and the subsequent operational phase monitoring surveys. They were very rarely recorded in flight and their activity and abundance in the non-breeding season was also observed very infrequently, therefore the comparative analysis focusses on the activity summary (abundance and distribution on the sea surface) in the breeding season, defined as April to August for this species.

3.3.19.1 *Activity Summary*

Guillemots were recorded in the survey area during approximately three quarters of the surveys in surveys in the baseline breeding season period (2007); numbers were typically less than ten birds, ten birds, but there was a peak of 27 birds in May. Birds were less frequently observed and in much and in much lower numbers in the survey area in monitoring Year 1 (2014). Numbers had increased increased again in Year 2, with a peak of 38 birds recorded in the survey area in June 2015, but were 2015, but were lower again in Year 3 (2016) (

Table 78 and Chart 23).

There is no clear trend in the number of birds or frequency of use of the survey area around the around the turbine, but the number of birds in the survey area during the monitoring surveys has surveys has remained lower than that recorded during the baseline surveys, which may indicate some indicate some level of displacement from the area around the turbine (

Table 78 and Chart 23). The distance away from the turbine that birds were recorded is also difficult to interpret as there were so few birds present during Year 1 (2014) and there was no comparable pre-construction data (

Table 78 and Chart 24).

Table 78: Monthly peak-mean number of guillemot in the survey area and mean distance of flocks from the turbine during each breeding season

Period	Date range	Monthly-peak-mean number of birds	Standard Deviation of peak-mean number of birds	Weighted mean distance (m)	Standard Deviation of weighted mean distance (m)
Baseline	Feb 07 - mid-Sep 07	10.40	9.61	Not recorded	Not recorded
Construction	Feb 13 - mid-Sep 13	Period not fully surveyed			
Year 1	Feb 14 - mid-Sep 14	0.20	0.45	250	-
Year 2	Feb 15 - mid-Sep 15	8.60	16.47	438	79
Year 3	Feb 16 - mid-Sep 16	4.40	4.39	346	104

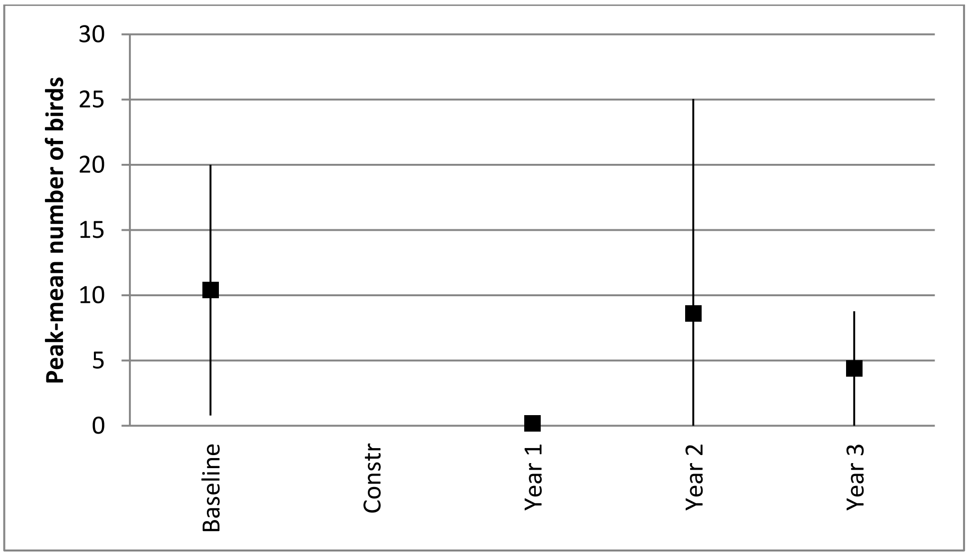

Chart 23: Monthly peak-mean number of guillemot recorded in the survey area each breeding season

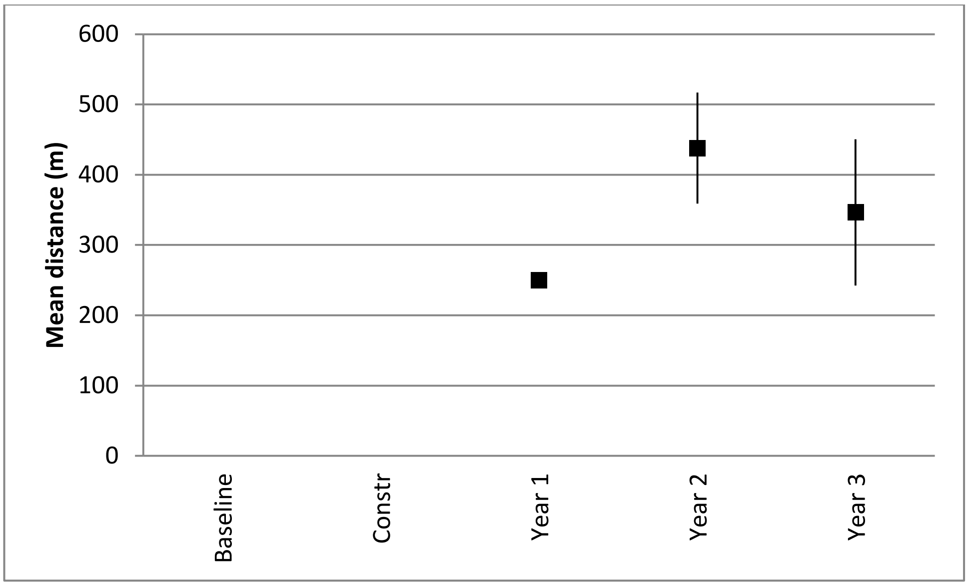

Chart 24: Mean distance of guillemot from the turbine during each breeding season

3.4 Combined Species/Seasons Account

3.4.1 Flight Activity

3.4.1.1 *Species Diversity and Abundance*

Table 79 provides a summary of the total number of flights recorded in each of the three years of operational monitoring – these do not reflect the different seasons as documented in the species accounts above, but summarise the results presented in each of the annual monitoring reports. Overall, species abundance and diversity was broadly similar across the three years of observation. The most frequently observed species were consistent between years: eider, cormorant, shag, and herring gull, although the order of their ranking varied slightly. The less frequently recorded species were also observed with relative consistency across the years.

Table 79: Total number of flights of target species recorded during Years 1–3 of operational monitoring (species with an asterisk (*) are associated with the European site designations)

Species	Year 1	Year 2	Year 3
Brent goose		1	2
Pink-footed goose*	2	2	
Mallard*	1		
Pintail			1
Teal	1		
Eider*	162	119	121
Long-tailed duck*	25	12	8
Common scoter*	8	5	1
Velvet scoter*	8	7	4
Red-breasted merganser*	6	12	3
Goldeneye*		1	
Fulmar*	17	9	21
Gannet*	33	32	131
Cormorant*	203	216	469
Shag*	474	485	276
Grey heron	3	2	4
Red-throated diver*	5		2
Black-throated diver	1		
Red-necked grebe	1		
Slavonian grebe*		2	2
Kestrel	1		
Peregrine falcon		1	
Moorhen		1	
Oystercatcher*	88	82	96
Ringed plover*	2	5	1
Turnstone*	1		2
Curlew*	11	20	10
Whimbrel	1	1	
Dunlin*	2	1	1
Redshank*	6	1	1
Razorbill*	1	1	1
Guillemot*	1	1	2
Puffin*	1		3
Mediterranean gull	7		1
Kittiwake*	15	23	27
Lesser black-backed gull*	85	46	71
Herring gull*	568	332	342
Great black-backed gull			5
Glaucous gull			1
Sandwich tern*	48	33	77
Common tern*	47	31	18
Arctic tern*	18		
Total	**1853**	**1484**	**1704**
Total species	**34**	**29**	**31**

3.4.1.2 *Spatial Distribution of Flights (all species)*

Table 80 shows the spatial distribution of all flights during the three years of operational monitoring[12]. Overall, the distribution was consistent between years with most birds flying low to the water (<5 m above sea level) and beyond the turbine structure. During Year 1, there was a slight tendency for birds to fly higher with an increased number of observations at 5–25 m above sea level). This could in part be explained by the higher prevalence of herring gull (68.5 % more than the Year 2/3 average), a species which typically flies higher than many others recorded.

Table 80: Spatial distribution of all recorded flights in Years 1 to 3

YEAR 1 (Apr14 – Mar 15)		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**	0	0	1	0	0	1
	110 – 196	1	1	1	1	1	0
	25 – 110	10	12	20	29	23	11
	12.5 – 25	61	29	65	102	67	24
	5 – 12.5	41	18	83	113	84	56
	0 – 5	23	15	209	278	255	218

YEAR 2 (Apr15 – Mar 16)		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**	0	0	0	1	0	0
	110 – 196	0	1	1	0	0	0
	25 – 110	6	3	11	14	18	13
	12.5 – 25	33	13	37	52	48	60
	5 – 12.5	13	9	25	32	47	59
	0 – 5	2	37	116	190	211	427

YEAR 3 (Apr16 – Mar 17)		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**	0	0	0	0	0	0
	110 – 196	0	1	0	0	1	1
	25 – 110	6	9	16	31	35	36
	12.5 – 25	24	30	32	43	68	64
	5 – 12.5	12	36	26	46	49	68
	0 – 5	7	123	191	215	203	331

12 Green cell shading as a visual aid and is proportionate to the number of flights: white (low) to dark green (high)

Table 81 compares the spatial distribution of all flights, combined across all three years of observations, for periods when the turbine blades were either operational or static. In total, 3,368 (66.84 % of 5,041 flights were observed when the turbine blades were static, which is likely to be a reflection of the amount of time that the turbine was static/operating during the surveys (static approximately 70 % of the observation period). There is no clear difference in the distributions of flights during these times.

Table 81: Spatial distribution of flights, Years 1–3, when turbine blades were static vs operational

STATIC		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**	0	1	1	1	0	1
	110 – 196	1	1	1	1	2	1
	25 – 110	17	18	30	58	47	45
	12.5 – 25	95	52	95	155	132	103
	5 – 12.5	41	36	107	129	126	123
	0 – 5	15	102	366	433	423	609

OPERATIONAL (moving rotors)		**Horizontal Distance Band**					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**	0	0	0	0	0	0
	110 – 196	0	1	1	0	0	0
	25 – 110	5	6	17	16	29	15
	12.5 – 25	21	19	39	42	51	45
	5 – 12.5	25	27	27	62	54	60
	0 – 5	17	73	149	251	249	372

3.4.1.3 *Avoidance Behaviour*

Table 82 shows that there were relatively few observations of discernible avoidance behaviour (i.e. flight behaviours other than 'Bullet', as defined in Table A-3; Appendix 1). The vast majority of flights in all years of observation exhibited a 'Bullet' flight path, apparently taking no avoiding behaviour towards the turbine.

Table 82: Avoidance behaviours, Years 1–3

Avoidance behaviour	**Year 1**		**Year 2**		**Year 3**	
	Number of flights	**% of all flights**	**Number of flights**	**% of all flights**	**Number of flights**	**% of all flights**
WEAVE	9	0.49	1	0.07	1	0.06
HORIZ	76	4.10	20	1.35	35	2.05
VERT	2	0.12	1	0.07	1	0.06
AVOID	9	0.49	2	0.13	3	0.18
Total*	**96**	**5.18**	**24**	**1.62**	**40**	**2.35**
BULLET (no avoidance)	1757	94.82	1460	98.38	1664	97.65

*The summation of avoidance behaviours WEAVE, HORIZ, VERT and AVOID.

Table 83 shows the spatial distribution of flights showing avoidance behaviour towards the turbine. Birds passing through the airspace close to the turbine showed an increased incidence of avoidance behaviour, whereas those observed at greater distances from the turbine exhibited fewer avoidance behaviours. Relatively low numbers of birds showed avoidance behaviour when passing through the distance band 'B' (equating to RSA), in which the turbine is located, which may be due to the generally low numbers of birds observed in this area (*cf.* Table 80).

Table 83: Spatial distribution of flights showing avoidance behaviour

		Horizontal Distance Band					
		Shore – RSA	**RSA**	**RSA – 25 m**	**25 – 100 m**	**100 – 200 m**	**>200 m**
Vertical Height Band (m)	**>196**	0	0	0	0	0	0
	110 – 196	0	0	0	1	1	0
	25 – 110	4	2	9	8	1	0
	12.5 – 25	14	5	19	10	1	0
	5 – 12.5	14	1	7	6	0	0
	0 – 5	5	15	9	17	7	2

Birds showed an apparent increase in the frequency of avoidance behaviours when the turbine blades were moving. The majority of flights exhibiting avoidance behaviour (*n* = 104; 65.0 %) were recorded when the turbine blades were moving, compared with 65 % of all flight activity being recorded when the turbine was static.

3.4.2 Activity Summary data

Data were collected on the distribution of birds alighted on the water around the turbine during the three years of operational monitoring. Overall, results were consistent between years with similar numbers of observations of birds on the sea surface (year 1: 826, year 2: 920; year 3: 686) and comparable diversity of species. Robust comparison with pre-construction data is not possible due to the differences in survey methods and survey area; however, qualitative analyses are provided in the individual species accounts.

Across the three years, 65.17 % (n = 1585) of observations occurred when the turbine blades were static, which is likely to be a reflection of the amount of time that the turbine was static versus operating during the surveys (static approximately 70 % of the observation period). Table 84 provides a comparison of mean distance from the turbine of birds (all species combined) at times when the turbine blades were static and moving. Overall, variation in the spatial distribution of birds during different periods of turbine activity is small.

Table 84: Spatial distribution of alighted birds when turbine was static and operational

Species	**Mean distance to the turbine structure (m)**		
	Year 1	**Year 2**	**Year 3**
Turbine blades static	253.5	259.3	283.1
Turbine blades moving	249.8	290.1	283.8
Difference	- 3.7 (-1.5 %)	+ 30.8 (+11.9 %)	+ 0.7 (+0.2 %)

4 CONCLUSIONS

The aim of this report is to review the monitoring data over the three years of operational surveys completed to date and to make comparisons where possible with the pre-construction baseline data. The differences in survey methods between the baseline and monitoring periods preclude the use of statistical analyses to examine more fully the potential changes in bird abundance and distribution around the turbine. However, the review of trends and comparison of data presented in this report provide a useful outline that may identify further more detailed research into the understanding of bird interactions with the turbine. This would be beyond the remit of the current project, but all baseline and monitoring data can be made available.

The flight activity monitoring has demonstrated that a very small proportion of flight activity is close to the turbine structure and very few birds were observed flying through the RSA (27 of 5,041 flights in 432 hours of observation). Those that did pass close to the turbine showed a possible increased incidence of avoidance behaviour. No collisions were witnessed. Collision risk for a turbine of this size and in this location is therefore likely to be negligible in terms of its potential to affect populations through increases in mortality.

Activity Summary surveys which counted birds alighted on the sea surface and noted their distance relative to the turbine demonstrated that birds continue to use the area within 500 m of the turbine. For some species, there was some evidence of a decrease in numbers of birds in the area around the turbine or the frequency of use of the area around the turbine, sometimes coupled with evidence that the birds tended to be recorded further away from the turbine over time. These included eider, red-breasted merganser, red-throated diver and cormorant. However, other species such as velvet scoter have been present in higher numbers in some seasons during the operational phase than during the baseline period.

There were more observations of birds (during both Flight Activity and Activity Summary Surveys) when the turbine blades were static. This is considered a reflection of the amount of time the turbine was operational, rather than a genuine change of bird behaviour in response to the operation of the turbine. The results suggest that the abundance and distribution of birds around the turbine is independent of whether the turbine blades are moving or static. Turbine blades were static for c. 70 % of the operational monitoring survey period overall; comparable to the percentage of observations when the turbine blades were static: 67 % (Flight Activity data) and 65 % (Activity Summary data). Furthermore, the data suggests that the spatial distribution of birds observed was unaffected by the operation of the turbine.

Although efforts were made to standardise the operational monitoring data by using established and recommended methods, the identification of avoidance behaviours is inherently subjective. It can be very difficult to judge birds' exact flightpaths in environments with few visual distance markers and if movements are detected, the cause of this can be hard to ascertain. By using the same observers throughout the three years of survey it is hoped that this subjectivity is minimised.

Overall, there are few notable differences between the baseline survey results and operational monitoring results. Abundance and diversity are comparable and many differences identified are considered to be within the variation of populations and not thought to be unnatural or caused by the LDT. The numbers of birds recorded during the Activity Summary Surveys was mostly consistent between the two survey periods suggesting that a high level displacement has not occurred as a result of the LDT.

Detailed spatial data for the baseline Flight Activity Surveys are not available but the information within the report[8] suggests that most flights occurred beyond the proposed turbine structure. This pattern of observation matches that of the operational monitoring surveys suggesting that the presence of the turbine structure has not significantly altered the flight distribution of birds commuting through the area.

Similarly, relatively few of the flights recorded during the baseline surveys occurred at potential collision height (73 flights; 3.50 %), a pattern repeated in the operational monitoring surveys when relatively few flights occurred at RSH.

Based on the data collected over the three years since installation of the turbine, the LDT appears to have had no clear adverse effect on the abundance and behaviour of local bird populations.

APPENDIX 1

Vertical and horizontal recording bands and avoidance behaviour definitions.

Table A-1: Horizontal distance bands

Band	Approx. Distance (m)	Description
A	Shore – RSA	The area from the shore to the turbine
B	RSA	The rotor-swept area, approx. 86 m seaward of the turbine base
C	RSA – 25	The area of the Firth within the SA that lies 0 – 25 m seaward of the tip of the rotor sweep
D	25 – 100	5 – 100 m seaward of the rotor sweep area
E	100 – 200	100-200 m seaward of the rotor sweep area
F	>200	Beyond 200 m seaward of the rotor sweep, up to 500 m seaward of the maximum rotor sweep area

Table A-2: Vertical Height Bands

Band	Approx. Distance (m)	Description
I	0 – 5	Sea level – 5 m above sea level (asl)
II	5 – 12.5	5 m asl – Mid-point between sea level and lowest rotor tip
III	12.5 – 25	Mid-point between sea level and lowest rotor tip – lowest rotor tip
IV	25 – 110	Lowest rotor tip – nacelle
V	110 – 196	Nacelle – highest rotor tip
VI	>196	Above highest rotor tip

Table A-3: Behavioural categories for the observation of bird interactions with turbines, as outlined by Meredith et al. (2002)[13]

Flight Behaviour	Description
WEAVE	Weaving flight line up to maximum height of the turbine
DIRECT	A direct flight line, through the rotor swept area, with no avoidance behaviour shown
HORIZ	A bird flying towards the turbine, which takes avoiding action by a horizontal movement (i.e. no change in height) so as to take it around the perimeter of the turbine
VERT	As for HORIZ but this time, the bird gains or drops altitude to take it over or under the sweep of the rotors
BULLET	Flight behaviour within or outside a wind farm site, which appears to take no avoiding action with regard to turbines
HIT	A recorded collision event.
AVOID	Avoidance behaviour near a turbine, generally taken at short notice, and is likely to appear as a sudden change in direction or height (or both)
OTHER	Any behaviour not easily classifiable into any of the above categories

[13] Meredith, C., Venosta, M. & Ressom, R. (2002) *Cordington Wind Farm Avian Avoidance Behaviour Report, 2002*. Biosis Research Report.

APPENDIX 8.1

SOCIO-ECONOMIC ANALYSIS

BiGGAR Economics

Levenmouth Demonstration Turbine: Socio-economic Analysis

A Report to:

Offshore Renewable Energy Catapult

7th December 2017

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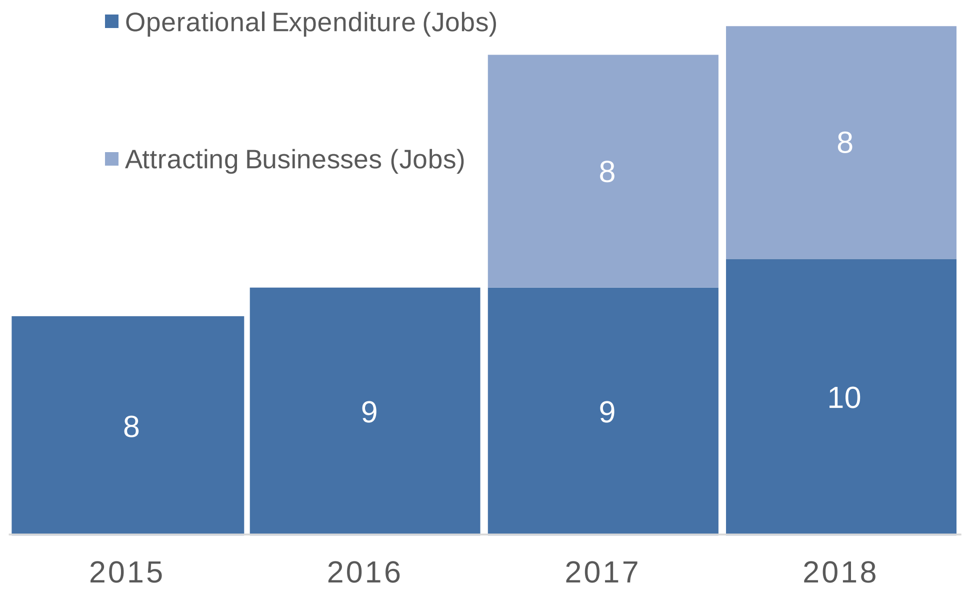
Contents Page

1 EXECUTIVE SUMMARY

The Levenmouth Development Turbine (LDT) in Fife is a uniquely accessible offshore wind turbine that forms a vital component of Scotland's industrial research and development infrastructure for the renewable energy sector. Since the Offshore Renewable Energy Catapult (OREC) acquired it, the impact of the LDT has grown through its engagements with Small and Medium sized Enterprises (SMEs), educational institutions and supply chain companies.

In 2017, the LDT **supported 17 jobs** in Fife. This is double the number of jobs that were supported in 2015, when OREC acquired the LDT. These jobs are split roughly equally between the supply chain expenditure of OREC and the businesses that have been attracted into Fife as a result of the LDT. Combined, these jobs contributed **£1.1 million Gross Value Added (GVA)** to the Fife economy in 2017.

Figure 1.1 - LDT Employment supported in Fife by Source over time



Source: BiGGAR Economics

The LDT has granted access to SMEs that work in the offshore renewable energy sector to enable them to undertake research and product development. This activity has enabled one Scottish SME to develop a revolutionary approach to offshore turbine access, which could **increase by 30%** the time that offshore turbines are accessible for maintenance**.** Innovations such as these will lead **to longer term cost reductions for the offshore wind energy sector** and the LDT enables Scottish companies to **take advantage of the opportunities** that this sector presents.

The development of the offshore wind energy sector represents a significant opportunity for both the Fife and Scottish economies. Fife is marketed as an attractive location to establish a business in this sector and the LDT is contributing to this through the skills development of the local student population. This activity has included **supporting Science, Technology, Engineering and Mathematics (STEM) engagement** at Levenmouth Academy and offering aspiring technicians in Fife College the **unique opportunity to go inside an operational offshore wind turbine.** These activities will support the students in entering positive destinations as they leave education and contribute to the attractiveness of Fife as a destination for further investment.

The LDT also contributed to the local and national economies through its development and construction. Samsung Heavy Industries invested £23.0 million during the development and construction of the LDT and this supported **126 job years and £15.2 million GVA** in Scotland, of which **38 job years and £4.7 million GVA** were in Fife.

The economic impact of the LDT is expected to continue and change over the coming years. The data is not available to meaningfully quantify future impacts. However, it is expected that as the Research and Development (R&D) activity realises its commercial potential and the students translate their enhanced education into the workplace, **the economic impacts of the LDT will grow in the future**.

2 IMPACTS TO DATE

The Levenmouth Development Turbine (LDT) has supported employment and generated economic activity in the first few years of its operations. It has done this through the:

- development and construction phase; and
- operations, maintenance and training phase.

This section quantifies some of these impacts in the Fife and wider Scottish economies.

2.1 Development and Construction Impacts

The LDT supported employment while the project was being developed and during its construction. The LDT formed part of the wider Fife Energy Park development investment and the developer, Samsung Heavy Industries (SHI) stated at the time that the LDT was part of a £100 million investment in the offshore renewable energy sector in Fife. Of this, £23 million was capital investment in the LDT.

The capital investment expenditure was split between:

- development;
- balance of plant;
- turbine; and
- grid connections.

The economic impact associated with these contracts is realised when companies are awarded these contracts and employ individuals to undertake the work.

Specifically, the civil engineering firm Graham undertook a large proportion of the balance of plant and turbine contracts, including:

- marine works;
- transport and offloading of components from quayside;
- turbine installation;
- mechanical and electrical installations; and
- all temporary works.

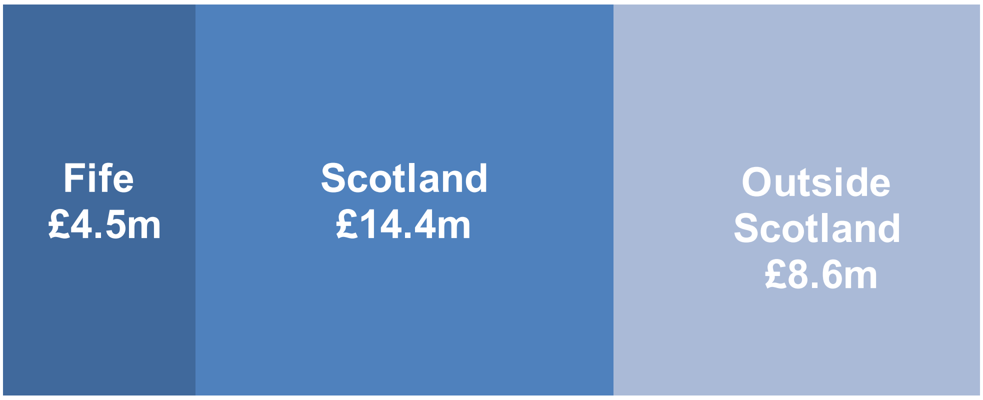
The total value of this contract to Graham was £12 million[1] and lasted for an eight month period.

The economic impact of the expenditure is dependent on the sectors in which the money is spent, and the location of this expenditure. These sector and location assumptions were taken from previous BiGGAR Economics research for RenewableUK and publically available data. Using these assumptions it was

[1] Graham Construction (2014) Samsung Prototype Offshore Wind Turbine https://www.graham.co.uk/samsung-prototype-offshore-wind-turbine (accessed 13th September 2017)

estimated that contracts worth £4.5 million were secured in Fife, £14.4 million were secured in Scotland and £8.6 million were secured outside Scotland.

Figure 2.1 - Estimated Total Capital Investment by Area



Source: BiGGAR Economics Calculations

The number of jobs that were supported by these contracts was estimated by considering the turnover to employment ratios in each of the key sectors where this expenditure occurs. The impacts are reported in job years, and are equivalent to a full years employment for one individual. It was estimated that during the development and construction phase the LDT supported 126 job years[2] in Scotland and generated £15.2 million Gross Value Added (GVA). In Fife, the contribution was 38 job years and £4.7 million GVA.

Table 2.1 – Summary of Development and Construction Impacts to date

	Fife	Scotland
Employment (Job Years)	38	126
GVA (£m)	4.7	15.2

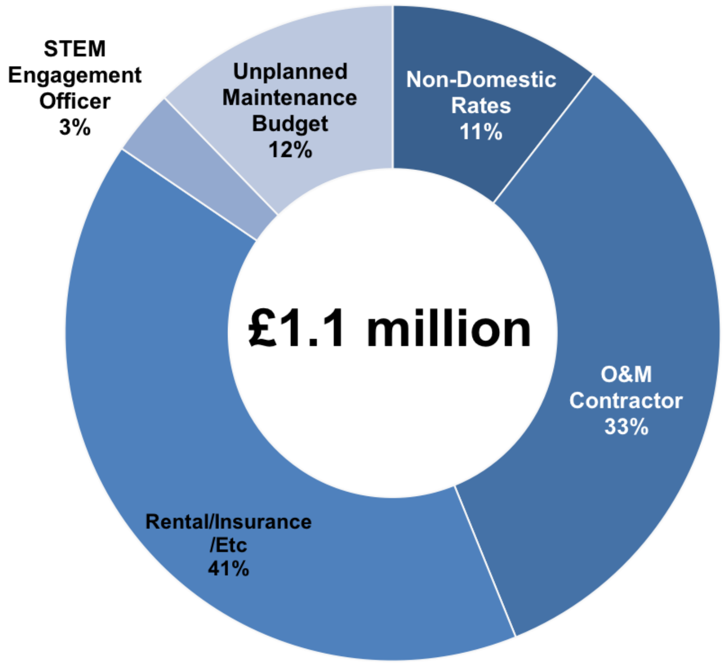
Source: BiGGAR Economics

2.2 Operations and Maintenance

The LDT also has an impact on the economy while it is operational through its expenditure on supplies and community programmes. To date, the average annual budget for the Operations and Expenditure of the Levenmouth Development Turbine has been £1.1 million. This is split between non-domestic rates, an operations and maintenance contractor, rental, insurance and other services costs and an unplanned maintenance allowance.

[2] Note that these figures are reported in job years and because the contract period with Graham Construction was less than one year, there will have been more than this number of people employed during the 8 month time period.

Figure 2.2 - Split of Annual O&M Expenditure



Source: OREC

The employment supported by this expenditure was estimated by considering the turnover to employment ratios in each of the key sectors where this expenditure occurs. For example, the revenue per head in Fife Council is approximately £42,500[3]; therefore the Non-Domestic Rates paid supported the equivalent of three jobs within Fife Council.

The employment supported in each of the areas of operations and maintenance spend are summarised in Table 2.2. This shows that the total employment supported through this expenditure is equivalent to 13 jobs.

Table 2.2 – Employment Supported through Operations and Maintenance Expenditure

	Turnover Per Job	Employment Supported	...in Fife
Non-Domestic Rates	£42,500	3	3
O&M Contractor	£132,300	3	1
Rental/Maintenance/Other	£84,600	5	3
Unplanned Maintenance	£132,300	1	0
STEM Engagement Officer	£35,000	1	1

Source: BiGGAR Economics

In addition to these jobs supported directly by the operational expenditure, there is induced employment supported by the salary expenditure of these positions. This was calculated using the data on average salaries in the renewable energy sector

[3] BiGGAR Economic calculations based on Fife Council Annual Accounts and Scottish Governments Local Authority Employment Statistics

and Scottish Government data on the proportion of household spending that is retained in Scotland. It was estimated that this expenditure would support one more job in Fife and two jobs across Scotland.

The combined economic impact of the core employees and those in the supply chain is given in Table 2.3. This includes the induced impacts associated with the spending of the salaries of those people who are directly employed. This shows each year, the operations and maintenance activities of the LDT generates £0.6 million GVA for Fife and £1.2 million GVA for the Scottish economy. It does this through supporting 15 jobs in Scotland, of which nine are in Fife.

Table 2.3 – Summary of Annual Operations and Maintenance Impacts

	Fife	Scotland
Employment	9	15
GVA (£m)	0.6	1.2

Source: BiGGAR Economics

2.3 Wider Impacts

The LDT has had impacts on companies and prospective employees that cannot be quantified in terms of GVA and employment. These are discussed qualitatively below.

2.3.1 STEM Engagement Officer[4]

The development of the local skills base is an important part of the remit of the OREC. Part of their involvement with the LDT, OREC has funded a post in Levenmouth Academy to encourage pupils to consider the possibilities of careers in STEM (Science, Technology, Engineering and Mathematics) and improve the number of pupils who progress on to positive destinations after leaving the school. The STEM Engagement Officer is working to try and get local businesses involved to show the types of opportunities that are available through STEM channels. The STEM Engagement Officer is a £35,000 per annum commitment by OREC into local skills development.

The school that was selected for the STEM Engagement Officer to be placed is a new school, Levenmouth Academy, which was formed with the merger of two nearby schools in Kirkland and Buckhaven. Levenmouth Academy has been operational for one academic year and the STEM engagement officer was in place for that full year. The school is now the second largest school in Scotland with over 1,600 pupils.

There is currently limited data regarding the positive destinations and performance of the pupils in Levenmouth Academy as only one academic year has been completed. Therefore it is not possible to quantify any of the educational benefits associated with this, however it has been recognised as leading initiative as it was awarded the 'Best Community Engagement Award' at the 2016 Green Energy Awards.

2.3.2 Further Education Support

In addition to supporting education in the Levenmouth Academy, OREC is also running more targeted education support through its collaboration with Fife College

[4] The direct economic impacts of this position are discussed in Section 2.2 and the implications of the work with the students is discussed qualitatively here.

and the Energy Skills Partnership. As part of this, renewable energy technicians trained at Fife College are offered the opportunity to go up the LDT towards the end of their course. This is a unique programme, as access to offshore wind turbines is not easy and usually requires a time-consuming journey and downtime for the turbine.

In the last year, 18 students were offered the opportunity to visit the turbine and climb to the nacelle; 16 took advantage of this opportunity.

OREC is also working with Heriot Watt University (HWU) and the Energy Skills Partnership to deliver an Immersive Hybrid Reality Turbine (IHR). With this technology the students are able to wear Oculus Rift goggles to explore the inside of the turbine. This will enable a larger number of students, in Fife and further afield, to experience the turbine environment, without the costs and risks associated with physical access.

The advance in the technology brought in from HWU is that the students will also be able to partially see their own hands and classmates, as well as the turbine. To their knowledge, this is the most advanced IHR system of its kind.

This is primarily used in the college to contribute to the training of future wind energy professionals, however there is also a mobile version of the IHR, which has toured at Science Events and in schools. This has allowed over 2,000 people to experience it.

2.3.3 Promoting Research and Development in Renewable Energy

The OREC team at the LDT is undertaking its own research that will support the knowledge and understanding of the sector as a whole. OREC will be working on the Clone of Levenmouth Offshore Wind Turbine (CLOWT). This involves putting sensors on various parts of the turbine, including the blades, the core and the tower. This allows real time measurements to be taken on how the turbine is operating under the various strains. Despite the obvious benefits from understanding the reaction of the turbine to its environment, this is rarely done and most stress data is taken from calculations. The measurements that this will generate could have a significant impact on the long term cost off offshore wind energy, for example by reducing the amount of steel that is used in the turbines.

2.3.4 Proving Technology

The LDT site also serves an important function as a testing facility, providing an opportunity for companies to experiment with new technologies and innovations. The LDT offers companies and small businesses the unique environment of an offshore wind turbine, within an easily accessible shoreline location.

For example, Limpet Technology, a Scottish SME who specialise in height safety and industrial access solutions, has worked with the LDT to develop a revolutionary product that will allow them to enter and impact on the offshore wind energy sector operations and maintenance market through the development of a new offshore personnel transfer system. Limpet Technologies are an award winning Scottish R&D and Engineering company who manufacture safety devices to allow safe working at height. Prior to their engagement with OREC and the LDT their focus was on theatre riggings, met masts and onshore wind turbines.

Limpet Technology are currently developing a product that will improve the current methods by which turbine technicians transfer from the boat to the turbine, in order to undertake repair work while at sea. The most popular current method of transferring people between the two is via a ramp that is attached to the boat.

However, this mechanism only allows transfers to take place in sea swells of less than 1.5 meters. However, because offshore wind turbines are positioned far out at sea, sea swells are greater than 1.5 meters 45% of the time and therefore there are significant delays and cost implications as operators wait for seas to calm before undertaking their maintenance.

Limpet Technologies answer to this problem is a laser guided winch, attached to the turbine that allows the technician to be safely transferred between the boat and the turbine in seas swells of up to 3 meters. This increases the potential access window for offshore wind turbines from 50% to 80% of the time. This is a significant development and will help to reduce the long term operational costs of offshore wind, contributing to the technologies competitiveness.

Limpet Technology has been able to test out the different iterations of the product at the LDT and invite potential clients to come and visit the site to see their technology in action. Without the access to the LDT, Limpet Technology would have been forced to take a large risk by approaching a potential client to gain permission to undertake testing offshore. This would have been a much more expensive development model and would have forced the technology to be developed under the supervision of a client. Access to the LDT has been greatly beneficial for both their ability to develop the technology and make it commercially successful.

The LDT is opening up to other companies who are keen to prove and commercialise their technology and innovations on an easily accessible offshore wind energy turbine. Whilst OREC is fitting the sensors required to complete the CLOWT, other companies will be given access to the turbine in order to test their sensor technologies. There were 50 entries into a competition of which seven have been selected to gain access to the turbine, five from the UK and two from overseas. The access to the turbine will be free for those companies based in the UK.

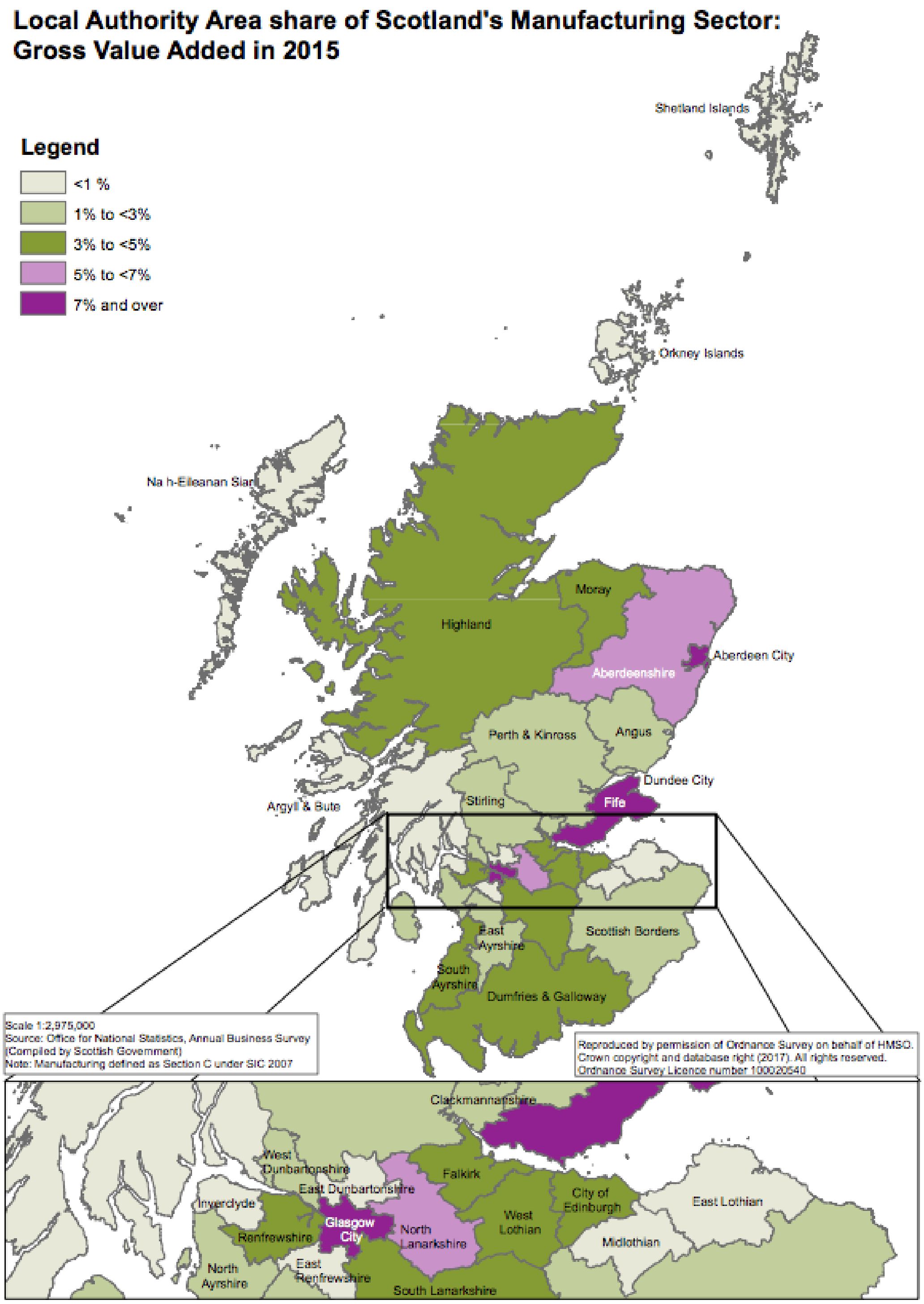
Quantifying the future economic impacts associated with these technologies would be purely speculative at this stage. However, access to such testing facilities is a significant hurdle for companies, particularly SMEs, as they work to validate and gain confidence in their product.

All development work undertaken at the LDT is focused on ways to reduce the costs associated with offshore wind energy. Therefore in addition to the benefits with for the companies that develop cost saving products, there will be wider implications for the renewable energy sector as it becomes more competitive, prolific and attractive to investors. Recent contracts awarded to offshore wind projects as part of the Contracts for Difference programme have shown a significant cost reduction over the past few years. This is in part due to innovations in operations and maintenance that have reduced the long term costs associated with this form of energy.

2.3.5 Attracting companies to Fife

Fife is a leading region within the Scottish manufacturing sector and the largest contributor to the Scottish Manufacturing GVA. The sector in Fife generated £1.3 billion GVA in 2015, up from £1.0 billion GVA in 2010. In this time period the number of manufacturing companies in Fife has increased by 14%, from 590 companies in 2010 to 672 in 2015. Over this time period the number of manufacturing businesses in Scotland has increased by 10%, therefore Fife has performed better than the Scotland as a whole in attracting new and existing manufacturing businesses.

Figure 2.3 - Local Authority share of Scotland's Manufacturing Sector



Source: Scottish Government (2017) Scottish Annual Business Statistics 2015

The LDT is one of the 'Pull' factors that are supporting Fife's success as a manufacturing base. The LDT is presented as an attractive asset by Invest in Fife in the brochure "Locating your Offshore Wind business in Fife"[5]. The industry backed wind turbine technician apprenticeship programme, which is supported by

[5] Invest in Fife (2014) Locating your Offshore Wind Business in Fife

the LDT is also highlighted because this shows the offshore wind skills base that exists within Fife.

One of the manufacturing companies that has moved to Fife as a result of the presence of the LDT, is Limpet Technologies, previously discussed in Section 2.3.4. In 2017, Limpet Technologies relocated their main operations from Edinburgh to Fife in order to be closer to the LDT. This move has brought in eight, high value manufacturing jobs into Fife. Limpet Technologies is a growing SME and it is likely that the eight jobs will grow as the company moves from the R&D phase of its offshore wind technology to the production and sales phase.

2.4 Summary of Impacts to Date

The LDT supports 17 jobs in Fife and generates £1.1 million GVA. This impact is split roughly equally between the supply chain expenditure of OREC and the businesses that have been attracted into Fife as a result of the LDT.

Table 2.4 – Summary of Annual Operational Impacts beyond 2018

	Fife	Scotland
Supply Chain (Jobs)	9	15
Attracting Businesses (Jobs)	8	-
Total Jobs	17	15
Supply Chain GVA (£m)	£0.6m	£1.2m
Attracting Businesses (£m)	£0.6m	-
Total GVA (£m)	£1.1m	£1.2m

Source: BiGGAR Economics

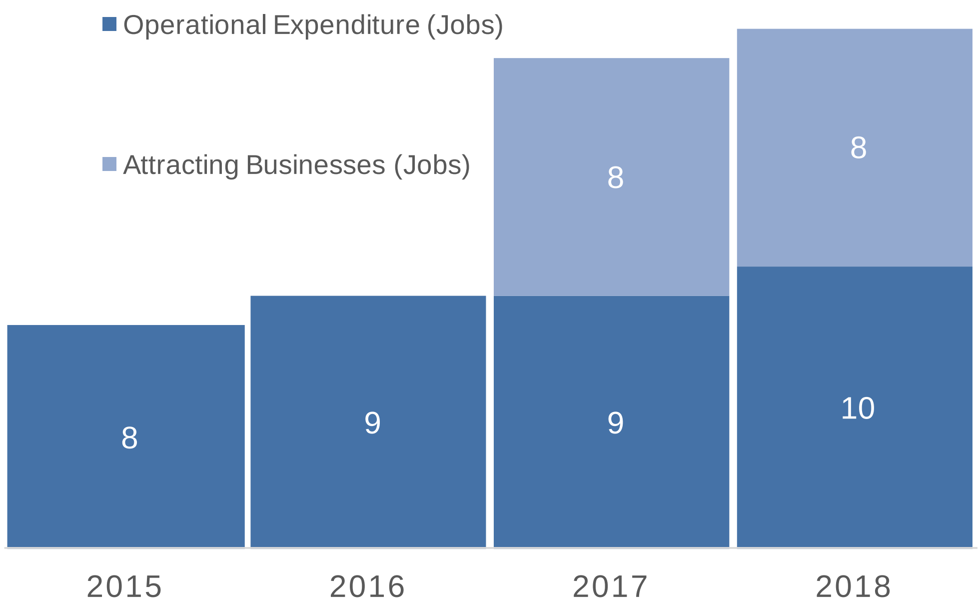
3 FUTURE IMPACTS

The LDT will continue to have an impact on the Scottish economy from its operation as a testing and training facility and the interaction that it has with the community.

The quantifiable economic impacts associated with the on-going operations and maintenance will continue as long as the site remains operational. In estimating these impacts, it was assumed that future operations and maintenance expenditure would be at a similar level to the annual expenditure to date. Therefore, the operations and maintenance expenditure is expected to continue to support at least nine jobs across Fife.

In addition to the jobs supported by the operating expenditure, the LDT has plans to recruit an additional full-time member of staff to be onsite. The purpose of this role will be to support the project work that will be undertaken at the LDT. Therefore in 2018, there will be 10 jobs supported directly by the operation of the LDT.

Figure 3.1 - LDT Employment supported in Fife by Source over time



Source: BiGGAR Economics

As is shown in Figure 3.1, the employment supported in Fife has grown since the OREC acquired the LDT in 2015. The majority of this growth has been as a result of the businesses that have been attracted to Fife due to the presence of the LDT. This is the area in which any future growth in employment impacts is expected, however at this stage it is not possible to speculate how much growth there shall be in this area.

Over the ten-year time period being considered for consent, the LDT will make a significant contribution to the Fife economy. The annual impacts are expected to grow, however if current activity levels are maintained the LDT will generate **£11.5 million GVA for the Fife economy** and contribute at least **£1.1 million to Fife Council** through the payment of Non-Domestic Rates.

Table 3.1 – Cumulative impacts in Fife over 10 years – based on current activity levels

	Fife
Non-Domestic Rates	£1.1 million
GVA	£11.5 million

Source: BiGGAR Economics

The main future impacts will arise from the impact that the LDT will have on the sustainability of the offshore wind energy sector. The economic opportunities that could be created by this sector are significant[6]. In order to realise these opportunities, the sector needs to continue to pursue research and development in all areas that could bring down the long-term costs. Research infrastructure, such as the LDT, will be vital in ensuring that the industry can become cost competitive and therefore sustainable.

Recent Contracts for Difference awarded to offshore wind energy projects have stimulated billions of pounds of investment. These projects were awarded at competitive prices as a result of the R&D the sector has undertaken in areas such as turbine design and operations and maintenance efficiency[7]. This includes improving efficiencies in vessel to turbine transfers, which has been one of the active areas of research at the LDT. It is through this activity that the full impacts of the LDT will be realised.

[6] Green Investment Group (June 2015), UK Offshore Wind: Opportunities for Trade and Investment

[7] Douglas Fraser (September 2017) Blowing Away Costs, BBC, accessed http://www.bbc.co.uk/news/uk-scotland-scotland-politics-41236734