Methil Offshore Demonstration Wind Turbine

Environmental Statement

Non Technical Summary

March 2010

2-B Energy

arcus

PREFACE

This document is the Non Technical Summary of the Environmental Statement (ES) which accompanies the application by 2-B Energy to Scottish Government to develop an offshore wind turbine prototype on the northern shore of Firth of Forth, Scotland.

The Environmental Statement (ES) has been prepared by Arcus Renewable Energy Consulting Ltd on behalf of 2-B Energy and comprises the following:

- Environmental Statement Volume I containing the written statement;
- Environmental Statement Volume II containing the figures; and
- Environmental Statement Volume III containing the technical appendices.

A printed copy of the ES with its Technical Appendices costs £200. In addition, all documents are available as Adobe Acrobat Files on DVD ROM for £15. Copies of the Non Technical Summary are available free of charge.

Copies of the ES may be obtained from:

Arcus Renewable Energy Consulting Ltd.

507-511 Baltic Chambers

50 Wellington Street

Glasgow

G2 6HJ

The public can view the ES during normal office hours at the Scottish Government Library at Saughton House, Broomhouse Drive, Edinburgh, EH11 3XD. The ES is also available for viewing by the public during normal opening hours at the following locations:

- Buckhaven Local Services Centre, Buckhaven Local Office,1 College Street, Buckhaven, Leven, KY8 1AB
- Methil Local Services Centre, Methil Library, Wellesley Road, Methil, Leven, KY8 3PA
- Fife Council, Development Services, Forth House, Abbotshall Road, Kirkcaldy, KY1 1RU

Comments on the application for consent (Section 36 application) should be forwarded to the address below;

Scottish Government

Energy Consents Unit

4th Floor

5 Atlantic Quay

150 Broomielaw

Glasgow

G2 8LU

Or by email at: energyconsents@scotland.gsi.gov.uk

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1 NON-TECHNICAL SUMMARY

1.1 Introduction

This Non-Technical Summary (NTS) forms part of an Environmental Statement (ES) to accompany an application to Marine Scotland for planning permission under the section 36 of Electricity Act 1989[1] by 2-B Energy ("the Developer") to develop an offshore wind turbine prototype on the northern shore of Firth of Forth, Scotland.

The Methil Offshore Demonstration Wind Turbine (hereafter referred to as "the Development") is located approximately 20 m offshore from Fife Energy Park, Methil as shown on Figure 1.1. The Development involves installing and testing a new concept offshore wind turbine that consists of a two-bladed turbine on a steel lattice tower.

The Development will comprise of:

- A single, two-bladed demonstration wind turbine with an installed capacity of approximately 6 MW. The turbine tower is 120 m (including the subsea tower section), with a rotor diameter of 130 m giving a maximum height from the turbine base to turbine tip of 185 m;
- Bridge connection between the site and turbine tower;
- Construction of crane hard-standing;
- Relocation of a lighting tower and installation of anemometry equipment; and
- Construction of one onshore control and monitoring building.

The proposed layout of the Development is shown on Figure 1.2.

Owing to the scale and nature of an offshore wind farm, an ES has been prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended) ("The EIA Regulations")[2].

The ES considers the environmental and socio-economic effects during the two phases of the Development, including:

- Site preparation and construction of the Development; and
- Operational period for up to 5 years.

After a maximum period of five years, during which the turbine components will be tested, the turbine will be dismantled and relocated to an offshore location. However, this will be subject to a separate development process.

This NTS presents a summary of the principle findings reported in the ES.

1.2 Developer

2-B Energy is an active offshore wind energy company based in Hengelo, Netherlands that was founded in 2007. 2-B Energy, together with a reputable network of key partners in the industry, has developed an innovative, new design for offshore wind turbine. The low-cost, holistic concept includes differentiating designs for the rotor, nacelle, support structure and electrical system. The Methil Offshore Demonstration Wind Turbine project is the testing and certification of the first prototype of this concept. For more information, please refer to the website http://www.2-benergy.com/

1.3 Renewable Energy Overview

Energy underpins virtually every aspect of the economy and society. However, the use of fossil fuels such as gas and coal, which currently provide the bulk of our energy, release

[1] *The Electricity Act 1989*. OPSI, London
[2] *The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 ("The EIA Regulations"),* OPSI: London

greenhouse gases, such as carbon dioxide (CO_2) into the atmosphere which directly affects our climate. In order to help lessen the effects of climate change, greenhouse gas emissions must be reduced. One way of helping to achieve this is by generating energy from sources that emit low or even zero levels of greenhouse gases, such as from wind, waves or tides.

The UK has the largest potential wind energy resource in Europe[3]. The UK Renewable Energy Strategy states that wind power is currently one of the most developed and cost-effective renewable electricity technologies. While offshore wind is more technologically challenging and more expensive than onshore wind, it has a larger potential due to a stronger and more consistent wind resource out to sea, leading to higher power outputs per turbine and more hours spent generating each year[4]. The UK currently leads the world for installed offshore wind capacity[5]. However, the newest wind turbines, built as part of Crown Estate's Round 3 Offshore Wind Development, will be built further offshore than ever before and new technologies are needed to meet the more challenging environments found in these locations.

UK Government policy has long recognised the role for renewables in meeting our energy and climate change goals. The main legislation and subsequent strategy that currently guides the UK renewable energy generation are stated below.

The United Kingdom is committed to reducing greenhouse gas emissions by 12.5% from 1990 levels by 2008-2012 as part of the Framework Convention on Climate Change (the Kyoto Protocol)[6].

The Climate Change Act[7] was passed into law on 26 November 2008. The introduction of this Act intends to improve carbon management in the UK, establish the move towards a low carbon economy and demonstrate the UK Government commitment to improve the causes of global climate change. This Act seeks to reduce the greenhouse gas emitted by 80% by the year 2050 against a 1990 baseline figure. This makes the UK the first country in the world to establish such a legally binding long-term and significant carbon reduction target.

Following the recent 15th Conference of Parties (COP 15) to Kyoto Protocol held at Copenhagen in December 2009; a Copenhagen Accord was agreed between the nations to move towards immediate global action on climate change. UK re-iterated its commitment to reduce emissions by at least 34% by 2020 and aspires that together with the European Union a target of 30% cut in emissions by 2020 is reached[8].

The Renewable Energy Strategy 2009 (RES) (part of the Government's Overall UK Low Carbon Transition Plan) outline why and how the UK needs to increase the use of renewable electricity, heat and transport. It sets out a path to achieving the UK's legally binding target to ensure 15% of energy comes from renewable sources by 2020[9].

1.4 Scottish Overview

The Scottish Government is committed to promoting the increased use of renewable energy sources to tackle climate change and to support economic growth in Scotland.

The Climate Change (Scotland) Act 2009, creates a long-term framework for the current and successive administrations in Scotland to ensure a reduction in Scottish greenhouse gas emissions by 80 per cent by 2050 with an interim milestone of 42% by 2020[10].

[3] Sustainable Development Commission (2005) *Wind Power in the UK*
[4] DECC (2009) Renewable Energy Strategy, London: TSO
[5] ibid
[6] http://www.defra.gov.uk/environment/ climatechange/internat/un-kyoto.htm [Accessed 4th March 2009]
[7] *Electricity Act 1989*. OPSI: London.
[8] DECC (2009) *Copenhagen Outcomes* [online]. Available at http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/copenhagen/copenhagen.aspx [Accessed on 21/01/2010]
[9] DECC (2009) Renewable Energy Strategy, London: TSO
[10] *Climate Change (Scotland) Act 2009*, OPSI: London.

Targets have since then increased to supply 50% of Scotland's electricity demand from renewable sources by 2020, and an interim milestone of 31% by 2011. Ministers emphasize that they want to see targets exceeded and not merely met[11].

In July 2009, the Scottish Government published a Renewables Action Plan (RAP)[12] that sets out a framework for action for the next 24-36 months. The plan implements the above national targets by setting out a strong commitment to support and accelerate the implementation of renewable energy. The action plan emphasises that offshore wind development *'will be a key policy focus in the short to medium term, not only for its generation potential, but also in terms of manufacturing and infrastructure opportunities.'*

These objectives and opportunities are a very good fit for the 2-B Energy Demonstration Project. The project in particular is in line with the following policies that are delivered to focus on the following objectives set out in the RAP:

- *"Developing, welcoming, and enabling the strong overseas interest and investment in the Scottish low carbon economy; and*
- *Promoting innovation through Research, Development, Demonstration and Deployment (RDD&D)."*[13]

2 ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment (EIA) is a process intended to ensure that developments with potentially significant effects on the environment are granted permission only after full consideration of the likely environmental effects has been made and suitable prevention or management measures have been identified. This ES provides information to allow Scottish Government to fully consider the environmental effects of the Development prior to granting consent to the planning application.

2.1 Consultation and Scoping

The aim of the Scoping process is to identify key environmental issues at as early a stage in the process as possible, to determine which elements of the proposal are likely to result in significant effects on the environment and to establish the extent of survey and assessment required for the EIA.

A Scoping Report was prepared which outlined the proposed scope of the EIA, the key issues to be addressed, along with a description of the Development. The Scoping Report was issued to Scottish Government and other statutory consultees in December 2009. In addition, recreational sailing clubs and other fishing associations were also consulted during the EIA process. Consultations with other local fishing and recreational groups will continue throughout the Development. The ES was prepared with regards to the scoping opinion.

As a part of wider consultation process, a public information day is planned to take place prior to the submission of the planning application, to inform the residents in the area surrounding the Development. The public information day will present information related to the Development, the EIA process undertaken and the likely planning timeframe. Local communication and consultation initiatives are planned to continue during the application determination period with the public.

[11] Scottish Government (2009) *Renewables Policy* [online], Available at (http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17612/) [Last accessed on 18/01/10].
[12] The Scottish Government (2009) *Renewables Action Plan*, Scottish Government: Edinburgh, online. Available at (http://www.scotland.gov.uk/Publications/2009/07/06095830/0) [Last accessed on 18/01/10]. Pp. 12
[13] Ibid

2.2 The Scheme

The Development is a key part of 2-B Energy's strategic development plan to deliver offshore wind installations with a large significant reduction in the 'cost of energy'. This first prototype is the first stage of a larger demonstration scheme that is proposed in two phases:

- Phase 1 - near shore 1st turbine (approximately 20 m offshore) on a 5 year building permit with onshore grid connection system;
- Phase 2 - offshore 2nd turbine and relocation of the Phase 1 turbine to a second offshore location after five years operation.

This application refers only to Phase 1.

2-B Energy is developing wind turbine technology for application to the global offshore wind market. The development of 2-B Energy's prototype system includes the manufacture, assembly and installation of a full scale 6MW turbine and the use of an electrical grid system with variable grid frequency. The demonstrator scheme, effectively a proof of concept, requires the turbine to be connected to the electrical grid system.

The target market for commercialisation of the 2-B Energy technology is the UK Offshore Round 3. Assuming the demonstration project is successful then the aim is for serial production of the turbines in a UK facility, to meet the anticipated timescales for Round 3 installation in 2014/2015.

As a result, this Development can play a key role in development of Scotland's Renewable Energy Infrastructure and provide a long term economic benefits.

2.3 The Proposed Development

The turbine tower is 120 m (including the subsea tower section), with a rotor diameter of 130 m giving a maximum height from the turbine base to turbine tip of 185 m from the sea bed. Approximately 179 m of the turbine will be visible above the Mean High Water Springs (MHWS) mark. The turbine will be fixed to a steel tubular lattice structure which will provide the foundation and tower as a continuous structure without transition pieces. Figure 1.3 shows the turbine arrangement.

The turbine is a downwind turbine, meaning that the nacelle faces away from the wind and the blades are on the downwind site of the tower. The blades will be manufactured from fibre-reinforced epoxy. As the blades will be downwind from the tower they can be made to be more flexible and lighter than those of a similar sized 'standard' wind turbine.

The turbine would be of variable speed, so that the turbine rotor speed varies according to the energy available in the wind. The rotor speed varies between 5 and 13.25 revolutions per minute, dependant on the wind speed. The turbine will generate electricity in wind speeds between 4 and 25 m/s (9-56 mph or force 3-10 on the Beaufort Scale). At the cut-out wind speed the turbine will shut down for self protection.

The nacelle houses the gearbox and generator and is mounted on the steel lattice tower. The tower will have three or four legs strengthened by diagonal crossbeams. The number and frequency of any horizontal cross beams has been minimised to discourage birds roosting on the tower.

The lower section of the tower would be constructed so that boats servicing the turbine can dock safely within the lattice structure of the tower. Therefore, allowing equipment, replacement parts or machinery to be hoisted up the central column directly from the craft below.

Access to the demonstration turbine would be gained via a bridge structure which will provide for permanent access between the shore and a platform on the turbine tower.

The finish and colour of the nacelle and blades is likely to be a minimum reflective, semi-matt pale grey.

Lighting and marking requirements for the purposes of navigational safety have been taken into account as advised by relevant organisations.

The Development will require a connection to the grid to allow power produced by the turbine to be exported from the site. The wind turbine will be connected to the national grid via an existing 33 kV underground supply which currently supplies power to the Fife Energy Park. The connection to the project transformer station will be routed underground from the existing termination which is approximately 400 m from the turbine location. Discussions are currently ongoing with the Scottish Power, the grid operator and Scottish Enterprise, the landowner, with regard to details of the connection and route across the site.

2.4 Policy Context and Legislation

A consent is being sought for the building an operation of the demonstration wind turbine to the Scottish Government under section 36 of the Electricity Act 1989. Fife Council is a Statutory Consultee and regard must be given to the local Development Plan. However, all aspects of the development including both onshore and offshore works will be determined by the Scottish Government.

2.5 Landscape and Visual Assessment

An assessment of landscape and visual effect has been carried out with potential landscape and visual effects arising from the proposed Development. The landscape and visual assessment for the Development assesses the following effects:

- Effects on the landscape fabric of the Demonstration Turbine site;
- Effects on the wider landscape character;
- Effects on areas designated for their particular landscape value or special interest;
- Effects on views and viewers; and
- Cumulative effects.

The objective of the assessment has been to identify what the significant effects of the wind turbine will be on the landscape and visual resource. The significance of an effect on identified landscape and visual receptors is judged against those factors which combine to determine the sensitivity of each receptor and the magnitude of effect. A high level of significance is usually attached to large-scale effects on sensitive or high value receptors.

A *significant effect* will occur where the combination of variables results in the Development having a material effect on a landscape or visual receptor, so that the landscape character or view becomes defined by the presence of the Development. A *not significant effect* will occur where the effect of the Development is not definitive and the landscape or visual receptor will continue to be defined principally by its baseline characteristics. In this instance, the Development may have an influence on the receptor and may alter its characteristics, but this influence will not be definitive.

The assessment has been carried out within a study area extending to a radius of 15 km from the turbine position. The study area has been determined from site visits and a range of computer generated graphic material which suggests this is the maximum radius within which a significant effect is likely to occur for the height of the proposed turbine.

Assessment of cumulative effects considers wind farm developments that are within a 30 km radius of the wind farm site to take account of areas within the Development Study area which may have visibility of other wind farms beyond the study area boundary.

The assessment has concluded that there will be significant effects on the following landscape types and visual resources of the study area:

- Wemyss unit' of the 'Coastal Hills' landscape character type, extending for a distance of about 5 km south-west of the Demonstration Turbine;
- 'Mid-Leven Valley unit' of the 'Lowland River Basins' landscape character type, extending for a distance of about 5 km west of the Demonstration Turbine;

- 'Largo Law unit' of the 'Lowland Dens' landscape character type, extending for a distance of about 5 km north of the Demonstration Turbine;
- A section of Fife Coastal Walk, between West Wemyss and Lower Largo, covering a total distance of about 12 km; and
- Local views from a small number of individual houses, farmsteads and roads, primarily to the west and north of the Demonstration Turbine, extending for a distance of about 5 km

Local views from a small number of individual houses, farmsteads and roads, primarily to the west and north of the Demonstration Turbine, extending for a distance of about 5 km.These effects are confined to the close vicinity of the Demonstration Turbine and will be 'short term', limited to a period of no more than 5 years. The effects will also be 'reversible' as the Demonstration Turbine will be relocated to an alternative off-shore location at the end of this period. Beyond those significant effects identified above, the Demonstration Turbine is likely to have an effect on some of the other landscape character areas or views within the study area but these are not judged to be significant.

The cumulative assessment concludes that the Development will not result in any significant cumulative effects as the addition of a single turbine will not increase the wind farm influence overall.

Whilst those significant effects will result in material alterations to the localised landscape and visual resource in the vicinity of the Demonstration Turbine, it is considered to be acceptable in the broader context. This is due to a number of factors that relate to both the Demonstration Turbine and the landscape setting within which it will be seen.

A major factor is the single turbine proposed, which ensures it will be seen from fewer locations and will only occupy a small proportion of available views, despite its size. Other factors include the medium to large-scale and predominantly horizontal nature of the coastal landscape in which the Demonstration Turbine will be seen, which avoids awkward scale comparisons and ensures the Demonstration Turbine will appear as a minor component in views; the vegetated and built-up nature of parts of the study area, which limits visibility; the absence of significant effects on landscape-related planning designations; and lack of significant cumulative effects. For local residents there is also a certain familiarity between the Demonstration Turbine and the sight of large-scale structures associated with the off-shore oil and gas industry that are manufactured and repaired at Methil.

2.6 Noise

An assessment of noise during operation of the Development has been carried out in line with relevant guidelines (ESTU-R-97 *The Assessment and Rating of Noise from Wind Farms*) and in consultation with Fife Council's Environmental Services department.

The nearest noise sensitive locations have been identified and measurements of the existing levels of background noise made at 3 locations representative of these. The results of this survey have been used to define limits on the acceptable levels of wind turbine noise for daytime and night-time. Theoretical noise emission levels have been established for the proposed turbine design and used to predict the resulting noise levels at the nearest noise-sensitive locations. These have then been assessed against the noise limits and were found to comply with requirements. Notwithstanding this, due to the theoretical nature of the assumed noise emissions, potential mitigation measures that could be employed in the event of noise problems occurring have been identified.

Noise during construction of the Development and the relocation of the turbine to an offshore position at the end of its five-year testing and certification process will be addressed through the application of planning conditions restricting hours of working and the use of good practice measures.

2.7 Ecology

An assessment of the potential effects of the proposed Development on ecology was conducted using data gathered from existing sources and a field survey. The field survey was

carried out to identify the habitats on the site and the potential of them to support notable species such as otter. The main impacts that were considered in the assessment were the loss or change of habitats during construction of the Development, and noise disturbance due to the construction and operation of the turbines.

The habitat survey recorded a patchwork of bare ground and short vegetation across the majority of the onshore areas with very limited potential to support notable species. The coastal areas were dominated by man-made sea defences which therefore supported very few habitats. The habitats of both the onshore and coastal areas were assessed as being of negligible value and no significant effects on them have been identified.

The nearby Firth of Forth Site of Special Scientific Importance (SSSI) supports important estuarine and coastal habitats, but none of these are present within the development, and the methods used in the construction of the development will minimise the risk and impacts of pollution. Therefore, no significant impacts on the SSSI have been identified.

The potential of the coastline to support otter was specifically assessed during the field survey. The poor quality habitats combined with disturbance from nearby industrial activity and coastal defence works suggest that otter is very unlikely to be present and so no significant impacts to this species are predicted.

The potential impacts of the Development on offshore habitats and species were also assessed. None of the marine animals (including fish, seals, dolphins and whales) recorded in the Firth of Forth are strongly associated with the local area. In addition, it is considered very unlikely that the short-term and low-intensity noise generated during both construction and operation would impact these species. Therefore, no significant impacts on the marine animals have been identified.

There are no other developments in the area in combination with which the proposed Development could cause significant impacts. Overall the development site is of low sensitivity with respect to habitats and protected species and sites, and no significant effects are predicted.

2.8 Ornithology

The assessment has considered and evaluated the potential for the Development to have impacts upon ornithological interests in the local and wider area. Wind energy developments can have effects on bird populations as a result of the construction, operation and decommissioning of the development. Birds may be affected by:

- The loss or change of habitats to accommodate the Development;
- Disturbance due to construction/decommissioning or the presence and operation of the turbines;
- Acting as a barrier to regular movements of birds; and
- Collision with the rotors.

The scoping process highlighted that the key issue was the potential for effects on waterbirds and seabirds associated with internationally important sites designated as Special Protection Areas (SPAs) in the region: the Firth of Forth and the Forth Islands.

Baseline studies were carried out between September 2006 and September 2007 to quantify the use of the site and surrounding area by birds, and to assess the risk of bird collision with the turbine rotors. The species of nature conservation value that were present at the site and considered in detail in the assessment included:

- Eider
- Long-tailed duck
- Red-throated diver
- Fulmar
- Gannet
- Cormorant
- Shag

- Peregrine
- Oystercatcher
- Kittiwake
- Herring gull
- Lesser-black-backed gull
- Sandwich tern
- Common tern

Several other species, including qualifying species associated with the SPAs were observed during the surveys, but were recorded so infrequently the potential for anything more than negligible impacts on those species' populations is extremely unlikely.

Displacement of small numbers of eider, long-tailed duck, red-throated diver, cormorant, shag, herring gull and lesser black-backed gull may occur. It was concluded that this would not result in any significant impacts on their populations because the number of birds affected was very small and more suitable habitats to accommodate displaced birds was abundantly available.

There may be a barrier to the normal movement of small numbers of birds along the coastline. This would mostly affect eider, cormorant and oystercatcher and to a lesser degree, shag, Sandwich tern and common tern. These species making movements along the coastline may be forced to fly around the turbine, having energetic consequences for the individual birds, potentially affecting their ability to survive. It was concluded that this effect would not result in any significant impacts on their populations because the number of birds affected would be low and the scale of the Development is very small, having inconsequential effects on their survival.

There is a very low risk of collision to fulmar, gannet, cormorant, shag, oystercatcher, kittiwake, Sandwich tern and common tern. The collision risk would not increase overall mortality by more than 1% for the SPA qualifying populations of any of these species, resulting in the conclusion that collision risk to birds is not significant.

There is a small risk of collision to peregrines that have been observed near the Development. The risk was judged to be very low and the effects of the Development on the peregrine population are not significant.

The potential effects of the Development on birds were considered in combination with the consented Hydrogen Office turbine to the north-east. The Development contributed very little to the cumulative impact and no significant in-combination effects are likely to occur.

Mainly because of the small-scale of the Development and its location in a part of the Firth of Forth that is not important for birds, it is concluded that the potential impacts of the Development on birds are not significant and that the integrity of the Firth of Forth SPA and Forth Islands SPA would not be adversely affected.

2.9 Water Resources and Coastal Hydrology

The assessment has been based on a detailed desk study, walkover, and consultations with a range of organisations, including Fife District Council, The British Geological Survey and the Scottish Environment Protection Agency.

No onshore surface water features, such as burns or drainage channels, exist within 500 m of the Development.

Only one hydrological designation exists within 2 km of the Development: Firth of Forth SSSI, which lies directly adjacent to the Development. No effects are predicted on this designation.

The strong flood and ebb currents, with maximum velocities of 0.9 m/s and 0.5 m/s on spring and neap tides respectively (Hydrographic Office, 1975), within the Firth of Forth tend to be deflected by the rocky headlands and are considered to have minimal influence on beach development. Typical tidal flows adjacent to the Fife Energy Park are between 0.25 m/s and 0.5 m/s during mean neap and spring tides respectively.

The Development is sheltered from waves approaching from between 045º and 090º by the headland at Elie Ness. The northern end of Fife Energy Park is protected from waves approaching from between 045º and 090º by Methil Harbour breakwater.

Potential impacts on coastal hydrology have been managed through surface and coastal water management measures and through best practice.

Water Management Measures

Water management measures, referred to in the Surface and Coastal Water Management Plan, based on good practice, have been proposed to control and minimise effects on water quality and quantity of the receiving coastal environment. The water management measures proposed have been demonstrated elsewhere to be effective, and their effectiveness on this site will be ensured by supervision by the construction team.

Good Practice

A Pollution Prevent Plan (PPP) will include measures that will be used to avoid or reduce potential impacts for all phases of the Development, and will also include an Incident Plan to be followed, if pollution occurs. An engineer will also be appointed who will have specific responsibility to ensure measures within the PPP are followed during construction.

Method statements will also be applied, which will follow the principles laid out in relevant SEPA Pollution Prevention Guidelines (PPGs).

With the proposed mitigation measures, the potential effects of the Development on hydrology and hydrogeology are not considered to be significant.

2.10 Cultural Heritage

This assessment has considered the potential for the Development to have impacts upon features of cultural heritage within and beyond the site boundary. It has considered both the potential for direct impacts (damage or destruction of archaeological features within the site) and indirect impacts (principally the potential for visual impacts upon the setting of cultural heritage features beyond the site boundary).

A desk based assessment was carried out by Headland Archaeology using documentary, cartographic and photographic evidence to inform the baseline condition. This covered both onshore and offshore elements of the project. A site visit and walkover by an experienced archaeologist was also undertaken in February 2010 to confirm the data gathered as part of the desk-based assessment, and to identify (and if appropriate, record) any previously unrecorded cultural heritage features within the boundary.

The baseline work established that there are no known archaeological features within the site nor there is considered to be any potential for any unknown remains to exist (due to previous land-use). Due to the limited nature of the footprint of the turbine foundation there is unlikely to be any effect on unknown archaeological remains offshore. Features outside the site boundary included scheduled ancient monuments (SAM), Listed Buildings, Conservation Areas and Historic Gardens and Designed Landscaped that were considered as a part of the preliminary assessment. Only those features that are nationally important and highlighted by Historic Scotland as a potential concerns that were likely to experience significant indirect visual effects were assessed further.

Only one moderately significant indirect (visual) effect is predicted to occur upon the setting of Macduff's Castle Scheduled monuments, Index 860. This is temporary, lasting only for 5 years, and fully reversible upon relocation. No recorded features within the site will be directly affected by the construction and therefore no mitigation is proposed or considered necessary.

2.11 Socio-economics, Tourism, Land-Use and Commercial Fishing

The assessment has been based on a detailed desk study, relevant offshore guidance and consultations with Scottish Government and organisations related to commercial fishing and marine recreation and tourism.

The construction of the Development and setting up of the Scottish subsidiary will create 5 full-time office-based job opportunities within the local area as well generate opportunities for approximately 60 local workers to establish site facilities, office, workshop and grid connection cabling and buildings. Once the Development is operational, there will be 6 full-time maintenance and administrative jobs created.

In addition to the direct and indirect job impacts, successful delivery of the 2-B Energy Demonstrator Scheme in Fife will 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.

The construction of the Development is not predicted to have any indirect or direct effects on any land-based or marine-based recreational and tourist facilities. The area surrounding the turbine will not be accessible to marine recreational users for health and safety reasons. However, the assessment concludes that there will be plenty of opportunities for marine activities to be carried further along the coastline.

The operation of the Development is likely to have a significant impact on local views up to 6 km along Fife Coastal Path up to 6 km. Beyond 6 km, there will be no significant impact due to distance, screening and limited visibility. No other significant visual effects are associated with the operation of the Development.

Impacts on tourism and recreation resource relate strongly to the attitudes of the individuals experience the wind farm. Studies undertaken by professional bodies across the UK have suggested that the public is generally in favour of generating energy from renewable resources and that majority of those surveyed do not have a negative attitude towards windfarms. It is however, relevant to note that the Development – a single demonstration wind turbine will be operational for 5 years that is located within an industrial area and any effects will be fully reversible after the turbine is relocated to another offshore position after the operational period.

The Development will be located offshore and as such there will be change in land-use. The redevelopment of FEP is an improvement to the existing land in Fife region.

Given the location of the single prototype demonstration wind turbine 20 m offshore, there will be no need for an exclusion zone for fishing vessels during construction. Relevant health and safety measures will be employed to ensure that there are no safety risks to fishing vessels. Consequently, no potential financial losses are predicted on commercial fishery vessels, given the small scale, location and type of Development, number of fishing operations within the vicinity and availability of alternative fishing grounds in the area.

2.12 Navigation

The assessment examined the effect of the Development on navigation. It considered shipping navigation, fishing vessel movements, recreational vessel movements and other navigational issues.

The assessment has been based on:

- Desk studies (including data gathering from the Department of Energy & Climate Change Maritime Data/DTI Shipping Database and Fisheries data obtained from the Sea Fisheries Division of the Scottish Government);
- Consideration of relevant offshore guidance and consultations with Scottish Government; and
- Various organisations responsible for navigation, fishing associations and recreational sailing clubs.

No negligible (not significant) effect on navigation is predicted due to the following factors:

- The near shore intertidal location of the Development;
- The shallow water depth at the Development location;
- The Development will be connected to shore with a bridge or gantry, either permanent or wheeled out when necessary;
- Data from the Maritime Data online GIS Shipping Database and the Sea Fisheries Division of the Scottish Government indicates that the Development is located within an area of very low density for shipping and that there is relatively little fishing vessel activity (vessels 15 m and over) near the Development, with the majority of fishing activity located further out to sea;
- Consultation with Forth Ports, Methil Docks Harbour Master (FPMD) confirmed the Development will not have any impact on commercial shipping as the location is well clear of any shipping and navigational lanes;
- Consultation with the Scottish Fisherman's Federation and local fishing associations confirmed the there is very limited use of this area for fishing due its near shore location and the shallow water depths and no concerns were raised;
- No significant concerns were raised during consultations with recreational sailing groups;
- Any changes in tidal and current flows close to shore resulting from the turbine foundation are considered to be of negligible magnitude, due to the limited nature of the turbine foundation, and will have no effect on the navigation of small recreational crafts along the coast;
- The Admiralty Chart for the area shows that the Development is not in close proximity to any navigational aids such as major lights and lit buoys and FPMD confirmed that the Development will not impede any existing navigational aids;
- Confirmation from the Ports and Harbours Branch of the Scottish Government that the Development is not classed as offshore. Therefore, the full requirements do not apply and that the navigation assessment should be proportionate to the levels of use in the area. Collision risk modelling is not therefore considered necessary for the Development.

In addition a number of mitigation measures will be put in place to ensure navigational safety at all times, including:

- Appropriate navigational markings will be used following Northern Lighthouse Board recommendations and in agreement with FPMD and based on guidance that includes painting the turbine a light colour and the use of appropriate navigation lights and markings
- Information on the location of the Development will be provided to FPMD and to mariners via "Notices to Mariners", radio navigational warnings and marking on admiralty charts;
- No permanent exclusion zone is considered necessary around the Development for fishing vessels or recreational craft. However, a temporary exclusion zone will be provided during the temporary construction phase for health and safety reasons. Construction of the Development will be undertaken in accordance with relevant health and safety procedures and regulations.
- The Developer will continue to consult with FPMD, local fishing associations, Royal Yachting Association (RYA) Scotland, local boat clubs and the Scottish Canoe Association throughout the development and construction process to ensure there is a good level of awareness of the Development.

2.13 Telecommunication and Existing Infrastructure

Ofcom identified twelve microwave links operating in the vicinity of the Development during consultation stage. Further consultation with each link operator confirmed that the Development lies out with the recommended safeguarding distance for each link. No further effects are predicted on microwave links.

The closest civilian airports to the Development are Dundee (approximately 31.5 km north of the Development) and Edinburgh Airport (approximately 33.4 km south west of the Development). The Development will have no effect on the operations of Dundee Airport. BAA confirmed that the Development will have no effects related to operations or safeguarding of the Edinburgh Airport.

Defence Estates, Ministry of Defence (MoD), has indicated that they have no concerns regarding the Development, with reference to either radar or low flying activities. This was re-affirmed by assessing the Development against the NATS En Route Plc ("NERL") maps, which confirmed the Development is not sited in an area where it is likely to interfere with NATS operations.

It is possible for interference on television reception to occur in any direction within 500 m of a wind turbine (known as the reflection zone), or within an area of up to 5 km in the line of site between a transmitter and receiver (shadow zone)[14]. Consultation with BBC via the online assessment tool identified two transmitters – Black Hill Ch5 and Craigkelly Ch5 that may be affected. Further assessment confirms that the affected zone lies entirely over the Firth of Forth and is not considered to affect properties located onshore.

Digital transmissions do not suffer from the same effects as analogue transmissions. The Digital Switchover (DSO) for STV central region is expected to be completed by June 2011[15]. The switchover is intended to take place prior to the installation of the Development. This will result in digital signals will be transmitted as opposed to analogue.

In the event of any technical complaints registered by the Local Authority, the Developer will endeavour to reduce any adverse effects to television reception by providing technical solution such as re-tuning television sets to another transmitter or stronger signal, or provide an alternate off-air service to each affected residence i.e. digital set-up boxes. Following mitigation, no further significant effects are predicted.

2.14 Shadow Flicker

Shadow flicker is the term used to describe the effect that occurs when the shadow of a wind turbine blade passing a narrow opening (usually a window), appears to quickly turn on and off as blades pass the opening in succession, resulting in a flicker.

Guidance issued by Scottish Government[16] states that there are limited atmospheric conditions in the UK during which shadow flicker can take place and occurrence relates to the position of the sun relative to the turbines and the window opening. It further states that the distance over which this effect can occur is generally within ten rotor diameters (1300 m) and 130 degrees of north relative to the proposed turbine location or the "shadow flicker study area".

In addition, more recent guidance published in 2009 in Northern Ireland provides further information in relation to significance criteria. It recommends that shadow flicker effects should not exceed 30 hours per year or 30 minutes per day at offices or houses within 500 m of a wind turbine[17].

[14] Ofcom (2009). *Tall structures and their impact on broadcast and other wireless services.*
[15] Digital UK (2010) "*When do I switch: STV Central Region*". Available online at http://www.digitaluk.co.uk/when_do_i_switch/stv_central [last accessed 11/03/2010]
[16] Scottish Executive (2002) *Planning Advice Note 45 (PAN 45) Renewable Energy Technologies*
[17] Planning and Environmental Policy Group (2009) *Best Practice Guidance to Planning Policy 18 'Renewable Energy' Northern* Ireland Department of the Environment, Belfast.

A detailed shadow flicker assessment was undertaken using a computer model designed specifically for wind turbines[18] and a Geographic Information System. The assessment identified numerous potential receptors within the shadow flicker study area in which effects could occur.

Further analysis helped to narrow down the receptors as well as inform the choice of the assessment locations and include those that were within the worst-affected areas. As a result, the final choice of representative "Assessment Locations" has undergone an iterative approach/subsequent revisions and refinement.

The final assessment calculated approximate times of day and year that effects may occur based on a number of worst-case assumptions, including the likelihood of bright sunshine occurring at those times. Shadow flicker effects are unlikely to exceed the 30 hour threshold recommended by the Guidance.

In the event that shadow flicker does occur, results in complaints and that these complaints are proven to constitute a Statutory Nuisance, then measures are available which would allow for flicker to be reduced or prevented to comply the terms of any notice that may issued under the terms of the Environmental Protection Act 1990 (as amended).

2.15 Miscellaneous Issues

The demonstration wind turbine prototype will generate electricity during the operational period of 5 years beginning 2011.

The wind turbine will have a positive benefit on carbon dioxide (CO_2) emission savings. Energy generated by the wind turbine will have the potential to displace electricity generated from other sources such as fossil fuels. It is estimated that Methil Offshore Demonstration Wind Turbine would displace a minimum of 6,279 tonnes of CO_2 emissions each year from entering the atmosphere[19].

The primary aim of the Development is to build a prototype to test the unproven technology. Therefore, the displacement will relate the operational duration of the machine at any given time.

The majority of the turbine components (abnormal loads) will either be manufactured on site or delivered by sea to the nearest suitable water port i.e. Forth Ports. Therefore, an abnormal loads study relating to preferred route options for delivering the turbines is not required. The traffic generated during the construction and operation of the single turbine will be minimal and use the surrounding trunk road network. Overall, the Development will have a negligible effect on the capacity of the surrounding road network.

2.16 Summary

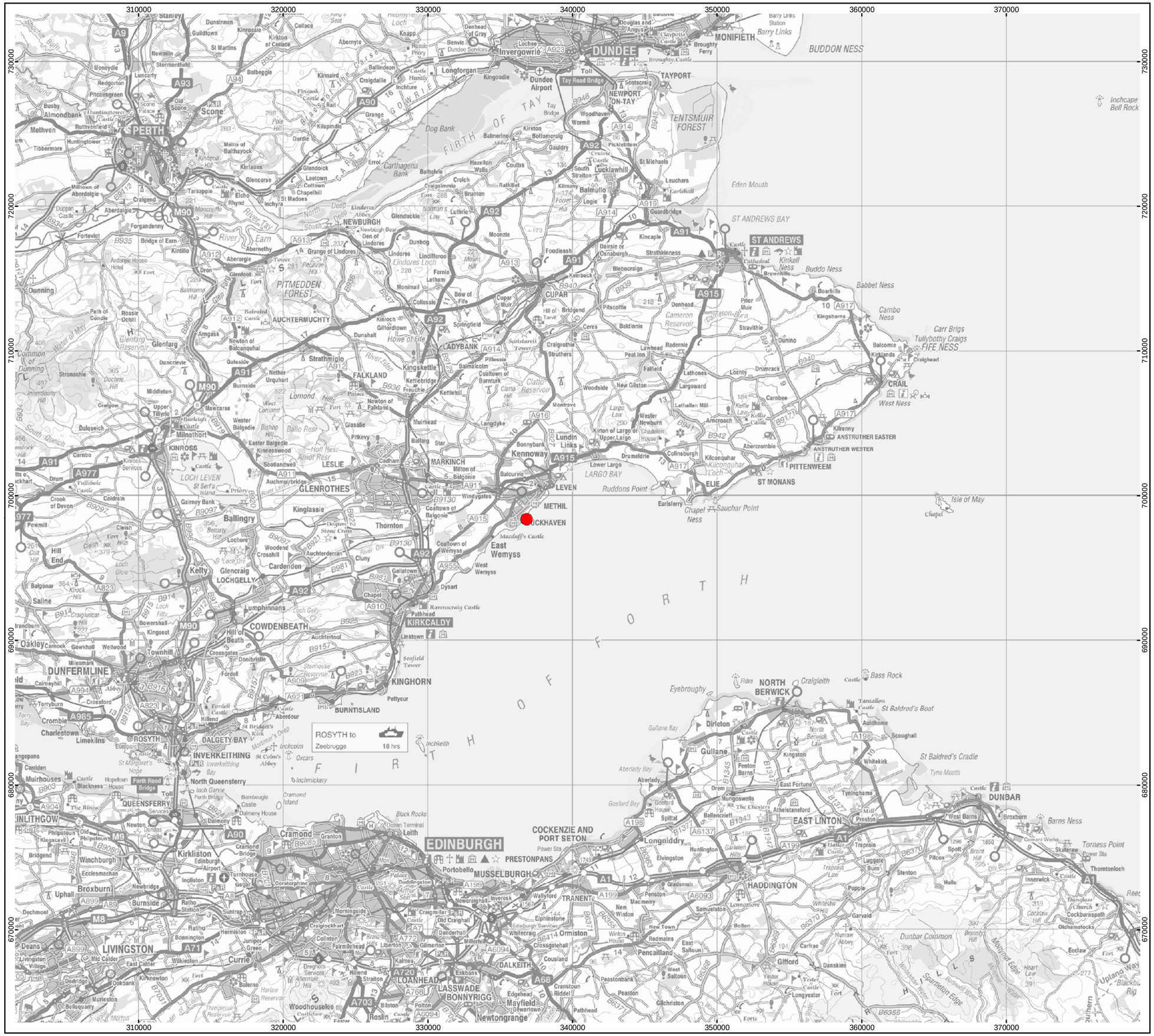
There are strong legislative and policy drivers for renewable energy developments in the UK. New wind turbine technologies are required if Round 3 offshore developments are to be realised. These turbines will be built further offshore than ever before and the new technologies are needed to meet the more challenging environments found in these locations. The proposed turbine at Methil presents one new such option. Fife Energy Park has been selected by the Scottish Government as one of the locations around Scotland for development of future marine renewables technologies.

The turbine, if granted planning permission, will be developed and tested at Fife Energy Park by 2-B Energy, for a maximum of five years before being relocated to an offshore location for further testing.

[18] WindFarm version 4.1.2.2

[19] Based on displacement of electricity generated by gas for 2008 (393 tonnes of CO_2 per GWh) which is considered to be an under-estimate of the emissions of CO_2 displaced by the operation of the Development.

Significant effects from the development are limited to landscape setting and visual effects in relatively close proximity to the turbine location and there are no significant effects predicted on ecological or ornithological receptors.



2-B Energy

arcus

Key

- Proposed Turbine Location

1:250,000 Scale @ A3

0 5 10 km

N

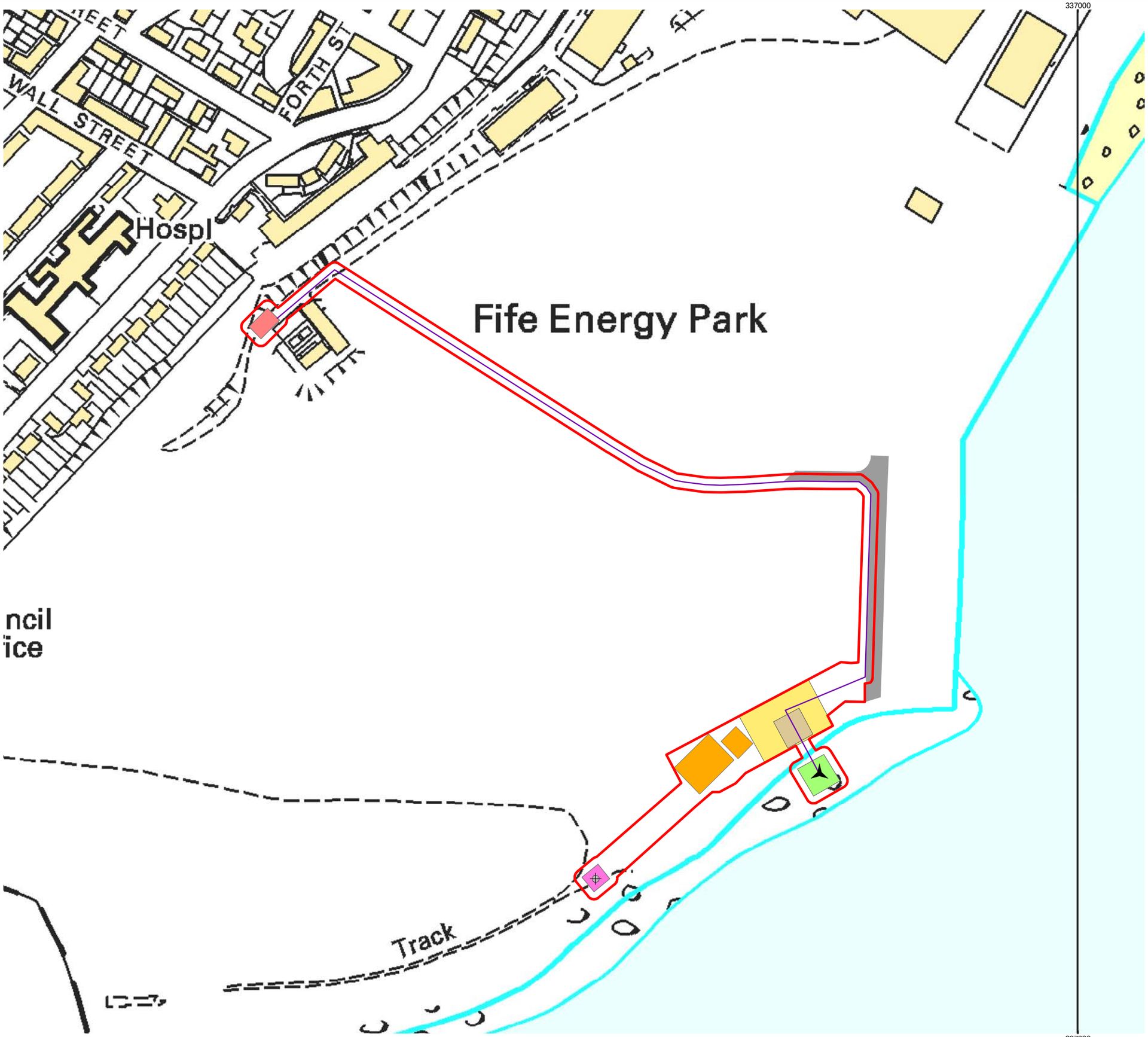
Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/066 | Revision: A

Date: 13/03/2010

Site Location
Figure 1.1

Methil Offshore Demonstration Wind Turbine
Non Technical Summary



2-B Energy

arcus

Key

- Proposed Turbine Location
- Wind Monitoring Mast
- Site Boundary
- Cable Route
- Transformer
- Common User Access Road
- Wind Mast Foundation
- Turbine Foundation
- Building
- Construction Pad
- Construction Hardstanding

Turbine Location
OSGB-36: 336824 mE, 698397 mN
WGS-84: 56.174015 °N, -3.019113 °W

1:2,500 Scale @ A3

0 50 100 m

N

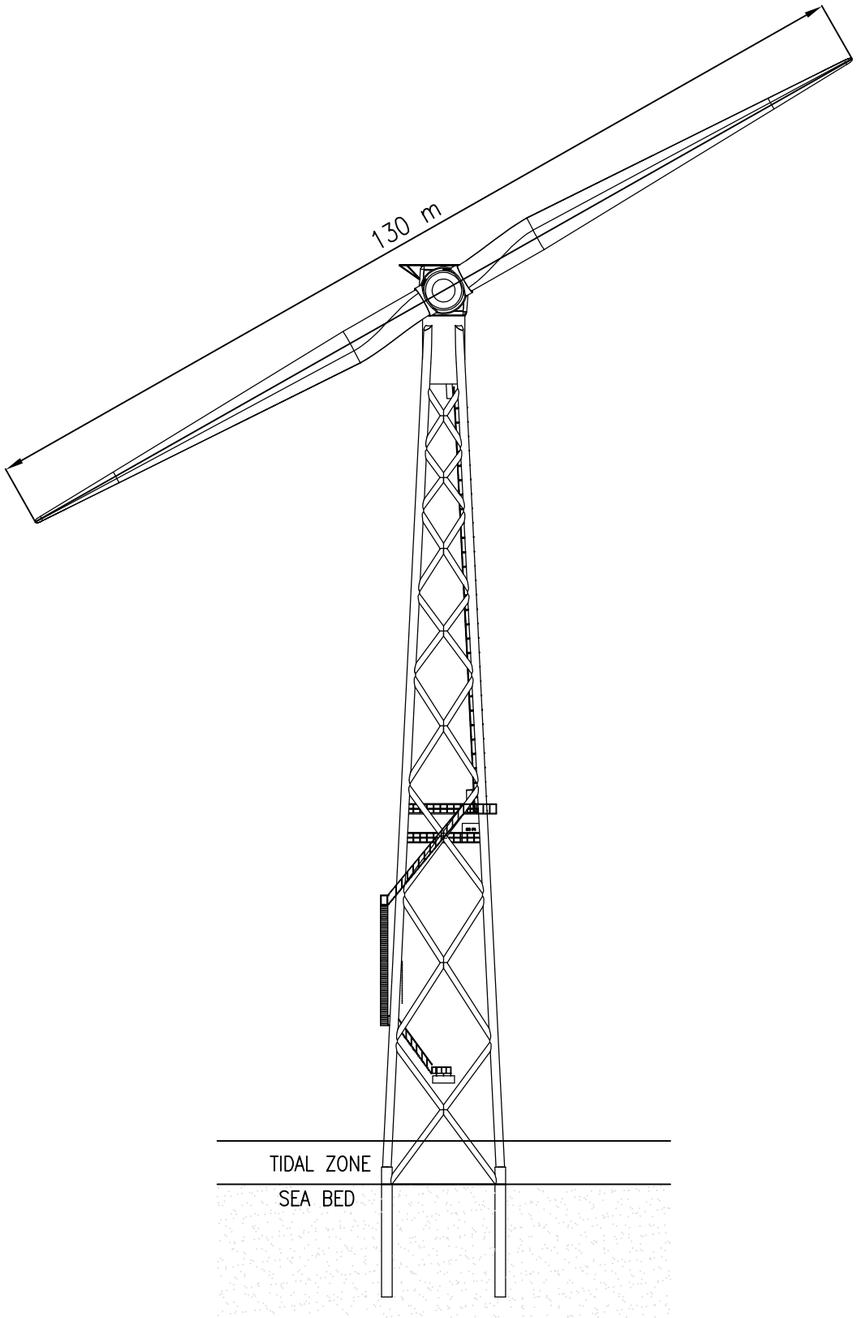
Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/062 | Revision: A

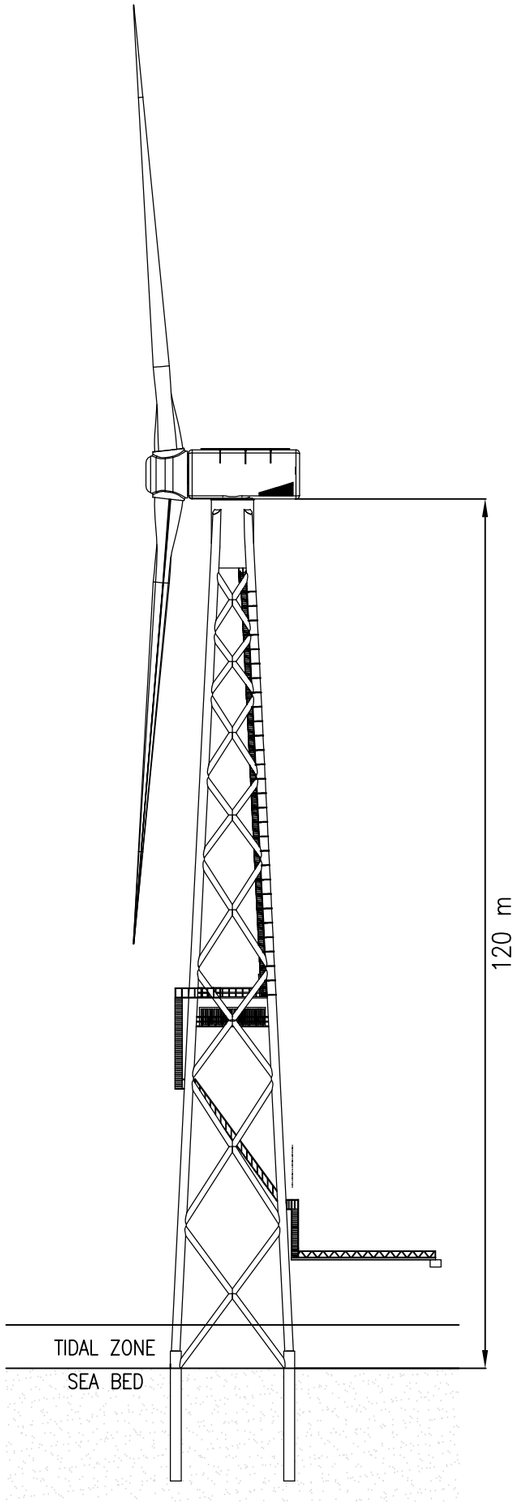
Date: 16/02/2010

Site Layout
Figure 1.2

Methil Offshore Demonstration Wind Turbine
Non Technical Summary



FRONT VIEW
SCALE 1:850



SIDE VIEW
SCALE 1:850

2-B Energy
arcus

NOT FOR CONSTRUCTION

Produced By: SC
Reviewed By: PM
Approved By: FM

Ref: 323/ES/070	Revision: A
Date: 18/03/2010	

Wind Turbine
Figure 1.3

Methil Offshore Demonstration
Wind Turbine
Non Technical Summary

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A full list of accompanying figures is provided within Environmental Statement Volume II: Figures.

Technical Appendices referenced in Chapters may be found in Environmental Statement Volume III: Technical Appendices.

1 INTRODUCTION

1.1 Overview

2-B Energy ("the Developer") is proposing to develop an offshore wind turbine prototype on the northern shore of Firth of Forth, Scotland. The project to be known as Methil Offshore Demonstration Wind Turbine (hereafter referred to as "the Development") is located approximately 20 m offshore from Fife Energy Park, Methil as shown on Figure 1.1.

The Development will comprise of:

- A single, two-bladed demonstration wind turbine with an installed capacity of approximately 6 MW. The turbine tower is 120 m tall (including subsea tower structure), with a rotor diameter of 130 m, giving a maximum level from the turbine base to turbine tip of 185 m;
- Bridge connection between the site and turbine tower;
- Construction of crane hard-standing;
- Erection of a single wind monitoring mast not exceeding 110 m in height; and
- Construction of two onshore site buildings for grid connection.

This Environmental Statement (ES) accompanies an application to Marine Scotland for planning permission under the section 36 of Electricity Act 1989[1]. The ES has been prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000[2] (as amended) to identify and consider the potential effects of the Development on the environment.

The ES describes the environmental and socio-economic effects during the two phases of the Development, including:

- Site preparation and construction of the Development; and
- Operational period for up to 5 years.

After a maximum period of five years, during which the turbine components will be tested, the turbine will be relocated to a permanent offshore location. However, this will be subjected to a separate development process.

This ES is designed to inform decision makers of the nature of the Development, the likely environmental effects, the measures taken to avoid likely significant environmental effects, and the measures proposed to mitigate those remaining effects.

The methodology used to define and assess the significance of the likely environmental effects is described in detail within Chapter 2: EIA Methodology of this ES.

1.2 The Developer – 2-B-Energy

2-B Energy is an active offshore wind energy company based in Hengelo, Netherlands that was founded in 2007. 2-B Energy, together with a reputable network of key partners in the industry, has developed an innovative, new design for offshore wind turbine. The low-cost, holistic concept includes differentiating designs for the rotor, nacelle, support structure and electrical system. The Methil Offshore Demonstration Wind Turbine project is the testing and certification of the first prototype of this concept.

For more information, please refer to the website http://www.2-benergy.com/

1.3 Proposed Development Summary

The Development will be located at the Fife Energy Park (FEP) which comprises 133 acres of semi-derelict industrial land. The FEP is currently undergoing a major redevelopment

[1] *The Electricity Act 1989*. OPSI, London
[2] *The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 ("The EIA Regulations"),* OPSI: London

program which will create ideal industrial facilities for the offshore renewable energy sector in Scotland. The site is currently owned by Scottish Enterprise, who acquired it from Wemyss Estate Trustees and Crown Estate in 2005.

The site was historically occupied by mining and oil industries and has been regenerated from the former Kvaerner Yard in 2001. Currently, there is an active steel fabrication facility operated by Burntisland Fabrications (BiFab) that produces major components for the offshore wind industry as well as offshore oil and gas.

The turbine will be located approximately 20 m offshore within a control building and bridge connection to Fife Energy Park at grid reference NT 368 984 as shown on Figure 1.1. The Development includes installing and testing a new concept offshore wind turbine that consists of a two-bladed turbine on a steel lattice tower. The power produced by the prototype will be fed to a high-voltage, variable frequency grid system and transmitted to shore with 10 kV AC cabling.

The demonstrator scheme is proposed in three stages:

- Stage 1 - near shore 1st turbine (approximately 20 m offshore) on a 5 year building permit with onshore grid connection system;
- Stage 2 - offshore 2nd turbine (approximately 1.5 km offshore) with extension of grid system; and
- Stage 3 - relocation of the Stage 1 turbine to a new second offshore location after five years operation.

This application refers only to Stage 1. A separate application will be submitted in due course for stages 2 and 3.

For the purpose of this EIA, the Development will consider the effects for the construction and operational phase for Stage 1 that is planned for installation in early 2011. In addition to the turbine, there will be a number of ancillary structures and infrastructure requirements. Chapter 3: Project Description of this ES, provides full details of the Development.

The Development will require a connection to the national grid to allow power produced by the turbine to be exported from the site. The underground cable connection to the national grid does not form part of this planning application and consequently is not considered within this ES.

The target market for commercialisation of the 2-B Energy technology is the UK Offshore Round 3. Assuming the demonstration project is successful then the aim is for serial production of the turbines in a UK facility, to meet the anticipated timescales for Round 3 installation in 2014/2015.

As a result, this Development can play a key role in development of Scotland's Renewable Energy Infrastructure and provide long term economic benefits.

1.4 Legislative Framework

A consent is being sought for the building and operation of the Development to the Scottish Government under section 36 of the Electricity Act 1989. All aspects of the Development including both onshore and offshore works will be determined by the Scottish Government

1.5 Renewable energy

1.5.1 UK Overview

The United Kingdom is committed to reducing greenhouse gas emissions by 12.5% from 1990 levels by 2008-2012 as part of the Framework Convention on Climate Change (the Kyoto Protocol)[3].

[3] http://www.defra.gov.uk/environment/ climatechange/internat/un-kyoto.htm [Accessed 4th March 2009]

The Climate Change Act[4] was passed into law on 26 November 2008. The introduction of this Act was intended to improve carbon management in the UK, establish the move towards a low carbon economy and demonstrate the UK Government commitment to alleviating the causes of global climate change.

There are several key provisions within the Act, including the introduction of legally binding targets in respect of greenhouse gas emissions and a system of carbon budgeting which sets a limit upon emissions. The Committee on Climate Change was borne out of this legislation and it seeks to advise the Government on the progress in relation to targets and carbon budgets (on successive five year periods). The Act seeks to reduce the greenhouse gas emitted by 80% by the year 2050 against a 1990 baseline figure. This makes the UK the first country in the world to establish such a legally binding long-term and significant carbon reduction target.

Following the recent COP15 Copenhagen Conference in December 2009, a Copenhagen Accord was agreed between the nations to move towards immediate global action on climate change. UK is committed to reduce emissions at least 34% by 2020 and aspires that together with the European Union a target of 30% cut in emissions by 2020 is reached[5].

Latest estimates show that in 2008, the net UK CO_2 emissions[6] were 10.5% (532 $MtCO_2e$/yr) below 1990 levels which was 2% lower than 2007[7,8]. In 2008, the main sources of UK CO_2 emissions were from power stations (33%), followed by road transport (24%), domestic/commercial combustion (18%), other industrial combustion (16%)[9].

The Renewable Energy Strategy 2009 (RES) (part of the Government's Overall UK Low Carbon Transition Plan) outline why and how the UK needs to increase the use of renewable electricity, heat and transport. It sets out a path to achieving the UK's legally binding target to ensure 15% of energy comes from renewable sources by 2020[10].

1.5.2 Scottish Overview

The Climate Change (Scotland) Act 2009 which received royal assent on 4th August 2009, creates a long-term framework for the current and successive administrations in Scotland to ensure a reduction in Scottish greenhouse gas emissions by 80 per cent by 2050 with an interim milestone of 42% by 2020[11].

The Scottish Government is committed to promoting the increased use of renewable energy sources to help tackle climate change and to support economic growth in Scotland. The Scottish Government has recently set an increased target of supplying 50% of Scotland's electricity demand from renewable sources by 2020, and an interim milestone of 31% by 2011. Ministers want to see targets exceeded and not merely met[12].

Progress towards these targets is mainly driven by the Renewables Obligation (Scotland) 2002 (ROS) that places a legal obligation on every electricity supplier in Scotland to ensure that an increasing proportion of their supplied energy is generated from eligible renewable resources.

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[4] *Electricity Act 1989*. OPSI: London.
[5] DECC (2009) *Copenhagen Outcomes* [online]. Available at http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/copenhagen/copenhagen.aspx [Accessed on 21/01/2010]
[6] CO_2 emissions contribute to 70% of the potential global warming effect of anthropogenic emissions of greenhouse gases and in UK the CO_2 accounts for about 85 % of the total greenhouse gas emissions
[7] $MtCO_2e$/yr = Millions of tonnes of carbon dioxide equivalent emitter per year
[8] DECC (2009) *Special Feature – CO_2 Emissions* [online]. Available at http://www.berr.gov.uk/files/file50671.pdf [Accessed on 14/07/2009]
[9] DEFRA (2008)*UK Emissions of Air Pollutants 1970 to 2006* , AEA. (Table 7.1)
[10] DECC (2009) Renewable Energy Strategy, London: TSO
[11] *Climate Change (Scotland) Act 2009*, OPSI: London.
[12] Scottish Government (2009) *Renewables Policy* [online], Available at (http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17612/) [Last accessed on 18/01/10].

The Scottish Government published a Renewables Action Plan (RAP) in July 2009[13] that sets out a framework for action for the next 24-36 months. The plan implements the above national targets by setting out a strong commitment to support and accelerate the implementation of renewable energy. The key objectives set out in the Renewables Action Plan are as follows:

- *"To maximise the economic, social and environmental potential of Scotland's renewables resource, across different technologies;*
- *To establish Scotland as a UK and EU leader in the field;*
- *To reduce the time for renewables to become cost-effective;*
- *To ensure maximum returns for Scotland's economy, in terms of jobs created, company wealth and IP generated, inward investment secured, and tonnes of carbon saved;*
- *To meet targets for energy from renewables, and for emissions reductions, to 2020 and beyond; and*
- *To ensure an advantageous integration between the activities of the Scottish Government, the UK government, and Europe."*

The action plan emphasises that offshore wind development *'will be a key policy focus in the short to medium term, not only for its generation potential, but also in terms of manufacturing and infrastructure opportunities.'*

These objectives and opportunities are a very good fit for the 2-B Energy Demonstration Project. The project in particular is in line with the following policies that are delivered to focus on the following objectives set out in the RAP:

- *"Developing, welcoming, and enabling the strong overseas interest and investment in the Scottish low carbon economy; and*
- *Promoting innovation through Research, Development, Demonstration and Deployment (RDD&D)."*[14]

1.5.3 Fife Overview

One of Fife Council's '*Big 8*' Objectives is to make Fife the leading Green Council in Scotland. Fife Council has recognised the national commitment of reducing carbon emissions and increasing renewable energy generation and intends to make a significant contribution to the national targets. It is anticipated that the renewable energy projects in Fife have a potential of generating 7% of Fife's energy and lead to a reduction of 25% of carbon emissions by 2013[15]. This energy generated will be sufficient to meet the domestic electrical consumption within Fife[16]. The development will respond to these requirements for renewable energy production by contributing around 6 MW.

1.6 Project Team

The EIA has been project managed and compiled by Arcus Renewable Energy Consulting Ltd ("Arcus"). The contributor to the various sections of the ES is provided in Table 1.1.

[13]The Scottish Government (2009) *Renewables Action Plan*, Scottish Government: Edinburgh, online. Available at (http://www.scotland.gov.uk/Publications/2009/07/06095830/0) [Last accessed on 18/01/10]. Pp. 12
[14] Ibid
[15] Fife Council (2009) *Growing Fife's Future: The Renewable Energy Opportunity*, Fife Council: Glenrothes.
[16] Ibid

Table 1.1 EIA Project Team

Chapter / Assessment	**Organisation**
Introductory Chapters	Arcus
Planning Policy	Arcus
Landscape and Visual Assessment	RV Design and Arcus
Noise	Arcus
Ecology	Arcus
Ornithology	Arup and Arcus
Coastal Hydrology, Ground Conditions and Contamination	Arcus
Cultural Heritage	Headland Archaeology and Arcus
Navigation,	Arcus
Socio-economics, Tourism, Land-Use and Commercial Fishing	Arcus
Telecommunication and Existing Infrastructure	Arcus
Shadow Flicker	Arcus
Miscellaneous Issues	Arcus

1.7 Structure of Environmental Statement

This ES reports the findings of the assessment of the likely environmental effects of the Development and comprises the following documents:

- Environmental Statement Volume I containing the written statement;
- Environmental Statement Volume II containing the figures;
- Environmental Statement Volume III containing the technical appendices; and
- A separate Non-Technical Summary (NTS).

The information within the ES Volume I is structured as follows:

- Chapters 1-3 provide an overview of the Development, the environmental assessment methodology and full description of the Development covering the construction and operational phases;
- Chapter 4 provides background regarding local and national policy;
- Chapter 6-15 contain a topic by topic discussion of the potential effects and mitigation measures proposed and/or adopted during the Development design to minimise such effects.

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11 SOCIO-ECONOMICS, TOURISM, LAND-USE AND COMMERCIAL FISHING

11.1 Introduction

This chapter of the Environmental Statement (ES) evaluates the following effects associated with the Methil Offshore Demonstration Wind Turbine ("the Development").

- Local and National Economy;
- Tourist attractions and recreation facilities around the Development (excluding the landscape and visual effects which are considered in Chapter 5: Landscape and Visual Assessment);
- Land-use; and
- Commercial Fishing.

This chapter contains the following sections:

- Guidance and consultation: summary of relevant guidance and consultation undertaken as a part of the assessment;
- Assessment Methodology and Significance Criteria: describing the methods used in baseline surveys and in the assessment of significance of effects;
- Baseline Description: a description of the development site and the surrounding area based on the result of desk information, site visit and consultation;
- Potential Effects: identifying the ways in which socio-economics, tourism, land-use and commercial fishing could be affected by the Development;
  - Mitigation Measures;
- Residual effects;
- Cumulative effects; and
- Statement of significance.

11.1 Guidance and Consultation

11.1.1 Policy and Guidance

Relevant national, regional and local planning policy documents are referred to in Chapter 4: Planning, of this ES. The following documents have been considered for the assessment of the potential effects of the Development on socio-economics, tourism & recreation, land-use and commercial fishing.

- Guidelines for Environmental Impact Assessment[1];
- A Handbook on Environmental Impact Assessment[2];
- CEFAS, Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements, June 2004[3]; and
- A report on the perceptions of the fishing industry into the potential socio-economic impacts of offshore wind energy developments on their work patterns and income[4].

[1] Institute of Environmental Management and Assessment (2004) *Guidelines for Environmental Impact Assessment*
[2] Scottish Natural Heritage (2005) *A Handbook on Environmental Impact Assessment*
[3] Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the Marine Consents and Environment Unit (MCEU) (2004) *Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements*
[4] Mackinson, S. et al. (2006) A report on the perceptions of the fishing industry into the potential socio-economic impacts of offshore wind energy developments on their work patterns and income, *Science Series, Technical Report no. 133*. CEFAS SEAFISH [online]. Available at (http://www.cefas.co.uk/projects/renewable-energy.aspx). [Accessed on 21/01/2010]

11.1.2 Reference Material

The following sources of information have been used to inform the baseline description set out in this Chapter:

- National Statistics Online (www.statistics.gov.uk);
- NOMIS Official Labour Market Statistics (www.nomisweb.co.uk);
- Fife Council (www.fife.gov.uk);
- DECC Maritime Data/DTI online GIS Shipping Database (www.maritimedata.co.uk)
- Crown Estate (http://www.thecrownestate.co.uk/); and
- Centre for Environment, Fisheries and Aquaculture Science (http://www.cefas.co.uk/projects/renewable-energy.aspx).

Fisheries data was obtained from the Sea Fisheries Division, Scottish Government.

The economic value of UK Offshore Wind Industry has been based as per the information provided in the National Renewables Infrastructure Plan[5] and Towards Round 3: Building the Offshore Wind Supply Chain[6] document.

The relevant policies and action plans from the UK and Scottish Government highlighting the importance of offshore industry has been identified from the UK Renewable Energy Strategy 2009, Securing a Renewable Future: Scotland's Renewable Energy, the reports from Forum for Renewables Development Scotland (FREDS) and the Renewables Action Plan.

Baseline conditions have been established through desktop studies, site visit and consultation. Additional information was also obtained via a scoping exercise (outlined in Chapter 2: EIA Methodology of this ES). Information concerning the public's perception of wind farms has been gathered from all parts of the United Kingdom.

11.1.3 Consultation

Relevant organisations were contacted with regard to the Development. Table 11.1 lists the relevant responses related to commercial fishing and marine recreation and tourism.

Table 15.1: Summary of Consultation Responses

Consultation	Response
East Lothian Yacht Club	Club members seldom use this area.
Fife Fishermen's Association	Provided contact information for local fishing groups in the area who should be consulted
Forth Ports/Methil Docks Harbour Master (FPMD)	No impact on commercial shipping. Only smaller coast vessels heading for Methil transit this area and location of turbine does not interfere with the passage of these vessels.
Non Affiliated Creel Fishermen, South East IFG Executive Committee	Do not see any problem with stage 1 as the turbine will be located only approximately 20 metres from the shore this shouldn't affect any fishing or fishing vessels.
Royal Yachting Association (RYA) (Scotland)	The recreational users of Methil are mainly longshore fishermen using creel and pot fishing methods.
Scottish Canoe Association	No significant landscape or seascape concerns. In particular, concerned if the development would result in tidal flows close to shore being altered or landfall facilities leading to additional dangers for small craft navigating along the coast of Methil.

[5] Highland and Island Enterprise and Scottish Enterprise (2009) *National Renewables Infrastructure Plan* http://www.scottish-enterprise.com/nationalrenewablesinfrastructureplan.pdf
[6] BVG Associates (2008) *Towards Round 3: Building the Offshore Wind Supply Chain* *http://www.thecrownestate.co.uk/round3_supply_chain_gap_analysis.pdf*

Consultation	Response
Scottish Fishermen's Federation	Only smaller vessels fish in the Forth. No concerns about stage 1 turbine as near shore and very limited use of this area for fishing as too shallow.
Sea Fisheries Division, Scottish Government	Data from the Vessel Monitoring System on board fishing vessels of 15 meters and over show relatively little activity near the Development

11.2 Assessment Methodology and Significance Criteria

The scale of significance described below has been used to assess the potential and residual effects of the Development against baseline conditions. The assessment process aims to be objective and quantifies the effects as far as possible; however some effects can only be evaluated on a qualitative basis.

For the purpose of this EIA, the Development will consider the effects of the construction and operational phase for the proposed demonstration wind turbine that is planned for installation in early 2011. The proposed turbine will be relocated within 5 years to an offshore position. The relocation will form part of a separate EIA. Therefore, the effects associated with the construction and operation phase of the demonstration turbine are considered to be temporary and short term effects.

Effects are defined as:

- Negligible/No effect: either no change or no detectable change to a location, environment or sensitive receptor; and
- Minor: a detectable but non-material change to a location, environment or sensitive receptor;
- Moderate: a material, but non-fundamental change to a location, environment or sensitive receptor; and
- Major: a fundamental change to a location, environment or sensitive receptor or in breach of recognised legislation, policy or standards.

For assessing significance, consideration is given to the national, regional and local baseline situation. The magnitude of the impact is determined in proportion to the area of impact relevant to each receptor. For the purpose of the assessment, a moderate or major effect is deemed to be 'significant'.

In terms of socio-economic factors, potential effects would be significant if the Development resulted in any fundamental or material changes in population, structure of the community, and economic activity during the construction or operation phases.

With respect to land-based tourism and recreation, the assessment of potential effects was undertaken broadly following the Scottish National Heritage (SNH) "Guide to Outdoor Access Assessment". The potential indirect effect of the Development on tourism and recreation is closely related to public attitudes towards wind turbines in the landscape and a number of studies have been conducted on the subject. The relevant conclusions from the most recent studies are discussed later in this chapter.

The physical effects of the Development on existing land use are assessed by considering the possible effect of the Development on the current land use of the site. Significant effects would be those which resulted in a material or fundamental change in the predominant land-use of the site.

The effects on commercial fishing are assessed on the basis of the report Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements published by CEFAS in conjunction with SEAFISH[7]. If the Development results

[7] Mackinson, S. et al. (2006) *A report on the perceptions of the fishing industry into the potential socio-economic impacts of offshore wind energy developments on their work patterns and income*, Science Series, Technical

in a material or fundamental change in the fish populations, navigation of commercial fishing vessels and results in a socio-economic impact on their work patterns and income then they are considered to be major. Effects on marine-based tourist activities will be considered separately within the tourism & recreation section.

11.3 Baseline Description

11.3.1 Socio-Economics

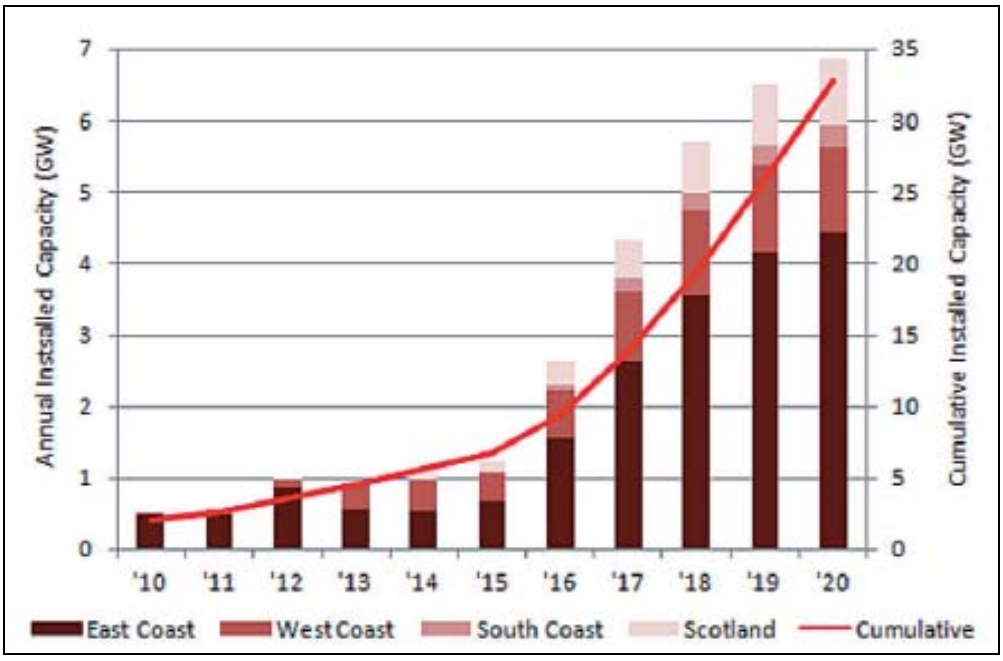
11.3.1.1 The Economic Value of UK Offshore Wind Industry

This section has been based on documents listed in section 11.2.2 - Reference Material

There is a huge potential for offshore wind in the UK due to the availability of natural renewable resources. The relevant policies and action plans from UK and the Scottish Government and the key leadership role played by Crown Estate to establish the offshore renewable industry has created development opportunities within this sector.

A BVG report prepared on behalf of the Crown Estate forecasts that the annual and cumulative installation capacity will reach 33 GW by 2020. This forecast includes the repowering of Round 1 and Round 2 and an additional 25 GW resulting due to development in Scottish Territorial waters and Round 3. The projected increase by 2020 is shown in Figure 11.1.[8]

Figure 11.1: The projected annual and cumulative UK offshore installation by 2020[9]



The projected increase has the potential of installing in total 6000 turbines including 1300 turbines in Scottish waters by 2020. The estimated number of turbines installed offshore in UK by 2020 is shown in Figure 11.2. Further examination of the above projections suggests that the majority of the opportunity lies in East Coast and Scotland. This makes it ideal for manufacturing companies targeting the offshore market[10].

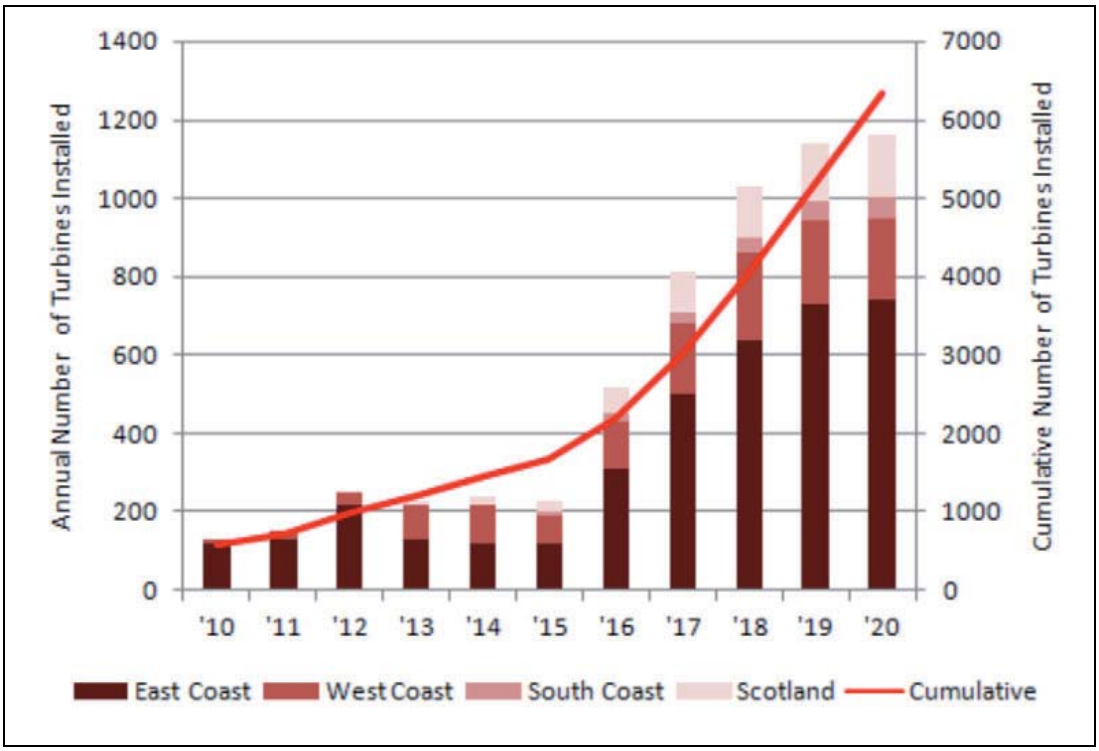
Report no. 133. CEFAS SEAFISH [online]. Available at (http://www.cefas.co.uk/projects/renewable-energy.aspx). [Accessed on 21/01/2010]

[8] BVG Associates , 2008

[9] BVG Associates, 2008

[10] Highland and Island Enterprise and Scottish Enterprise, 2009

Figure 11.2: The projected number of turbines installed offshore in UK by 2020[11]



There are a number of drivers for industrialisation of offshore wind in the UK. Firstly, an existing dominant home market in offshore wind. Secondly, the economic opportunity UK has due to the existence of a strong manufacturing and innovation pedigree and the recognised expertise in offshore engineering[12]. The relevant opportunities and constraints within the market that favour the establishment of a UK based turbine manufacturer are listed below:

- ***Skill Availability***: There exists a major opportunity to develop skills in the UK offshore wind industry. In 2009, the Renewable Energy Strategy stated that the UK offshore wind industry has the potential to create 40,000 to 70,000 jobs in operation and maintenance, turbine and component manufacturing, research & development.
- ***Turbine Manufacture***: At present, few turbines are specifically designed for offshore operation. This is a concern for all developers that there is insufficient choice of turbines available for offshore use that increases both the technical and commercial risk.
- ***Supply Forecast***: With little choice, the turbine market is not functioning as a competitive system with Siemens and Vestas leading the market by building a pedigree in offshore wind. Currently, this remains a critical item for most developers as no wind turbine suppliers have headquarters in the UK nor any turbines are assembled from key components in the UK.
- ***New Technology***: It is expected that variants of today's turbines will remain core products dominating sales into 2012/13, with next-generation, larger technology only taking over towards 2015. This means that for some time, the market will be dominated by technology adapted for offshore use, rather than fundamentally designed for offshore use[13].

The establishment of 2-B Energy in future as an offshore wind turbine manufacturer and its direct and indirect impact on the economy is further assessed in section 11.7.1.3.

[11] BVG Associates, 2008
[12] Ibid
[13] ibid

11.3.1.2 Local Authority Population and Economy

The Development site will be located on the northern shore of the Firth of Forth at Fife Energy Park (FEP), Methil. The coastal town of Methil is located 2.3 km south-west of Leven and approximately 12 km north-east of Kirkcaldy in Levenmouth ward.

Fife is Scotland's third largest Local Authority area based on the population. Based on 2008 NOMIS figure, the population of Fife was 361,900 representing 7% of Scotland's total, and a rise of 3.46 % since 2001. The majority of the population is concentrated in west and central where as the north and north-east is predominantly rural in nature[14].

Fife region has seen a continuous shift from traditional manufacturing economy to a service based economy with the majority employed in the public service sector. Fife has a slightly higher working age population that is economically active; 81% as compared to 80% for Scotland as a whole. Beginning July 2008, unemployment has been rising amounting to 4.1% as compared to 3.3% in Scotland. Fife's average annual growth in productivity is 1.3%, comparatively lower than the average (1.5% for Scotland) that is coupled with lower average workplace earnings i.e £434 gross average (median) weekly earnings. In 2006-07, the GVA for Fife was 2.1% that was estimated to contract by 1.2% due to recession[15].

11.3.1.3 Ward Population and Economy

In the past, coal mining, large-scale manufacturing and port-related were major employers. In the light of the current recession period, resulting in downturn of the finance sector and the depleting oil resources, the case for other upcoming sectors mainly manufacturing and renewable energy has been strengthened. Approximately 20% of the workers in Levenmouth are employed in manufacturing. In 2006, £1 million was invested in opening up a satellite campus by Adam Smith college with the aim that it will equip the local population with the skills required for the potential renewable energy opportunities in Fife due to the creation of FEP.

Scottish Enterprise together with Fife Council, acknowledge that there are massive opportunities to attract new companies particularly within the offshore renewables sector to the region in the next 10 years[16]. The Fife Renewable Opportunity document states that Fife has the skilled workforce, infrastructure and experienced industries in engineering and manufacturing to serve the renewable energy sector[17].

11.3.1.4 Fife Energy Park

FEP, a key project is a joint venture between Scottish Enterprise and Fife Council aimed to role in the development of Scotland's Renewable Energy Infrastructure and provide long term jobs. To date, over £10 million has been invested in FEP for strengthening the infrastructure and encouraging further growth and employment. The development of offshore wind farms also holds opportunity for employment in the surrounding area for suppliers and service operators.

Burntisland Fabrication (BiFab), a large scale fabrication manufacturer for the offshore energy market has centres located in Burntisland, Methil and Arnish and employs over 900 people. The company has previous experience of manufacturing support structures for wind turbine demonstration projects and has further received investment for other offshore projects in UK. BiFab has been identified as a potential supplier if the Development is consented.

The creation of FEP is a key investment and main site of business and industrial activity in Levenmouth. Five companies including Burntisland Fabrication (BiFab) have recruited more

[14] Fife Council (2007) *State of the Environment Report 2006-2007*
[15] The Fife Partnership (2008), *The State of Fife 2008 – Community planning achievements in Fife*, Fife Council.
[16] Fife Economic Forum (2009) *Growing Fife's Future - Fife Renewable Energy Opportunity*, Fife Council.
[17] ibid

than 30 staff from Levenmouth Ward in the last 5 years at Fife Energy Park. On completion of the park, it is expected to generate further employment within the local economy[18].

11.4 Recreation and Tourism

Fife is flanked by the River Tay to the north and to the south by the Firth of Forth. Fife is an important international tourist region that centres on its natural environment, particularly its coastline and golf centres, the majority of which are located in the eastern and northern parts of the region. Tourism is an important and growing sector in Fife, contributing over £200 million annually to the local economy, accounting for over 11,000 jobs (full-time and part-time) and representing over 8% of the workforce in Fife[19]. Site visits and the State of the Environment Report for Fife[20] indicate that although the landscape in Fife is an important tourism resource. However, the Development is located within Fife's more industrial area that has a strong urban presence in East Wemyss, Buchaven and Methil[21].

There are no formal onsite public rights of way or recreational opportunities. There are a few local recreational and tourist attractions located in the vicinity of the Development[22]:

- Leven Beach located approximately 3.9 km NE from the Development;
- Leven Links Golf course located approximately 3.9 km NE from the Development;
- Macduff Castle located approximately 2.5 km SW from the Development; and
- Wemyss Castle located approximately 5 km SW from the Development.

Other potential landscape and cultural heritage designations such as National Parks, Area of Great Landscape Value, Historic Parks and Gardens is further discussed in Chapter 5: Landscape and Visual and Chapter 10: Cultural Heritage of this ES.

The recreational routes of regional and national importance in the vicinity of the Development are listed below and illustrated on Figure 5.7.

- The Fife Coastal Path, a part of the international North Sea Trail, stretches approximately 90 miles (150 km) from North Queensferry to Tay Bridge. The 11.2 km (7 miles) section from East Wemyss to Lower Largo is located approximately 560 m from the proposed turbine[23];
- The section of the National Cycle route no. 1 (part of North Sea cycle route) that extends from Edinburgh to Aberdeen passes approximately 6.8 km (4.2 miles) from demonstration turbine at its closest point[24];
- The regional cycling route no. 63 passes approximately 5.8 km (3.6 miles) from the demonstration turbine at its closest point[25]; and
- The Visit Scotland website suggests that Fife Coastal Driving Route largely follows the coastline in Fife[26]. A map of the route is currently not available.

There are several small islands located within the Firth of Forth including Inchkeith, Craigleith and Bass Rock. A tourist ferry operates to the island Inchholm to the south-west of the proposed development site; however, access to the rest of the islands in the Firth of Forth is generally limited.

[18] Fife Economic Forum(2008) *Economic Profile Levenmouth*, Fife Council.
[19] Fife Economic Forum (2007) *Profile on the Tourism Sector in Fife;* Fife Council.
[20] Fife Council (2007) *State of the Environment Report 2006-2007*
[21] EnviroCentre and Centre for Sustainability (2007) *State of the Environment Report 2006-2007,* Fife Council.
[22] Tourist attractions were identified from Ordnance Survey 1:25,000 scale maps.
[23] Fife Coastal Path, *East Wemyss to Largo* [online]; Available at http://www.fifecoastalpath.co.uk/main.asp?lm=37 [Accessed on 02/02/2010].
[24] Sustrans GIS dataset
[25] Regional Cycling route identified from Ordnance Survey 1:50,000 scale maps
[26] Visit Scotland, *Fife Coastal Route* [online]; Available at http://classiccars.visitscotland.com/route/more/fife/ [Accessed on 02/02/2010].

The RYA Scotland, local RYA clubs, boat clubs and marinas were consulted with regards to the Development. The consultation response from RYA states that the area is generally used by longshore fishermen using creel and pot fishing methods. East Lothian Yacht Club response established that club members seldom use this area for recreation. Scottish Canoe Association does not have any significant landscape or seascape concerns. There are no landing facilities in the vicinity of the demonstration turbine and as such no effects are predicted. Chapter 12 Navigation provides further information on marine recreational activities in the area surrounding the Methil Docks/FEP.

Any potential visual impacts of the Development will be discussed within Chapter 5: Landscape and Visual Assessment in this ES.

11.4.1 Public Attitudes towards Windfarms

The potential impact of the Development on tourism is closely related to the perception of the windfarms by those visiting the area. Individual attitudes towards wind farms are subjective in nature and subject to a value judgement that differs amongst members of the public. It is however, relevant to note that the Development – a single demonstration wind turbine will be operational for 5 years that is located within an industrial area. A summary of studies carried out across the UK to establish an overview of public perception of windfarm development is presented below.

11.4.1.1 Tourism and Offshore Wind Farms (2003/04)

North Hoyle is the UK's first offshore wind farm that was constructed in 2003[27]. In 2004, RBA Research undertook a study to determine if tourists experienced a change in perception after the windfarm was operational. 96% of tourists in the area expressed that windfarm had no effect. Similarly, only 4% of the tourists felt that the presence of Gwynt y Môr[28] offshore wind farm (consented in 2008) would make them less likely to return to the area[29].

In 2003, prior to the construction of Scarweather Sands offshore windfarm, Greenpeace carried out a poll to determine if visitors were likely to return on holiday if the development went ahead[30]. The survey that was based on 650 visitors revealed that 96% of the visitors would return if the windfarm was constructed. Only 4% said that they were less likely to return. Majority of the visitors (83%) felt it would not make any difference.

11.4.1.2 Public Attitudes towards Renewables in the UK (2007)

In March 2007, Allegra Strategies undertook a comprehensive study into UK consumer views on Energy Efficiency and Alternative Energy Sources31. Key findings in relation to wind energy were as follows:

- Renewable energy sources featured highly when consumers were asked which source of energy would be best for society. Most popular was wind power cited by 19.9% of consumers, second was solar at 17.9%, third most popular was nuclear at 10.5% (not a renewable source);
- Wind power was believed to be the best energy source for society because there is plenty of wind in the UK, wind is considered to be a clean and natural source of energy, better for the environment, will not run out like fossil fuels and is cost efficient in the long-term;
- Consumers perceived windfarms as a good solution to benefit the environment. 18% of the public thought windfarms were aesthetically pleasing versus 6.4% who viewed

[27] The windfarm is located 4-5 miles off North Wales coast comprising of 30 turbines.
[28] The windfarm is located 8 miles off North Wales coast comprising of approximately 200 turbines.
[29] BWEA (2006) *The impact of windfarms on the tourist industry in UK* [online]. Available at: http://www.bwea.com/pdf/tourism.pdf [Accessed on 07/03/2010]
[30] Greenpeace (2003) *Poll shows windfarm could be a boon for tourism*, Sample: 650 visitors [online]. Available at: http://www.greenpeace.org.uk/media/press-releases/poll-shows-wind-farm-could-be-boon-for-tourism [Accessed on 07/03/2010]
[31] Allegra Strategies (2007) *UK Attitudes to Energy Efficiency & Alternative Energy Sources*.

windfarms as an eyesore. For a number of respondents the benefits of wind energy outweighed the visual impact and respondents were unsympathetic about other consumers complaints regarding the visual impact of windfarms;

- Many consumers believed wind turbines should be used more widely to produce clean energy and they generally responded positively to wind turbines in their local area;
- 70.1% of respondents stated that they would be happy to have a windfarm located close by, compared with 17.3% who would not;
- 85.9% of respondents who had wind turbines in their local area expressed positive feedback. 5.3% of residents were opposed; and
- Most consumers in UK (47.8%) favoured large–scale renewable such as wind energy as their most preferred source.

11.4.2 Land-Use

The FEP site comprises of 133 acres of semi-derelict, disused, industrial land that is owned by Scottish Enterprise. To the north-east of the site, there is an active steel fabrication facility, operated by BiFab Ltd. As detailed in section 11.4.1, the FEP is currently undergoing a significant redevelopment with a planned investment to convert it into an industrial park with commercial and industrial development. The FEP redevelopment is planned in two phases. Phase 1 improvements to infrastructure have already been carried out. Phase 2 improvement to coastal protection work, quayside improvements and continuation of site servicing is currently underway.

The Development is located approximately 20 m offshore from Fife Energy Park that will be connected to FEP by bridging structure. Site offices and construction workshop will be located within FEP close to the demonstration turbine.

11.4.3 Commercial Fishing

The proposed Development will be located in International Council for Exploration of Seas (ICES) area 41E6 as shown on Figure 12.1. Chapter 12 Navigation provides further information on the consultation undertaken with fishing organisations, type of commercial fishing vessels that operate in Firth of Forth and the level of fishing activity carried out in the area. The Maritime Data online GIS system and data obtained from the Sea Fisheries Division of the Scottish Government suggests that there is little activity near the Development. The volume and value of catch within ICES Rectangle 41E7 for the year 2008 is higher as compared to ICES Area 41E6 as shown in Table 11.2 and 11.3 below.

Table 11.2 Volume and Value of catches in ICES Rectangle 41E6 for the year 2008

Vessel Length	Volume	Value
15 metres or more	52. 6 tonnes	£99,984
Less than 15 metres	353.5	£940,205

Table 11.3 Volume and Value of catches in ICES Rectangle 41E7 for the year 2008

Vessel Length	Volume	Value
15 metres or more	516 tonnes	£1.12 million
Less than 15 metres	2066 tonnes	£5.3 million

A meeting with Scottish Fisherman's Federation further established that there is limited use of the area due to the shallow water depths and that smaller vessels fish in the area.

11.5 Information Gaps

No responses were received from local fishing groups consulted during the EIA process.

11.6 Potential Effects

The assessment of socio-economic, tourism and recreation, land-use and commercial fishing effects aim to predict the likely impacts (both positive and negative) arising from the Development.

11.6.1 Socio-economics

Social and economic effects can be divided into:

- Direct effects: opportunities that can be created as an immediate effect of the development, for example opportunities in the construction and operation of the site;
- Indirect effects: opportunities that will be created by the Development further down the supply chain. For example companies providing services to the proposed Development during construction and operation; and
- Induced effects: for example employments created by the additional spend of wages into the local economy and the purchasing of basic materials, equipment and office space for staff.

11.6.1.1 Construction

It is estimated that the Development and setting up of the Scottish subsidiary will create job opportunities for 5 local staff in the areas of project management, legal and accountancy services apart from generating opportunities for some 60 local workers to establish site facilities, office, workshop and grid connection cabling and buildings during the 6 month development and construction period. This represents short term, minor effects at a local level.

For the supply of different components of the turbines, which is a significant component of the project, there may be opportunity for numerous companies to supply parts and materials that will be utilised within the turbine.

Owing to the nature of the project requirements, local and regional businesses are also well positioned which will be advantageous to the process of tendering for contractors. Examples of direct opportunities for local and regional contractors and companies include supplying various building materials (e.g. fencing, concrete, cement, stone, etc.) and mechanical, electrical and supervisory services.

In addition to the above impacts, the project will also result in the turbine generating between 10 GWh and 25 GWh of green energy (equivalent to the usage of between 2000 and 5000 households) that may be utilised on site at FEP or by businesses in adjoining sites.

Overall, construction of the Development will bring about a short term, minor effect through increase in employment and business opportunities apart from generation of green energy on site. Consequently, socio-economic effects arising from the construction phase of this turbine are considered to be not significant.

11.6.1.2 Operation

The demonstration turbine includes new and currently unproven advancements in turbine technology. At least one engineer would access the turbine on a daily basis to test the various components under different conditions. Due to the unproven nature of the technology turbine parts may need to be replaced at regular intervals. It is estimated that the Development will support the equivalent of up to 6 full-time maintenance and administrative staff. It is anticipated that the operation of the Development will therefore have a negligible effect on the economy during this period. This effect is not significant.

11.6.1.3 The Economic Value and Impact of the Development

On a broader level, the various phases of the project have a higher value and impact on the economy at both local and national levels. The project can be described in three phases:

- Prototype Development – Deployment of the turbine at Fife Energy Park;
- 'O' Series Production – The five turbine project located in either Forth Estuary or Aberdeen Harbour; and
- Serial Production – for supply to the Round 3 Market.

At this stage, the design functions and the prototype development have been carried out in Germany and Netherlands where the expertise in turbine development and manufacturing lies. At this stage, the Developer does not have a home base and wishes to establish a main assembly facility from which to manufacture these turbines for Round 3 market at an appropriate location along the East Coast of the UK.

During each phase of the project, there are direct and indirect job outcomes and growth factors in the embedding of expertise within the local area, that are difficult to quantify but lead to significant impacts in the longer term. The direct, indirect and induced job outcomes of Stage 1 of the project have been described in Section 11.7.1.1 and Section 11.7.1.2.

Throughout the different stages of the project, the Developer is committed to working in partnership with national and local agencies to maximise the knowledge opportunity at all levels, from operational/installation training through to degree level and postgraduate research work. This will make a major contribution to enhancing the areas reputation and helping to make the aspiration of an Industry Centre of Technology in Fife a reality.

The Developer has already commenced discussions with the Energy Technology Partnership to explore the opportunity for research work and academic support for some aspects of the project. The area of smart grid technology is expected to be one where there is a high level of interest from universities. In future, there are opportunities for the development of technician level training and industry skills development.

In addition to the direct and indirect job impacts, successful delivery of the 2-B-Energy Demonstration Project in Fife will 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.

11.6.2 Recreation and Tourism

Potential effects on recreation and tourism resources are categorised as:

- Direct physical effects: for example construction activities with rights of access and marine recreational activities; and
- Indirect effects: such as the effects of noise and changes in view of tourists and recreational users.

11.6.2.1 Construction

The Development will be located within Scottish Enterprise ownership land. Within the immediate vicinity there no opportunities for formal or informal recreation as the Energy Park is a secure site for Health and Safety Reasons. The construction of the wind turbine is not predicted to have any indirect or direct effects on any land based recreational and tourist facilities.

Similarly, the area surrounding the turbine will not be accessible to marine recreational users for health and safety reasons. There will be plenty of opportunities for marine activities to be carried out further along the coastline. Overall, this is considered as a negligible effect. Potential navigational issues on marine recreational vessels is further discussed and assessed in Chapter 12: Navigation, of this ES.

Overall, there is a negligible effect that is considered not significant.

11.6.2.2 Operation

The land-based or sea-based recreational resources will not experience any direct effects during the operation of the Development. The indirect effect on visibility is assessed in Chapter 6: Landscape and Visual Assessment, of this ES. There is no significant visual effect on National Cycle Route 1 and 76 and Regional Cycle Route 63 due to no or limited visibility. Fife Coastal Path will experience significant impact on local views up to 6 km. Beyond 6 km, there will be no significant impact due to distance, screening and limited visibility. No significant visual effect was predicted on Wemyss Castle.

With regard to general effects on tourism in the area, as detailed above, studies have been undertaken to determine the effects of typical windfarms on tourism in the UK. Overall, the studies suggest that the majority of those surveyed do not have a negative attitude towards windfarms. The Methil Offshore Demonstration turbine would only be present in this location for a maximum of five years further reducing any significant effects.

Overall, the Development would have a negligible effect on tourism.

11.6.3 Land-Use

The Development will be located offshore and as such there will be change in land-use. The redevelopment of FEP is an improvement to the existing land in Fife region. This is considered as a short-term, positive effect at a local and regional level. Overall, these effects are negligible and not significant. Any potential impact on coastal hydrology due to the Development is further discussed in Chapter 9: Water Resources and Coastal Hydrology of this ES.

11.6.4 Commercial Fishing

11.6.4.1 Construction

The construction phase will last for 6 months in total, with the offshore piling and structure installation lasting for the duration of approximately 1 month. Given the location of the single prototype demonstration wind turbine approximately 20 m offshore, there will be no need for an exclusion zone for fishing vessels during construction. A safety zone will be declared to ensure that there are no safety risks to the fishing vessels due to the presence of jack-up barges during the construction phase. Any spoil arising during drilling of the foundation piles will either be utilised within FEP site works or removed from site and disposed of at a waste facility. There will be no underground cabling involved as the cable will run along the bridging structure between the turbine and the shore.

Consequently, no potential financial losses are predicted on commercial fishery vessels, given the small scale, location and type of Development, number of fishing operations within the vicinity and availability of alternative fishing grounds in the area.

Overall, no significant effects are predicted.

11.6.4.2 Operation

There will be no exclusion zone once the turbine is operational and no potential financial losses as described in Section 11.7.4.1. Further measures related to navigation of commercial vessels and lighting of turbines is discussed in Chapter 12: Navigation of this ES. No significant effects are predicted.

11.7 Mitigation and Enhancement

There are no significant effects predicted during the 5 year operational period of the Development. Therefore, no further mitigation is required.

11.8 Residual Effects

As a consequence of there being no requirement for mitigation, the significance of residual effects is as described above.

11.9 Cumulative Effects

Cumulative effects on outdoor recreational facilities are assessed in Chapter 5: Landscape and Visual Assessment of this ES.

11.10 Summary of Effects

A negligible impact is anticipated during the temporary construction phase and 5 year operational phase on local and national economy, tourism and recreational resources, land-use and commercial fishery.

11.11 Statement of Significance

There are no significant effects predicted during the construction and operation phase on the tourism, recreation, land-use and commercial fishery resources.

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2 EIA METHODOLOGY

This chapter of the ES details the overall approach that has been followed in undertaking the assessments of the likely environmental effects of the proposed Development and detailing the relevant legislative framework.

This ES considers the effects of the construction and operational phase of one near shore turbine which, is envisaged to be installed by early 2011, operational for a five year period, and after which the turbine will be dismantled and relocated to an alternative, permanent offshore position.

2.1 Legislative Context of the Application

Consents for the construction of offshore electricity generating stations in Scottish Waters are regulated under the provisions of Section 36 of the Electricity Act 1989 (As Amended). Consent is needed for all offshore generating stations over 1 MW installed capacity in territorial waters.

Environmental Impact Assessment (EIA) is a process intended to ensure that developments which are likely to have significant effects on the environment are only granted permission after a prior assessment of the likely environmental effects, associated with certain projects, has been undertaken. The assessment must be carried out on the basis of information supplied by the developer, in the form of an Environmental Statement (ES), together with information received as a result of consultation with stakeholders, including consultees and members of the public.

The Development accompanies a planning application to the Scottish Ministers under section 36 of the Electricity Act 1989. The requirement for EIA in Scotland for offshore windfarms is provided by the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended) ("The EIA Regulations")[1] which transpose the European Council Directive 85/337/EEC[2] as amended by the Council Directive 97/11/EC[3].

The Development is classed to be a Schedule II Development under the EIA Regulations as it falls within the description of development set out in Schedule 2 Regulation 2(1) (a):

"a generating station, the construction of which (or the operation of which) will require a section 36 consent"

In line with the guidance [4] and in view of the nature and size of the Development, the Developer considered that an EIA should be undertaken and therefore did not seek a formal 'Screening Opinion' as to whether or not an EIA was required.

The request for a Scoping Opinion was submitted to the Scottish Government in accordance with Regulation 7 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000. Details of the scoping opinion by the Scottish Government together with all received responses to consultation undertaken by the Scottish Government are provided in Section 2.3.

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[1] *The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 ("The EIA Regulations"),* OPSI: London

[2] Council of the European Communities (1985) *Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment'* , Official Journal L175, 05/07/1985, Pg: 40–48, online. Available at: [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31985L0337:EN:HTML] [Accessed on 18/01/2010]

[3] Council of the European Union (1997) *Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment*, Official Journal L 073, 14/03/1997, pp 5 – 15, online. Available at: [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997L0011:EN:HTML] [Accessed on 18/01/2010]

[4] Scottish Government (2000) Guidance on the Electricity Works (Environmental Impact Assessment) (Scotland0 Regulations 2000; [online], Available at (http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/ElectricityWorksEIARegs#a3) [Accessed on 10/02/2010] – Paragraph 3.2 and paragraph 3.3

2.2 EIA Guidance

The information that a developer is required to submit as part of the EIA process is specified in Schedule 4 of the EIA Regulations.

Guidance in relation to good practice, which have been considered throughout the EIA process comprises of the following documents:

- Scottish Executive Circular 8/2007 'The Environmental Impact Assessment (Scotland) Regulations', November 2007[5];
- CEFAS, Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements, June 2004[6];
- Environmental Impact Assessment: Guide to Procedures, January 2000[7];
- Planning Advice Note (PAN) 58 'Environmental Impact Assessment,' Scottish Executive, September 1999;
- Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydroelectric Schemes, SNH, 2002; and
- Guidelines for Environmental Impact Assessment, Institute of Environmental Management and Assessment, 2004[8].

2.3 Scoping and Consultation

2.3.1 Scoping

The aim of the Scoping process is to identify key environmental issues at as early a stage in the process as possible, to ascertain which elements of the proposal are likely to result in significant effects on the environment and to establish the extent of survey and assessment required for the ES.

A Scoping Report was prepared that identified the potential significant environmental effects and a proposed scope of works that would enable these to be assessed in sufficient detail to allow the planning authority to determine the planning application.

The scope of works included in the report extended to the range of technical assessments that should be undertaken, the extent of desk study and field work to be carried out and the approach that should be adopted to assess the likely effects of the Development on the receptors identified as part of these assessments.

The Developer requested a scoping opinion from the Scottish Government in December 2009. The responses were received from the Scottish Government in February 2010 and this ES has been prepared with regard to the content of the Scoping Opinion.

A summary of consultation responses from the Scottish Government, Fife Council and other relevant parties consulted during the Scoping stage is presented in Table 2.1.

[5] ibid
[6] Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf o the Marine Consents and Environment Unit (MCEU) (2004) *Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements*
[7] Communities and Local Government(2000) *'Environmental Impact Assessment: Guide to Procedures'* (http://www.communities.gov.uk/publications/planningandbuilding/environmentalimpactassessment)
[8] IEMA (2004) Guidelines for Environmental Impact Assessment

Table 2.1 Consultation Responses

Consultees	No Response/No Comments	No Objection	Referral to other consultees	Water Resources & Coastal Hydrology	Ecology/Ornithology	Landscape & Visual	Planning Policy	Archaeology and Cultural Heritage	Noise and Air Quality	Tourism and Socio-Economics	Telecoms and Aviation	Navigation and Commercial Fishing	Shadow Flicker	Cumulative Issues	Other Issues
Anstruther Harbour Marina												✓			
Arqiva Ltd.											✓				
Atkins Global[9]											✓				
BAA Airports Safeguarding											✓				
BT (Radio Network Protection Team)											✓				
Civil Aviation Authority (CAA)											✓				
Defence Estates, Ministry of Defence (MoD)											✓				
East Lothian Yacht Club												✓			
Fife Council				✓	✓	✓			✓		✓		✓		
Fife Fishermen's Association												✓			
Forth Ports (Methil Docks)											✓	✓			
Health and Safety Executive															
Historic Scotland								✓							
Joint Radio Company (JRC)											✓				
Marine Coastguard Agency (MCA)												✓			
Marine Scotland												✓			
NERL Safeguarding (NATS)												✓			
Non-Affiliated Creel Fishermen												✓			
Northern Lighthouse Board												✓			
OFCOM											✓				
Royal Society of Protection of Birds (RSPB)					✓									✓	
Royal Yachting Association (RYA) Scotland												✓			

[9] Atkins Global has taken over operations from CSS Spectrum Services Ltd.

Consultees	No Response / No Comments	No Objection	Referral to other consultees	Water Resources & Coastal Hydrology	Ecology / Ornithology	Landscape & Visual	Planning Policy	Archaeology and Cultural Heritage	Noise and Air Quality	Tourism and Socio-Economics	Telecoms and Aviation	Navigation and Commercial Fishing	Shadow Flicker	Cumulative Issues	Other Issues
Scottish Canoe Association										✓					
Scottish Development International	✓														
Scottish Enterprise	✓														
Scottish Environment Protection Agency (SEPA)					✓		✓								
Scottish Fishermen's Federation (SFF)												✓			
Scottish Government Renewable Energy Division			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Scottish Government, Energy Consents Ports and Harbour Branch												✓			
Scottish Government, Sea Fisheries Division												✓			
Scottish Natural Heritage (SNH)					✓	✓	✓	✓						✓	
The National Federation of Fisherman's Organisation (NFFO)												✓			

In addition to the above organisations, recreational sailing clubs and other fishing associations were also consulted during the EIA process:

- Methil Boat Club;
- Largo Bay Sailing Club;
- Dysart Sailing Club;
- Elie & Earlsferry Sailing Club;
- Scottish Fishermen's Organisation;
- Fife Creel Fishermen's Association;
- Methil Creel Fishermen;
- 10 Metre & Under Fishermen's Association; and
- Cockenzie & Port Seton Fishermen's Association.

Consultation with local fishing and recreational groups will continue throughout the Development process.

2.3.2 Public Consultation

The Developer plans to hold a public information day during the first week of April 2010 whilst the application is under consideration by the Scottish Ministers. The public information day will present the information on the Development, the EIA process undertaken and the likely planning timeframe. Local communication and consultation initiatives are planned to continue during the application determination period with the public.

2.4 Identification of Issues

As a result of the scoping responses and on-going consultation, the following issues are addressed in the ES:

- Landscape and Visual;
- Ecology and Ornithology;
- Water resources and Coastal Hydrology;
- Archaeology and Cultural Heritage;
- Noise;
- Shadow flicker;
- Existing infrastructure including aviation and telecommunications;
- Navigation;
- Socio-economics, Recreation & Tourism, Land-Use and Commercial Fishing; and
- Climate and Carbon Balance, Healthy and Safety and Access and Transport.

All elements of the project and associated infrastructure during the construction and operation phase have been assessed in the ES.

2.5 Technical Environmental Assessments

Each of the technical assessments follows a systematic approach, with the principal steps as follows:

- Description of baseline conditions;
- Prediction of potential effects including any cumulative effects;
- Assessment of effects;
- Identification of appropriate mitigation measures; and
- Assessment of residual environmental effects.

Where discussion is regarding non-environmental issues such as effects on existing infrastructure, the baseline conditions are established and potential effects identified, but no assessment of significance has been made.

A summary of each of these steps is provided below.

2.5.1 Baseline Description

In order to evaluate potential environmental effects, information relating to the existing environmental conditions was collected. This is known as the baseline which is used to assess the changes that may take place during the construction and operation of the proposed Development.

Within each technical assessment, the methods of data collection were discussed with relevant consultees. Data was also collected from public records and other archive sources and, where appropriate, field surveys were carried out. The timing of the work and the defined study area, specifically relating to the subject matter in question, are also outlined within each chapter.

2.5.2 Prediction of Potential Effects

The prediction of potential effects covers the two phases, construction and operation phase of the Development that is considered to be temporary and short term effects. During each phase of the Development different environmental effects are likely to arise. The technical assessment identifies direct and indirect effects and where possible, adverse or beneficial. Each technical assessment details any cumulative effects with other developments where appropriate.

Following identification of potential environmental effects, baseline information was used to predict changes to existing site conditions and permit an assessment of these changes.

2.5.3 Assessment of Effects and Evaluating Significance

The effect that the wind turbine may have will be influenced by a combination of the sensitivity of the environment and the predicted degree of change (the magnitude) from the baseline state. Environmental sensitivity may be categorised by a multitude of factors; for instance: status of rare or endangered species. The initial assessment, consultation and scoping stages identified these factors along with the implications of the predicted changes.

For the purposes of environmental assessment, the significance of 'effect' is generally considered in terms of:

- Negligible – no detectable change to a location, environment, species or sensitive receptor;
- Minor – a detectable but non-material change to a location, environment, species or sensitive receptor;
- Moderate – a material, but non-fundamental change to a location, environment, species or sensitive receptor; and
- Major – a fundamental change to a location, environment, species or sensitive receptor.

This ES generally follows the aforementioned theoretical approach. Where specific technical assessment areas adopt a variation, this is identified within the methodology set out in the assessment section of the chapter. Within each assessment chapter the criteria for assessing significance of effects are made explicit.

2.5.4 Mitigation and Enhancement

Where the assessment process identified potential significant adverse effects, mitigation has been proposed in order to minimise or remedy these effects, where appropriate. Measures included the management and operational measures during the course of the operation and testing of the prototype. Relevant mitigation measures have been proposed in each technical assessment where necessary.

2.5.5 Assessment of Residual Effects

The residual effects of the Development are those that remain, assuming successful implementation of the identified mitigation measures. Residual effects are identified in each technical assessment alongside an assessment of their significance in terms of the EIA regulations.

2.5.6 Cumulative Effects

In accordance with the EIA Regulations, the ES has given consideration to 'cumulative effects'. By definition these are effects that result from incremental changes caused by past, present or reasonably foreseeable actions together with the Development. For the cumulative assessment, the combined effects of several developments, which may on an individual basis be insignificant but, cumulatively, have a significant effect, such as landscape and visual effects, have been considered.

The extent of any cumulative assessment is defined in each technical assessment chapter and can include both existing and proposed windfarm developments and other forms of

development. The potential landscape and visual effects, for example that relate to the intervisiblity of individual windfarm development schemes will be much more wide ranging than noise effects which will be limited to receptors in the more immediate vicinity of the Development.

In relation to some of the technical chapters 5 to 15) of this ES, specific guidance and policy exists advising that effects associated with existing wind farm developments should be considered as cumulative effects. These are Chapter 5: Landscape and Visual Impact, Chapter 6: Noise and Chapter 8: Ornithology of this ES.

Where no cumulative effects have been identified, this is also stated.

2.5.7 Limitations of ES

A number of assumptions have been made during preparation of this ES, as set out below. Assumptions specific to certain environmental aspects are discussed in the relevant Chapters of the ES.

The assumptions are:

- The principal land uses adjacent to the site remain as they are at the time of the submission of the planning application, except in cases where planning permission has already been granted for development. In these cases, it is assumed that the approved development will take place, and these have been treated as contributing to "cumulative" effects; and
- Information provided by third parties, including publicly available information and databases is correct at the time of submission of the planning application (March 2010).

The EIA has been subject to the following limitations:

- Baseline conditions are accurate at the time of the physical surveys but, due to the dynamic nature of the environment, conditions may change during the site preparation, construction and operational phases; and
- The assessment of cumulative effects has been reliant on the availability of known information relating to existing wind farm developments at February 2010.

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3 PROJECT DESCRIPTION

3.1 Introduction

This chapter describes the site, the proposed development, the innovations that are being tested as part of the demonstration turbine, and the required onshore components of the development. It also provides an indication of the proposed methods and timescales for the construction, operation and relocation phases.

3.2 Site Selection Rationale

In 2007 2-B Energy began the search for prototype sites. The requirement is for 2-B Energy to find an onshore or near-shore site as a first step, where testing and certification of this first prototype can be achieved. The proposal is to undertake this in a controlled, safe environment which can provide regular, easy access to the demonstrator.

2-B Energy is working on proposals which represent a significant variation from the traditional design concept for wind turbines. As a result the deployment of a full scale offshore design with large rotor makes it difficult to find suitable locations. Locations in Sweden, Denmark, Netherlands and UK have been identified and assessed. Appropriate sites with land access are very difficult to deliver, as the full welded structure cannot be transported far onshore.

There is therefore a necessity to locate in a coastal area, either onshore or near-shore with the opportunity for regular access from the land. Given the offshore scale of the turbine it is clear that any near-shore or onshore location will have constraints in some areas. For this reason 2-B's strategy is for a limited demonstration permit of up to 5 years. At this size (6 MW) the wind turbine is not easy to relocate, therefore a coastal location is preferred. Relocation can then be completed without excessive costs or complications.

Given the industry opportunity in the UK and the progress which has been made in the development of the Crown Estate Scottish Round and Round 3 Licences, 2-B has focussed on identifying a site on the East Coast of the UK. Discussions were held with a number of regional development agencies. Scottish Enterprise and One North East have helped to identify and consider alternatives for the deployment of the 2-B project. Following careful assessment and with particular focus on deliverability and timescale, 2-B has chosen to progress with deployment at the Fife Energy Park, Methil.

Fife Energy Park is suitable for the following reasons:

- The site has grid connection for two wind turbines with reasonable conditions;
- The site aims to host this kind of technology and offers the potential to expand even into manufacturing activity;
- The site is an old coal mine, now a major industrial fabrication facility where large structures and platforms for the offshore Oil and Gas Industry, and now offshore renewable, have been constructed and launched over a significant period;
- The site is owned by Scottish Enterprise and part occupied by the offshore structure fabricator BiFab. There is additional land where further fabrication and manufacturing facilities could be established;
- Bird studies have been completed on site (for the nearshore turbine location) and almost 3 years of wind measurements have been recorded on site;
- The site can host a near shore unit, which would be located approximately 20 meters off the coastal defence of the site. The Forth Estuary is also well suited for two sites offshore (within 1.3 - 1.6 km from the shore), which would use the same grid connection as the first unit;
- The 2-B requirements for delivery of the technology of the demonstration project are optimal at the Fife Energy Park location. The first unit can be located near shore with full access in a position which can accommodate the relocation of the near shore unit once tested. For this relocation, the tower structure can be re-used as the seabed conditions and water depth are similar; and

- The site is also in close proximity to upcoming projects of interest to 2-B (Scottish Round and Round 3 projects).

3.3 General Project Description

The proposal is to construct and operate a 6MW demonstration wind turbine comprising the following elements:

- One demonstration wind turbine;
- Onshore control building and substation; and
- Permanent bridge link between site and turbine tower.

The proposed layout of the development is shown in Figure 1.2.

Construction would take place over a 6 month period after which the turbine would become operational, and would generate electricity for a maximum of five years, while the turbine is commissioned and the concept, components and performance are tested. At the end of the design proofing period the turbine would be relocated to a permanent offshore location. This relocation will be subject to a separate Environmental Impact Assessment and consenting process. In the event that the turbine is not relocated it will be decommissioned and removed from the site.

The wind turbine will be connected to the national grid via an existing 33 kV underground supply which currently supplies power to the Fife Energy Park. The connection to the project transformer station will be routed underground from the existing termination which is approximately 400 m from the turbine location. Discussions are currently ongoing with the Scottish Power, the grid operator and Scottish Enterprise, the landowner, with regard to details of the connection and route across the site. An indicative connection route is shown in Figure 1.2

The turbine would be located approximately 20 m offshore from Fife Energy Park (FEP).

3.4 Site Description

The FEP site comprises 133 acres of semi-derelict industrial land in Methil. Scottish Enterprise is the landowner, having acquired the site from Wemyss Estate Trustees and Crown Estate in 2005.

Fife Energy Park was originally the site of the Wellesley Colliery which operated from 1890 until closure in 1964. The site was largely established by the deposition of colliery spoil, gradually reclaiming land from the sea. Following the closure of the mine, the site was developed in the 1970s as a North Sea Oil fabrication facility by Redpath de Groot Caledonian (RGC). RGC subsequently sold their interest to Kvaerner Oil & Gas who operated the yard until 2001 when it was mothballed.

In the main, the site produced drilling rigs for the offshore oil and gas industry and at its peak, over 2000 people were employed on the site.

A major redevelopment programme with investment totalling over £20 million is currently underway. The vision for the FEP is to establish a state of the art industrial facility for renewable energy in Scotland, delivering excellence in engineering, fabrication and assembly. It will incorporate a vibrant local and national supply chain and host innovation in the supporting technologies, across the energy sector.

Interim works have been completed to a 300 m stretch of coastal defences along the southern edge of the site where existing defences had been breached and material was starting to slip into the sea. A draft Coastal Defence Strategy for the entire Park has been developed along with detailed design work for the quayside and some sections of the coastal defences.

3.5 The Proposed Development

3.5.1 Phasing of Turbine Installation

Phase 1 - This Environmental Statement considers only the effects of the installation of one near shore turbine which provides easy access to monitor and make adjustments as required to maximise the efficiency off the new technology. It is envisaged that this first turbine is installed by early 2011 for a five year demonstration period.

Phase 2 of the project, consists of a second turbine, which would be installed approximately 1.5 km offshore and the relocation of the near shore turbine which would be dismantled and moved to a second offshore location. Phase 2 will be subject to a separate Environmental Impact Assessment and consenting process.

3.5.2 The Demonstration Wind Turbine

2-B Energy is developing wind turbine technology for application to the global offshore wind market. The concept incorporates large, two-bladed turbines on steel lattice towers, producing power, which in the large scale offshore developments will be fed to an HVDC grid system. Please see Figure 3.1.

The development of 2-B Energy's first prototype includes the manufacture, assembly and installation of a full scale 6MW turbine. This demonstration project, effectively a proof of concept, requires the turbine to be connected via an electrical transformer to the national electrical grid system.

The turbine tower is 120 m tall, with a rotor diameter of 130 m, giving a maximum level from the turbine base to turbine tip of 185 m. However, as the turbine base will be located below ordnance datum, the maximum height of the turbine above ordnance datum (AOD) will be lower than 185 m. The Mean High Water Spring (MWHS) tide levels is 2.6 m AOD[1], therefore, the height of the blade tip visible will be approximately 179 m AOD. The turbine is fixed to a steel tubular lattice structure which provides the foundation and tower as a continuous structure without transition pieces. Figure 3.1 shows the turbine arrangement. Figure 3.3 shows a cross section of the turbine and the tidal range for the area surrounding the Development.

The turbine is a downwind turbine, meaning that the nacelle faces away from the wind and the blades are on the downwind site of the tower. The blades would be manufactured from fibre-reinforced epoxy. As the blades will be downwind from the tower they can be made to be more flexible and lighter than those of a similar sized 'standard' wind turbine.

The turbine would be of variable speed, so that the turbine rotor speed varies according to the energy available in the wind. The rotor speed varies between 5 and 13.25 revolutions per minute, dependant on the wind speed. The turbine will generate electricity in wind speeds between 4 and 25m/s (9-56mph or force 3-10 on the Beaufort Scale). At the cut-out wind speed the turbine will shut down for self protection.

The nacelle houses the gearbox and generator and is mounted on the steel lattice tower. The tower will have three or four legs strengthened by diagonal crossbeams. The number and frequency of any horizontal cross beams has been minimised to discourage birds roosting on the tower.

The lower section of the tower would be constructed so that boats servicing the turbine can moor safely within the lattice structure of the tower. Thus, allowing equipment, replacement parts or machinery to be hoisted up the central column directly from the craft below.

The nacelle would be accessed via ladders constructed within the lattice framework of the tower and rest platforms will be included at appropriate intervals for safety purposes.

Access to the demonstration turbine would be gained via a bridge structure which will provide permanent access between the shore and a platform on the turbine tower see Figure 3.6.

[1] UK Hydrographic Office Admiralty Tide Tables (2008)

The finish and colour of the nacelle and blades is likely to be a minimum reflective, semi-matt pale grey. For the purposes of navigational safety the lower sections of the turbine are required to be painted yellow to make the turbine easily visible to shipping, up to a height of 8m above the Mean High Water Springs (MHWS).

Lighting and marking requirements have been taken into account. 2-B energy has obtained guidance from the Maritime Coastguard Agency (MCA), Civil Aviation Authority (CAA), Trinity Lighthouse Service, the Royal Yachting Association (RYA) and others, to make sure that the wind turbine is appropriately marked and lit.

The turbine will be equipped with flashing yellow lights, fog horns, yellow paint and radar reflectors. Red aviation lights will also be installed.

Table 3.1 Turbine Specifications

Turbine Specification	**Dimension / Number**
Turbine Rated Capacity	6MW
Number of Blades	2
Tower Style	Lattice
Max hub height	120 m
Max blade diameter	130 m
Max height to blade tip	185 m
Revolutions per minute	5 – 13.25
Direction of Rotation	Clockwise

The supply chain for this project is already well developed. If the demonstration project outcome is positive, 2-B Energy envisage an annual production of up to 160 turbines, targeting the UK Round 3. Manufacturing will require to be carried out in a location close to the licensed Round 3 sites, and a location on the East Coast of the UK presents the best opportunity to service this market.

3.5.3 Turbine Power Output and Transformers

One of the main innovations of the Demonstration Turbine relates to the higher than standard power output. Unlike conventional installations, this turbine on its own is not grid compliant. As part of a large offshore power plant, power output will be controlled by the 2-B Energy electronic control module, which will harmonise the turbine output through variable frequencies.

When operating, the rotational speed of the blades is geared up through the gearbox which drives the generator. This produces a three-phase power output at 10kV, which in the case of this demonstrator, will be converted at the land based sub-station transformer to grid compliant 33kV output.

3.5.4 Wind Turbine Foundation

In order to construct the foundations, it is likely that at high tide a jack up barge will be floated to the turbine position, where the barge will jack up out of the water in order to provide a stable platform for construction. Alternatives to drill from the construction pad are also being investigated. Boreholes will be drilled to a depth of up to 20 m and steel piles

inserted and grouted. The piles are likely to be a maximum of 20 m long and approximately 2 m in diameter.

The final foundation design would depend on the results of detailed pre-construction geo-technical investigation. These investigations would provide confirmation of the suitability of the ground conditions for the intended foundation and allow detailed foundation design based on parameters such as stiffness and bearing values.

Any spoil arising from the drilling of the foundation piles will either be utilised within the Fife Energy Park site works or removed from site and disposed of at a licensed waste facility.

3.5.5 Crane Pad

Onshore, close to the turbine position, a hardstanding will be constructed with the stable base, on which to laydown the turbine components ready for assembly and erection. The cranes required to lift the tower and, nacelle and rotor will also be sited within this area. The total approximate area of crane hardstanding will be 400m^2 (20 m x 20 m) with an approximate thickness of 600 mm as shown on Figure 3.4.

It may also be necessary to undertake work to protect the existing coastal defences in the immediate vicinity of the crane pad.

The crane pad would be left in place for the duration of the consent, in order to allow for use by similar plant, should major components need adjustment or replacement during the course of the demonstration project.

3.5.6 Site Access

Vehicular access to the site will be via the entrance to Fife Energy Park (FEP), this route is suitable for Heavy Goods Vechicles (HGVs). It is not proposed to construct any additional tracks within the FEP).

3.5.7 Turbine Component Delivery

The majority of the turbine components will either be manufactured on site or delivered via sea. BiFab, a steel fabrication yard already making steel transition pieces for the offshore wind market, is located within the FEP, are capable of making the lattice tower utilised by the demonstration turbine. The nacelle and blades would be delivered by sea and offloaded at one of the quays. These would be driven around to the hardstanding area ready for erection.

3.5.8 Cabling

Cable connections from the turbine to the site will be routed either on, or within the structure and across the link bridge, thereby removing any need to disturb the foreshore area with cable routes. The turbine would then be connected to the grid via the turbine transformer station to the existing 33Kv national grid connection to the Fife Energy Park. A Supervisory Control and Data Aquistition (SCADA) system would be installed to gather information from the turbine and would provide the facility to operate the machine remotely. A 20 mm^2 fibre optic communications cable would run alongside the power cables to link the turbine to the SCADA system as shown on Figure 3.5.

3.5.9 On-site control Building

The turbine will be controlled from the on-site control building. Half the building will comprise a two-storey office with velux type windows in the roof to enable views of the nacelle and rotor, during the various testing phases.

The remaining half of the building will comprise a full height workshop. It will have one main entrance (double door) plus one larger garage door and one normal side door, as shown in Figure 3.2.

3.5.10 Wind Monitoring Mast

As part of the turbine certification, 2-B Energy require to measure wind speeds on site at the height of the turbine rotor. Within the site there already exist a number of lighting towers of steel lattice construction. These towers reach a height of approximately 80 m above ground level and 2-B Energy propose to re-use one of these existing site towers, extended to the nacelle height of 110 m to record wind speeds and directions for certification purposes. Should this prove not to be possible, 2-B Energy would erect a more standard wind monitoring mast at a height of 110 m.

The location of the proposed wind mast installation (referred as wind station) is shown on Figure 1.2.

3.5.11 Site Accommodation and Temporary Works

A temporary construction compound would be set aside within the FEP during the construction of the turbine. This would provide space for:

- Temporary 'Portacabins' needed for site offices and welfare facilities;
- Containers for tool and equipment storage;
- Parking for up to 10 vehicles; and
- Storage of components and materials.

The precise location and size of the compound will be determined by the appointed construction contractor.

Once construction and commissioning works are completed all portacabins, machinery and equipment will be removed.

3.5.12 Pollution Control Measures and Environmental Management

In order to ensure that all mitigation measures outlines within this ES are carried out on site, contractors would be provided with the following documents which must be adhered to throughout the construction process:

- Pollution/Spill Prevention Plan, relevant environmental procedures and method statements;
- Noise management plan;
- Planning conditions; and
- Other requirements of statutory bodies.

Selection of the construction contractor would be through a quality and price matrix which will include an assessment of their record of dealing with environmental issues. The contractor shall be required to maintain a clean and tidy site and manage the site area in accordance with best practice.

3.5.13 Foul Drainage

During construction, temporary toilet facilities for construction workers will be provided in the form of a standard 'Port-a-loo', hired during the construction phase from a local supplier and serviced at weekly intervals by a specialist pump truck which would evacuate the holding tank, clean the unit and add fresh water. No running water is required on-site as the unit's holding tank is replenished during each weekly service.

During operation and testing of the turbine, the welfare facilities with FEP will be utilised by staff attending to the turbine.

There would be no trade effluent, sewage effluent, or waste disposal into the sea, during the construction or operation of the turbine.

3.5.14 Site Safety and Emergency Procedures

Prior to construction commencing, the appointed contractor would be required to prepare a construction phase Health and Safety Plan.

An Operation and Maintenance Manual, for the design life of the turbine would also be prepared, which would cover the operation, design proving and re-location safety related procedures.

Emergency Services Vehicles and/or boat access would be addressed within the Health and Safety Plan. The contractor will liaise with all of the emergency services prior to works commencing, to ensure that access for Emergency Services vehicles or boats would be maintained at all times during construction.

3.6 Operation and Design Proofing

2-B Energy's concept is a new approach to the development and operation of offshore wind installations. Whilst the general arrangement of the turbine and the overall concept are novel and innovative, the turbine utilises already proven technology at a component level, thereby de-risking the project.

2-B Energy envisage that a site based engineering staff of 4-6 people will be required to undertake the commissioning and testing of the prototype. The engineers will require daily access to the turbine for instrumentation, maintenance and monitoring purposes. The operation and design proofing of the turbine involves no discharges, and utilises no chemicals other than lubricants such as oil. In the unlikely event of a pollution spill incident there would be an accidental spill procedure for the site. All operation and maintenance staff would be trained in the procedure. Any empty lubricant containers, waste oil and other waste would be removed from the site by the turbine engineers or by licensed waste carriers and disposed of at a licensed waste facility in accordance with current regulations.

3.7 Turbine Relocation

At the end of the five year period the turbine would be dismantled and relocated, to an offshore position. 2-B Energy has applied via Crown Estates Offshore Demonstrator Application Round for an offshore licence. The proposed site is approximately 1.5 km from the Fife Energy Park in the Firth of Forth.

In the event that the offshore location is not licensed or consented the turbine would be relocated to another suitable offshore location and a variety of options are being pursued.

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6 NOISE

This chapter of the ES provides an assessment of the potential effects of noise resulting from the Methil Offshore Demonstration Wind Turbine ("the Development").

The aim of the assessment is to predict the levels of noise potentially produced by the Development at the nearest noise sensitive receptors and assess these against relevant standards and guidelines. Note that only the effects of onshore noise on human receptors are assessed in this chapter. The effects of offshore noise on ecological receptors are addressed in Chapter 7: Ecology. The chapter is set out in the following structure:

- Introduction;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Assessment of Potential Effects;
- Mitigation Measures and Residual Effects;
- Cumulative Effect Assessment;
- Summary of Effects; and
- Statement of Significance.

A glossary of acoustic terminology and a definition of terms are provided at the end of this chapter.

This chapter is supported by the following Technical Appendices provided in Volume II of this ES:

- Appendix A6.1: Turbine Noise Emission Data; and
- Appendix A6.2: Baseline Noise Survey Records.

6.1 Assessment Methodology and Significance Criteria

6.1.1 *Relevant Guidance (Operational Noise)*

The following guidance and information sources have been considered in carrying out the operational noise assessment:

- Planning Advice Note 45 (PAN 45): Renewable Energy Technologies[1];
- ETSU-R-97: The Assessment and Rating of Noise from Wind Farms ('ETSU-R-97')[2];
- Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)[3]; and
- Prediction and Assessment of Wind Turbine Noise[4].

6.1.1.1 PAN 45

PAN 45 provides advice to local authorities on the planning issues associated with wind energy development. With respect to noise from windfarms (also applicable to single turbines), it states that *ETSU-R-97: The Assessment and Rating of Noise from Wind Farms "...presents a series of recommendations that can be regarded as relevant guidance on good practice."*

6.1.1.2 ETSU-R-97

ETSU-R-97 provides a framework for the assessment and rating of noise from wind turbine installations. It has become the accepted standard for wind energy developments in the UK, and the methodology has therefore been adopted for the present assessment.

[1] Scottish Government (2002). PAN 45 (revised 2002): Renewable Energy Technologies
[2] ETSU for the DTI (2006). ETSU-R-97: The Assessment and Rating of Noise from Wind Farms
[3] Draft National Policy Statement for Renewable Energy Infrastructure (EN-3), Department of Energy and Climate Change, November 2003
[4] Bowdler et al. (2009). Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects. Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics

ETSU-R-97 recommends the application of noise limits at the nearest noise-sensitive properties, to protect outside amenity and prevent sleep disturbance inside dwellings. It proposes that site-specific noise criteria are adopted based on the existing levels of background noise. Noise from wind turbines and background noise both typically vary with wind speed. According to ETSU-R-97, wind energy noise assessments should therefore consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the proposed wind turbines.

6.1.1.3 Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)

The UK Government published its draft National Policy Statement for Renewable Energy (EN-3) in November 2009. Paragraphs 2.7.63 and 2.7.64 confirm that "*...assessment of noise from the operation of the wind turbines should use ETSU-R-97 in accordance with latest industry good practice which should reflect any updated guidance issued in relation to ETSU-R-97 and accepted by Government"*.

6.1.1.4 Prediction and Assessment of Wind Turbine Noise

An article in the March / April 2009 Edition of the Institute of Acoustics' *Acoustics Bulletin* (the 'IOA Bulletin article') sets out a number of preferred procedures for the prediction and assessment of wind turbine noise and the form in which certain information should be presented to support an environmental noise assessment for a proposed wind energy development. The authors of the article included members of the Noise Working Group responsible for the preparation of ETSU-R-97, and include those who represent developers, local authorities and third party groups. The recommendations in the article are intended to enhance the quality of wind farm noise assessments and usefully limit areas of disagreement between parties acting for developers and those acting for objectors, and supplement the recommendations of ETSU-R-97.

Whilst the article does not have the status of official government guidance or policy, it is generally agreed to represent a statement of good practice on the specific aspects of wind farm noise assessments which it addresses.

The following issues were addressed:

- The acquisition of baseline data;
- The prediction of wind turbine noise immission level at receptors locations; and
- The significance of low-frequency noise, infrasound and ground-borne vibration.

Acquisition and Analysis of Background Noise Data

The recommendations of the IOA Bulletin article relate principally to the measurement and use of wind speed data, against which background noise measurements are correlated. The article recommends measuring wind speeds at two heights, H1 and H2, H1 being not less than 60% of the proposed turbine hub height and H2 being between 40% and 50% of proposed hub height. For each ten minute period the mean wind speed measured at height H1 should be corrected to hub height using a specified procedure, which takes account of the wind shear conditions occurring during that ten minute period. The calculated hub height wind speed is then corrected to 10 m height using the procedure specified in BS EN 61400-11:2003[5], which applies a standardised wind shear profile. This allows for site-specific wind shear characteristic to be taken into account and for a comparison with measured wind turbine noise emissions to be made on a like-for-like basis.

The above procedure has been followed in the assessment below. Specific details are included in Section 6.2.3.

[5] BS EN (IEC). 61400-11:2003 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques

Prediction of Wind Turbine Noise Immission Levels

The IOA Bulletin article recommends the use of the ISO 9613-2[6] method in calculating the levels of wind turbine noise at receptor locations ('immission levels'), with the following specific measures:

- The turbine sound power levels should be stated, along with whether these are measured levels, measured levels with an allowance for measurement uncertainty, warranted levels or generic levels;
- The atmospheric conditions assumed should be stated, with 10° C and 70% relative humidity preferred;
- The ground factor assumed should be either:
  (i) G=0 (hard ground), together with measured sound power levels; or
  (ii) G=0.5 (mixed ground); together with a receiver height of 4.0 m and manufacturer's warranted sound power levels, or measured sound power levels plus an allowance for measurement uncertainty;
- Barrier attenuation should not be included; and
- The predicted noise levels ($L_{Aeq,t}$) may be converted to the required $L_{A90,10min}$ by subtracting 2 dB.

The above procedure has been followed in the prediction of noise levels; employing a temperature of 10° C, 70% relative humidity and a ground factor of G=0 (receiver height does not affect noise predictions when applying such a ground factor). As neither measured nor warranted sound power data is currently available for the 2-B turbine, generic values have been used, based upon theoretical sound power levels (Table 6.1).

ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, i.e., down-wind or under a moderate, ground-based temperature inversion as often occurs at night (often referred to as stable atmospheric conditions). The specific measures recommended in the IOA Bulletin article have been shown to provide good correlation with levels of wind turbine noise measured at operational windfarms[7].

Vibration, Low Frequency Noise and Amplitude Modulation

Vibration refers to those vibrations transmitted through solid structures (e.g. the ground, turbine tower, buildings) rather than through the air.

Low Frequency Noise generally refers to sounds with frequencies between around 20 and 200 Hz, with sound of lower frequencies than this referred to as infrasound. Infrasound is usually considered to occur at frequencies lower than the typical threshold of human perception.

Sensitivity to low frequency noise and infrasound varies throughout the population, and to a greater degree than sensitivity to noise of medium to high frequencies. The criteria for assessing low frequency noise and infrasound are generally designed to take account of the perception thresholds of all but the most sensitive individuals.

Modern wind turbines are typically designed with the rotor on the upwind side of the tower. This design is less prone to producing low frequency noise than designs where the rotors are downwind of the towers. This latter design can cause low frequency noise to be generated due to the blades passing through pockets of low wind-speed air immediately down-wind of the tower. The 2-B turbine design is of the downwind variety. Theoretical calculations of the likely low-frequency noise levels generated by the turbine have been calculated for a distance of 400 m by RISO[8] (Appendix A6.1) NB: The nearest noise-sensitive receptors are approximately 550 m the proposed turbine location. This indicates that levels of low-

[6] IISO 9613-2:1996 Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation
[7] Bullmore et al. (2009). Wind Farm Noise Predictions and Comparison with Measurements, Third International Meeting on Wind Turbine Noise, Aalborg, Denmark 17 – 19 June 2009
[8] Madsen, H. (2008), 2B DWAS Turbine -investigation of low frequency noise and broadband noise, Risø National Laboratory, Technical University of Denmark, updated by email 17/3/2010

frequency noise at such distance from the turbine would be lower than the threshold of perception, and are therefore unlikely to cause problems.

A study[9], conducted in 2006 by Hayes McKenzie on the behalf of the Department of Trade and Industry (DTI) investigated low frequency noise from windfarms. This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines. It also noted, however, that a phenomenon known as Amplitude Modulation (AM) (sometimes referred to as Aerodynamic Modulation) was in some isolated circumstances (5 out of 126 operating windfarms in the UK) occurring in ways not anticipated by ETSU-R-97.

A further study[10] was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) (now the Department for Business, Innovation and Skills (BIS)) by the University of Salford, which investigated the incidence of noise complaints associated with windfarms and whether these were associated with AM. This report defined AM as "*aerodynamic noise from wind turbines, but with a greater degree of fluctuation than normal at blade passing frequency"*. Its aims were to ascertain the prevalence of AM on UK windfarm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

The study concluded that AM has occurred at only a small number (4 of 133)[11] of windfarms in the UK, and only for between 7% and 15% of the time. It also states that the causes of AM are not well understood as yet, and that prediction of the effect is not currently possible. The DTI decided against further research into the phenomenon at this stage, and no revision to the current guidelines (ETSU-R-97) on windfarm noise assessment was recommended.

Research undertaken by Snow[12]. in 1997 found that ground-borne levels of vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992 *Evaluation of human exposure to vibration in buildings (1Hz to 80 Hz)*, and were even lower than limits specified for residential premises.

Ground-borne vibration from wind turbines can be detected using sophisticated instruments several kilometres from the windfarm site as reported by Keele University[13]. This report clearly shows that, although detectable using highly sensitive instruments, the magnitude of the vibration is orders of magnitude below the human level of perception and does not pose any risk to human health.

The IOA Bulletin article concludes that:

"…there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms generally has adverse effects on wind farm neighbours".

There is therefore considered to be no need to specifically address these issues further in this ES.

6.1.2 *Consultation*

Consultation was carried out with Fife Council's Environmental Services department during the scoping process and subsequently. The following aspects were agreed upon:

- The assessment would be conducted in accordance with ETSU-R-97;

[9] Hayes McKenzie (2006) 'The measurement of low frequency noise at three UK wind farms', The Department for Trade and Industry, URN 06/1412
[10] University of Salford (July 2007) 'Research into aerodynamic modulation of wind turbine noise'. The Department for Business, Enterprise and Regulatory Reform, URN 07/1235
[11] The difference in the number of windfarms with such effects quoted in the two reports is due to different means of identifying AM used in the two studies.
[12] D J Snow (1997) Low Frequency Noise and Vibration Measurements at a Modern Wind Farm, ETSU: DTI
[13] Keele University (2005) Microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms: recommendations on the siting of wind farms in the vicinity of Eskdalemuir, Scotland".

- The most potentially noise-sensitive receptors are those on Wellesley Road whose rear elevation overlooks the Energy Park and those in Buckhaven with a direct view of the development site;
- Baseline noise monitoring would be carried out at three locations, to be representative of the background noise levels at the nearest noise-sensitive receptors; and
- The specific choice of monitoring locations and siting of the monitoring equipment.

6.1.3 *Operational Noise Assessment Methodology*

In summary, the assessment process for operational noise comprises:

- Identification of potential receptors, i.e. houses and other potentially noise-sensitive locations;
- Measurement of existing (baseline) background noise levels at a representative selection of the potential receptors;
- Establishment of limits for acceptable levels of wind turbine noise at residential receptors, based on the measured background noise and as specified in ETSU-R-97;
- Prediction of the likely levels of wind turbine noise received at the most sensitive receptors; and
- Comparison of the predicted levels with the noise limits.

ETSU-R-97 specifies the use of the $L_{A90,10min}$ descriptor for both background and wind turbine noise. Therefore, unless otherwise specified, all references to noise levels within this chapter relate to this descriptor. Similarly, all wind speeds referred to relate to a height of 10 m above ground level (AGL) unless otherwise stated.

6.1.3.1 Identification of Receptors

Potential receptors in the area around the Development were identified from Ordnance Survey 1:25,000 scale digital mapping. Ordnance Survey Address Layer 2 data; (a database which combines Royal Mail address data with buildings identified on large-scale Ordnance Survey Mapping and provides addresses, descriptions and grid references) was used to confirm the types of buildings present, i.e. whether residential or other uses.

Background noise measurements were carried out at three locations, previously agreed with the Environmental Services Department of Fife Council.

The method of measuring background noise is described in Chapter 7 of ETSU-R-97 and summarised in Section 6.2.3 below. In brief, it involves continuous measurement of both background noise levels at the receptors, and wind speeds at the location of the turbines for a period of at least one week. The resulting data is then sorted into quiet daytime and night time periods and the relationship between wind speed and background noise established for each location.

6.1.3.2 Turbine Noise Emissions

As previously discussed, as the 2-B turbine is a new design, no measured or warranted sound power level data is available. Calculations of the theoretical sound power level have been carried out, based on established algorithms, by RISO[14]. Wind turbine noise emissions are dependent on, amongst other factors, the rotational speed of the turbine and the pitch angle of the blades. RISO have calculated theoretical sound power levels for three scenarios, based upon varying rotational speed and provided theoretical sound power levels referenced against hub height wind speeds. Details of the variations in rotational speed, blade pitch angle and resulting sound power level are included in Appendix A6.1 Turbine Noise Emission Data. The standard operating parameters of the turbine are described in Appendix A6.1 as *Control 0*. These represent the worst-case, highest noise emissions and have therefore been used in the assessment. As ETSU-R-97 assessments are based on wind speeds at 10 m height, 10 m

[14] Madsen, H. (2008), 2B DWAS Turbine -investigation of low frequency noise and broadband noise, Risø National Laboratory, Technical University of Denmark, updated by email 17/3/2010

wind speeds equivalent to the stated hub height wind speeds have been calculated using the procedure specified in BS EN (IEC) 61400-11:2003. Table 6.1 details the hub height wind speeds, sound power levels and corresponding 10 m wind speeds.

Table 6.1: Wind Turbine Sound Power Levels provided by RISO

Hub Height Wind Speed, ms^{-1}	**4.1**	**6.1**	**8.1**	**10.1**	**12.1**	**14.1**	**16.1**	**18.1**
Sound Power Level, dB, L_{WA},	100.4	101.1	105.4	108.1	109.3	111.7	108.9	105.2
Corresponding 10 m Wind Speed, ms^{-1}	2.8	4.2	5.6	7.0	8.3	9.7	11.1	12.5

Sound power levels for integer 10 m wind speeds were then interpolated from the 'corresponding' 10 m wind speeds immediately higher and lower than the integer value, assuming a linear fit between each pair. The highest sound power level was assigned to the nearest equivalent 10 m integer wind speed. Table 6.2 shows the resulting sound power levels as a function of integer 10 m wind speeds.

Table 6.2: Wind Turbine Sound Power Levels as a function of Integer 10m Wind Speeds

Integer 10 m Wind Speed, ms^{-1}	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Sound Power Level, dB, L_{WA},	100.5	101.0	103.6	106.2	108.1	109.0	110.5	111.7	109.1	106.5

ISO9613 calculations require the use of a noise spectrum, detailing the distribution of sound at different frequencies, as air absorption varies with frequency. Such spectra are expressed in octave bands (each octave change represents a doubling or halving of frequency). As such a spectrum is not currently available for the 2-B turbine, a generic wind turbine noise octave-band spectrum, equivalent to a sound power level of 107 dB(A), has been used to calculate a reference predicted noise level at receptors. Table 6.3 details this reference octave band spectrum.

Table 6.3: Reference Octave Band Spectrum (equivalent to 107 dB(A))

Octave Band Frequency, Hz	31.5	63	125	250	500	1k	2k	4k	8k
Sound Power Level, dB, L_{WA}	75	86	95	102	103	99	95	90	85

The reference octave band spectrum has been used to derive the predicted noise levels for each 10 m integer wind speed by adding or subtracting, as appropriate, the difference between the reference sound power level (107 dB(A)) and the 10 m integer wind speed sound power level (Table 6.2) to the reference predicted noise level.

The testing and certification process that will be undertaken as a part of the project will include measurement of noise emissions in accordance with IEC 61400-11. This will allow for the actual noise emission from the turbine to be quantified at an early stage of the Development and for compliance with the requirements of ETSU-R-97 to be verified. In the event that sound power levels are higher than anticipated, adjustments to turbine operational parameters (such as rotational speed and blade pitch settings) may be made at sensitive times to ensure compliance (see Section 6.4.1 Operational Noise).

6.1.4 *Operational Noise Limits*

Separate limits for operational noise apply for quiet daytime and night time, as outlined below.

Quiet daytime is defined in ETSU-R-97 as 18:00 – 23:00 every day, as well as 13:00 – 18:00 on Saturday and 07:00 – 18:00 on Sundays. During these periods, the guidance prioritises the protection of outdoor amenity for residents, by applying noise limits that would not significantly affect the enjoyment of areas such as gardens.

ETSU-R-97 recommends a limit on turbine noise immission levels of 5 dB(A) above the prevailing, background noise level, referred against wind speed. The limit of 5 dB(A) above background is modified by a fixed lower limit applied at wind speeds or locations where background noise levels are low. Where the quiet daytime background noise level is less than 30-35 dB(A), the limit is defined as 35-40 dB(A). The quiet daytime limit also applies to all other daytime periods, with the limits based on the quiet daytime background noise level. Due to the relatively high prevailing daytime background noise levels in the vicinity of the site (greater than 30 dB(A), see Table 6.4), fixed lower daytime limits have not been applied in this case.

Different standards apply at night, where sleep disturbance is the primary concern rather than the requirement to protect outdoor amenity. Night time is considered to be all periods between 23:00 and 07:00. A limit of 43 dB(A) is recommended for night time at wind speeds or locations where the background noise level is less than 38 dB(A). Where background noise levels exceed 38 dB(A) the limit is set to 5 dB(A) above the background noise level.

The noise limits derived from ETSU-R-97 for this assessment are therefore:

- Daytime: 5 dB(A) above the prevailing quiet daytime background noise level; and
- Night time: The higher of 43 dB(A) or 5 dB(A) above the prevailing night time background noise level.

6.1.4.1 Operational Noise Significance Criteria

ETSU-R-97 does not define criteria for whether effects should be considered significant or not, but rather what levels of wind turbine noise may be considered to be acceptable. It also provides guidance on managing wind turbine noise through appropriate planning conditions. Therefore, no assessment of significance has been made; the assessment instead determines whether the predicted levels of operational noise would comply with the requirements of ETSU-R-97.

6.1.5 ***Construction Noise***

The following legislation, guidance and standards are of particular relevance to construction noise:

- The Control of Pollution Act 1974 (CoPA 1974);
- The Environmental Protection Act 1990 (as amended); and
- BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites.

6.1.5.1 The Control of Pollution Act (CoPA) 1974

CoPA 1974 provides Local Authorities in England, Scotland and Wales with powers to control noise and vibration from construction sites.

Section 60 of the Act enables a Local Authority to serve a notice to persons carrying out construction work of its requirements for the control of site noise. This may specify plant or machinery that is or is not to be used, the hours during which construction work may be carried out, the level of noise or vibration that may be emitted, and provide for changes in circumstances. Appeal procedures are available.

Section 61 of the Act allows for those carrying out construction work to apply to the Local Authority in advance for consent to carry out the works. This is not mandatory, but is often to the advantage of the developer, as once consent is issued, the Local Authority is no longer able to take action under Section 60 of CoPA 1974 or Section 80 of the Environmental Protection Act (EPA) 1990. It does not, however, prevent nuisance action under Section 82 of the EPA 1990. The application is expected to give as much detail as possible about the works to be carried out, the methods to be used and the measures that will be taken to minimise noise and vibration.

6.1.5.2 The Environmental Protection Act 1990 (as amended)

The Environmental Protection Act 1990 (as amended) specifies the duties of and powers available to Local Authorities in respect of any noise that either constitutes or is likely to cause a statutory nuisance, which is also defined in the Act. A duty is imposed on Local Authorities to carry out inspections to identify statutory nuisances, and to serve abatement notices against these. Procedures are also specified with regards to complaints from persons affected by a statutory nuisance.

6.1.5.3 BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open sites

BS 5228:2009 supersedes the previous version of the standard, issued in 1997, and is published in two parts: Part 1- Noise and Part 2- Vibration. The discussion below relates mainly to Part 1- Noise, however, the recommendations of Part 2 in terms of vibration are broadly very similar.

It refers to the need for the protection against noise and vibration of persons living and working in the vicinity of and those working on construction and open sites. It recommends procedures for noise and vibration control in respect of construction operations.

The Standard stresses the importance of community relations, and states that early establishment and maintenance of these relations throughout the carrying out of site operations will go some way towards allaying people's concerns. In terms of neighbourhood nuisance, the following factors are likely to affect the acceptability of construction noise:

- Site location, relative to the noise sensitive premises;
- Existing ambient noise levels;
- Duration of site operations;
- Hours of work;
- The attitude of local residents to the site operator; and
- The characteristics of the noise produced.

Recommendations are made regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the operation.

- Measures to control noise are described, including:
- Control of noise at source by, for example:
  - substitution of plant or activities by less noisy ones;
  - modification of plant or equipment to reduce noise emissions;
  - the use of noise control enclosures;
  - the siting of equipment and its method of use;
  - equipment maintenance; and
- Controlling the spread of noise, e.g., by increasing the distance between plant and noise-sensitive premises or by the provision of acoustic screening.

Another key revision to the standard is the inclusion of a discussion of noise control targets, and example criteria for the assessment of the significance of noise effects. These are not mandatory.

Methods of calculating the levels of noise resulting from construction activities are provided, as are updated source levels for various types of plant, equipment and construction activities.

6.1.5.4 Construction Noise Assessment Methodology

Due to the nature of the development site (i.e. an industrial site subject to 24-hour heavy industrial activity), surrounding area (a built-up area with relatively high background noise levels) and the limited duration of construction, it is not considered necessary to carry out a detailed assessment of construction noise. Rather, it is proposed that construction noise is managed through planning conditions restricting hours of working, and the implementation of good practice measures as recommended by BS 5228-1:2009, examples of which are included in Section 6.4.2 Construction and Relocation Noise.

6.2 Baseline Description

6.2.1 *Identification of Receptors*

It was agreed in consultation with Fife Council's Environmental Services Department that the most noise-sensitive receptors are those on Wellesley Road whose rear elevation overlooks the Energy Park and those in Buckhaven with a direct view of the Development site. Noise levels at receptors located further from the turbine are likely to benefit from the additional effect of barrier screening from intervening buildings, an effect that is not included in the noise prediction method. Therefore, where it can be demonstrated that noise levels would comply with the requirements of ETSU-R-97 at the most sensitive receptors, i.e. those closest and with an uninterrupted view of the turbine, it is considered reasonable to assume that compliance would also be achieved elsewhere. The assessment of operational noise effects therefore focuses on those properties closest to the background noise monitoring locations only.

6.2.2 *Baseline Noise Survey Locations*

It was agreed with Fife Council's Environmental Services Department that representative background noise levels could be obtained by carrying out baseline monitoring at the following three locations:

- Location 1: At the boundary of the Energy Park, adjacent to the rear boundary of 20 Wellesley Road. This location provides a representation of background noise levels at the closest properties to the proposed turbine location. The monitoring equipment was situated within a small fenced-off valley between an embankment that skirts the perimeter of the Energy Park and the steeply-sloping rear gardens. As such it was sheltered to a degree from the effects of wind, providing a conservative representation of background noise levels at the more elevated rear gardens of the nearby properties.
- Location 2: At the boundary of the Energy Park, adjacent to the rear boundary of 94 Wellesley Road. The monitoring equipment here was also situated within the small fenced-off valley between an embankment that skirts the perimeter of the Energy Park and the steeply-sloping rear gardens. This location is further from and more screened from noise from the Bifab works and this is shown in the lower background noise levels obtained (see Table 6.4) , thereby providing a conservative representation of background noise levels at the more elevated rear gardens of the nearby properties.
- Location 3: In the rear garden of 12 Erskine Street, Buckhaven. This slightly elevated property overlooks the Energy Park and will have a direct view of the proposed turbine, is one of the closest receptors within Buckhaven, and is therefore representative of the most noise-sensitive receptors within Buckhaven.

Full details of the background noise monitoring locations, including photographs, are included within the reproduced Survey Notes included in Appendix A6.2.

6.2.3 *Baseline Noise Survey*

The baseline survey was conducted between the 19th of February and 17th of March 2010, in accordance with ETSU-R-97, as follows:

- Type 1 measuring equipment, equipped with suitable windshields, was used, which was calibrated at the start of the survey, and calibration checked every 7 to 10 days at battery changes and at the end of the survey. No significant calibration drift occurred;
- Measurements were performed in free-field conditions, i.e., a minimum of 3.5 m and, where possible, more than 10 m from any reflective surface other than the ground, and at a height of 1.4 m AGL;
- Background noise levels were measured at continuous 10-minute intervals, as $L_{A90,10min}$;
- Wind speeds were measured simultaneously at heights of 51 m and 70 m AGL at a location representative of the proposed turbine locations (336756, 698400). Hub height

(108.5 m AGL) wind speeds were calculated from the 51 m[15] and 70 m wind speeds, and these used to derive 10 m wind speeds, using the procedure specified in Section 6.1.3.2. Noise measurements from each monitoring location were correlated with these derived 10 m wind speeds. Rainfall data was obtained from nearby personal weather stations published online[16],[17].

- When either of these stations recorded rainfall, data from the appropriate period (morning, afternoon, evening, night) was excluded from further analysis. The following periods were therefore excluded: the afternoon of Sunday February 21st, the evening of Wednesday the 24th of February through to the evening of Sunday 28th of February, the afternoon and evening of Saturday the 6th of March and the afternoon of Sunday the 14th of March ;
- Data from periods when the measurement equipment recorded an 'over-range' measurement were also excluded: these are typically due to local, short-term, high-intensity noise events such as barking dogs or overflying military jets; and
- An equivalent of a minimum of one week of data was obtained for each monitoring location, after exclusions are taken into account. In practice, this minimum was comfortably exceeded.

Survey record sheets and equipment calibration certificates are included in Appendix A6.2. Due to an instrumentation failure, the sound level meter at Monitoring Location 1 was replaced during the battery change on the 9th of March 2010. This did not result in significant data losses or any unreliable measurements.

The meter at Monitoring Location 3 was moved to a different position within the garden of 12 Erskine Street on the 9th of March to ensure that measurements were not corrupted by the equipment having been placed close to a hedge. On comparison of the measurements from the two positions, it appeared that those from the second position were lower. Data from the other monitoring locations, particularly Location 1 also appeared to exhibit a similar trend for the relevant period, although to a lesser degree, suggesting that other factors may also have contributed to the difference in measured levels. For example, wind directions during the first part of the survey were predominantly easterly, while those in the latter part were westerly, and levels of industrial activity within the Energy Park may have varied. However, only the results for position 2 have been used in deriving the prevailing background noise levels, and noise limits for this location as a precautionary approach. This has resulted in assumed prevailing background noise levels and therefore noise limits significantly lower than would have otherwise been obtained, particularly at higher wind speeds at night (see Table 6.4).

6.2.4 *Background Noise Levels and Noise Limits*

The measured background noise levels (after exclusions were applied) and derived 10 m wind speeds have been correlated and sorted into quiet daytime and night time periods. Regression analysis was carried out to fit 'measured background noise trendlines' to the data. The type of regression line applied has been selected to provide a conservative relationship between background noise level and wind speed, as well as seeking to maximise the correlation co-efficient (R^2). In most cases these trendlines show a decrease at wind speeds between 4 and 6 ms^{-1} relative to lower wind speeds, with an increase at wind speeds above 6 ms^{-1}. This may be explained by the effects of wind on noise propagation: in still or low wind speeds, the wind will have little effect on noise levels from a particular source, with noise levels around the source being independent of direction. As wind speeds start to increase however, noise levels upwind of the source will tend to be lower than those downwind. As wind speeds increase further, the effects of wind on vegetation and of increased atmospheric

[15] Although this is slightly less than the 50% of hub height recommended in the IOA Bulletin article, the difference would not significantly affect the results.

[16] http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=IFIFEGLE3&graphspan=week&month=2&day=19&year=2010

[17] http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=IFIFELEV3&day=26&year=2010&month=2&graphspan=week

turbulence will generate additional sources close to a receiver or measurement location, causing the measured levels to increase.

Prevailing background noise levels have been calculated from the measured background noise level trendlines, assuming as a precautionary approach that the minimum prevailing background noise level occurs at all wind speeds up to and including that at which it occurs on the trendline. Daytime prevailing background noise levels have also been assumed not to increase at quiet daytime wind speeds greater than 8 ms^{-1} and night-time wind speeds greater than 11 ms^{-1} as such wind speeds did not occur during the survey period. This is also a precautionary, conservative approach, as background noise levels will increase with increasing wind speed as a natural consequence of the effects of wind on vegetation and noise from increased atmospheric turbulence at higher wind speeds.

This analysis is presented graphically in Charts 6.1 to 6.6.

Table 6.4 details the prevailing background noise levels for each monitoring location, and the noise limits derived from these.

As previously stated, only the results for position 2 at Location 3 have been used in deriving the prevailing background noise levels, and noise limits for this location as a precautionary approach. Table 6.4 includes the prevailing background noise levels and noise limits that would result from the inclusion of all data obtained from both monitoring positions at Location 3, as well as those resulting from only using the data from position 2.

Table 6.4: Prevailing Background Noise Levels and Noise Limits

Location	Period	Derived 10 m Wind Speed, ms^{-1}											
		1	2	3	4	5	6	7	8	9	10	11	12
		Prevailing Background Noise Level, dB, $L_{A90,10min}$											
1	Day	39.0	39.0	39.0	39.0	39.1	39.8	41.3	43.8	43.8	43.8	43.8	43.8
	Night	36.4	36.4	36.4	36.4	36.4	37.4	39.5	42.2	44.9	46.6	46.2	46.2
2	Day	35.5	36.4	36.5	36.3	36.5	37.7	40.1	42.9	42.9	42.9	42.9	42.9
	Night	30.7	30.7	30.7	30.7	30.7	32.2	34.9	38.4	41.7	44.1	44.9	44.9
3 – all data[18]	Day	35.3	35.3	35.3	35.3	35.3	35.8	37.1	39.5	39.5	39.5	39.5	39.5
	Night	31.4	31.4	31.4	31.4	31.4	33.0	36.4	41.0	45.4	47.9	45.9	45.9
3 – Position 2	Day	33.9	33.9	33.9	33.9	33.9	33.9	36.2	39.1	39.1	39.1	39.1	39.1
	Night	31.1	31.1	31.1	31.1	31.0	32.0	34.0	36.6	39.2	41.0	41.0	41.0
		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 – all data[18]	Day	41.5	41.4	40.9	40.5	40.3	40.8	42.1	44.5	44.5	44.5	44.5	44.5
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.0	50.4	52.9	50.9	50.9
3 – Position 2	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

[18] Only background noise levels and limits from position 2 have been used in the assessment

6.3 Assessment of Effects

6.3.1 *Operational Noise*

Operational Noise Levels, detailed in Table 6.5, have been predicted for the three baseline noise monitoring locations, based upon the turbine noise emissions detailed in Table 6.1 and prediction methodology described in Sections 6.1.1.4 and 6.1.3.2.

Table 6.5: Predicted Operational Noise Level

Location	Derived 10 m Wind Speed, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
	Predicted Noise Level, dB, $L_{A90,10min}$									
1	35.4	35.9	38.5	41.1	43.0	43.9	45.4	46.6	44.0	41.4
2	33.2	33.7	36.3	38.9	40.8	41.7	43.2	44.4	41.8	39.2
3	31.4	31.9	34.5	37.1	39.0	39.9	41.4	42.6	40.0	37.4

It should be noted that these predicted levels are worst-case in terms of the propagation conditions assumed. In particular they represent the level of noise that may occur when the wind is blowing from the turbine towards the receiver (downwind propagation). When the wind is blowing in other directions, noise levels are likely to be lower than these predicted values. The prevailing wind direction at the Energy Park is westerly, based upon 21 months of wind monitoring data collected at the Hydrogen Office 50 m anemometer mast installed at the Energy Park. Under such conditions, the nearest noise-sensitive receptors would be upwind of the turbine. Therefore for the majority of the time, actual operational noise levels are likely to be lower than predicted.

Table 6.6 details the difference (margin) between the predicted operational noise levels (Table 6.5) and quiet daytime and night-time noise limits (Table 6.4). A negative margin indicates that the predicted noise level is lower than the noise limit for that location, period and wind speed. It should be noted that the noise limits derived from the prevailing background noise levels relating to the data obtained at Monitoring Location 3, position 2 have been used in this assessment, rather than the higher limits that would have been obtained using all data from Location 3. It can be seen that the predicted noise levels are lower than the limits in all cases, and would therefore **comply with the requirements of ETSU-R-97.**

Table 6.6: Operational Noise Assessment

Location	Derived 10 m Wind Speed, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
	Margin Between Predicted Level and Daytime Limit, dB									
1	-8.6	-8.1	-5.6	-3.7	-3.3	-4.9	-3.4	-2.2	-4.8	-7.4
2	-8.3	-7.6	-5.2	-3.8	-4.3	-6.2	-4.7	-3.5	-6.1	-8.7
3	-7.5	-7.0	-4.4	-1.8	-2.2	-4.2	-2.7	-1.5	-4.1	-6.7
	Margin Between Predicted Level and Night-time Limit, dB									
1	-7.6	-7.1	-4.5	-1.9	-1.5	-3.3	-4.5	-5.0	-7.2	-9.8
2	-9.8	-9.3	-6.7	-4.1	-2.2	-1.7	-3.5	-4.7	-8.1	-10.7
3	-11.6	-11.1	-8.5	-5.9	-4.0	-3.1	-2.8	-3.4	-6.0	-8.6

Charts 6.1 to 6.6 show the above assessment in a graphical form.

Existing industrial noise from the site is a dominant source of background noise in the area. Although noise from this source will decline with distance from the site, due to increasing distance, air and ground absorption and the barrier effects of intervening buildings, it is likely that wind turbine noise would also decline in a similar manner. Therefore, it is considered reasonable to conclude that given that likely compliance with the requirements of ETSU-R-97 has been demonstrated at the nearest noise-sensitive receptors, compliance would also likely be achieved at those situated beyond those in immediate proximity to the Energy Park.

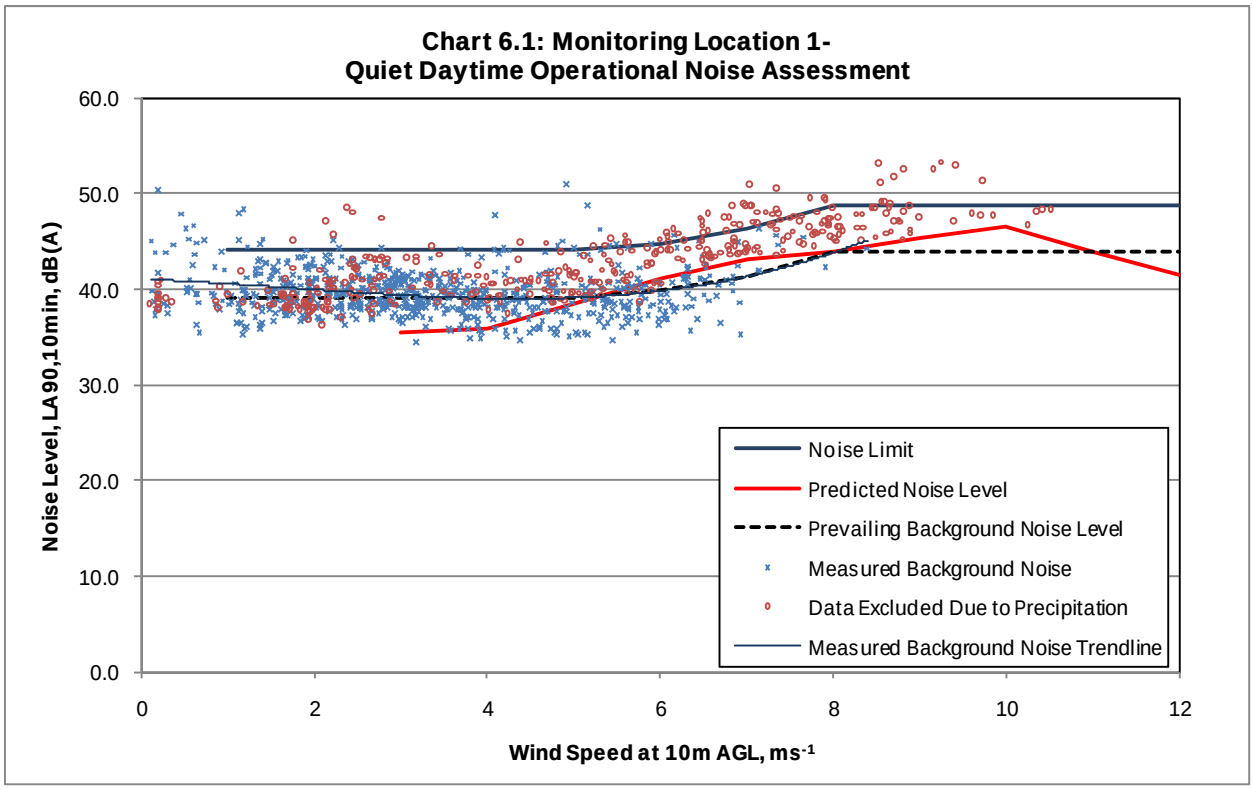
Chart 6.1: Monitoring Location 1-
Quiet Daytime Operational Noise Assessment
Noise Level, LA90,10min, dB(A)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Noise Level
Prevailing Background Noise Level
Measured Background Noise
Data Excluded Due to Precipitation
Measured Background Noise Trendline

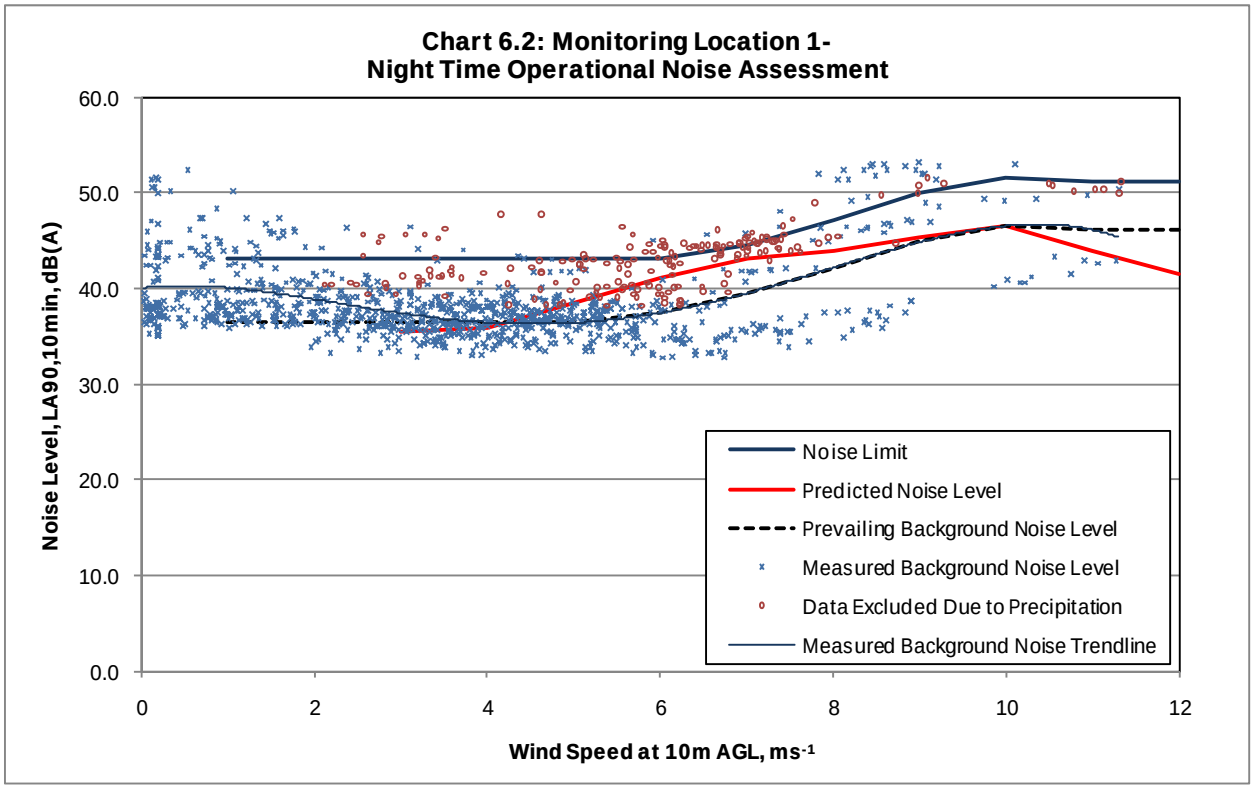
Chart 6.2: Monitoring Location 1-
Night Time Operational Noise Assessment
Noise Level, LA90,10min, dB(A)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Noise Level
Prevailing Background Noise Level
Measured Background Noise Level
Data Excluded Due to Precipitation
Measured Background Noise Trendline

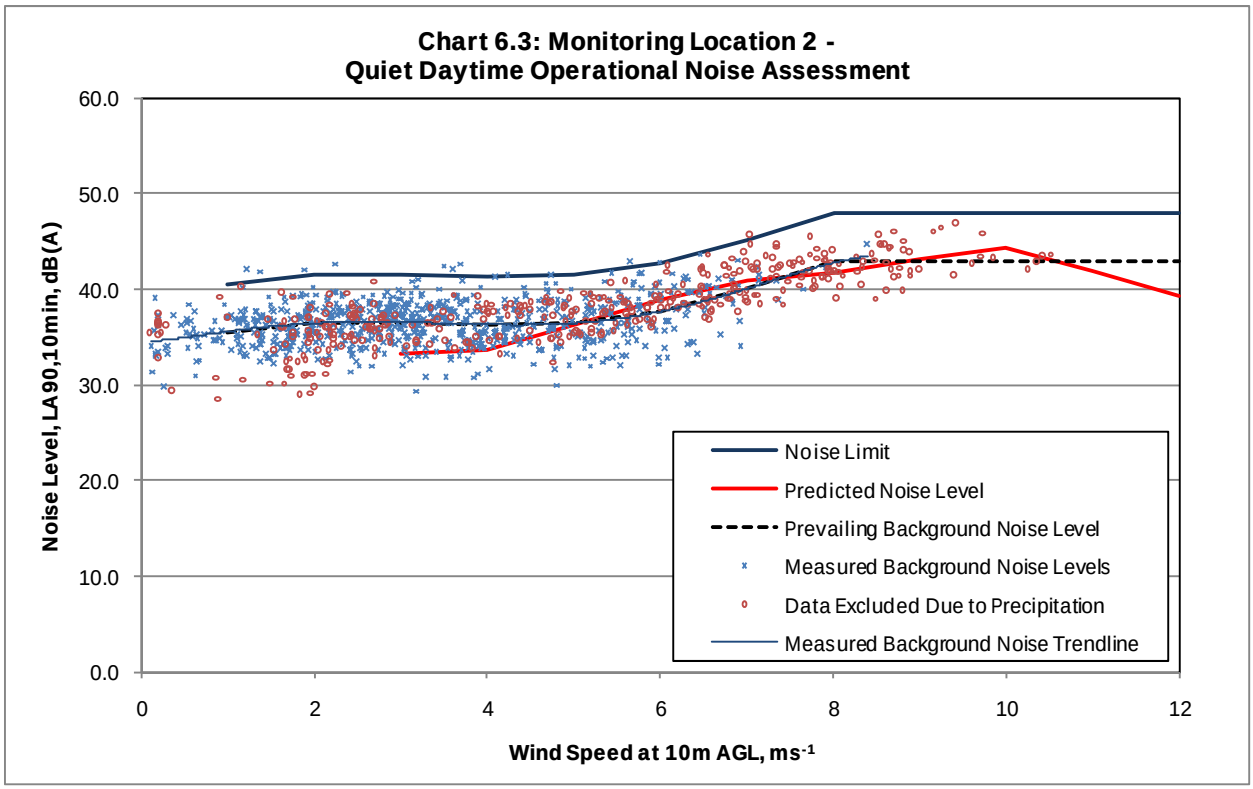
Chart 6.3: Monitoring Location 2 -
Quiet Daytime Operational Noise Assessment
Noise Level, LA90,10min, dB(A)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Noise Level
Prevailing Background Noise Level
Measured Background Noise Levels
Data Excluded Due to Precipitation
Measured Background Noise Trendline

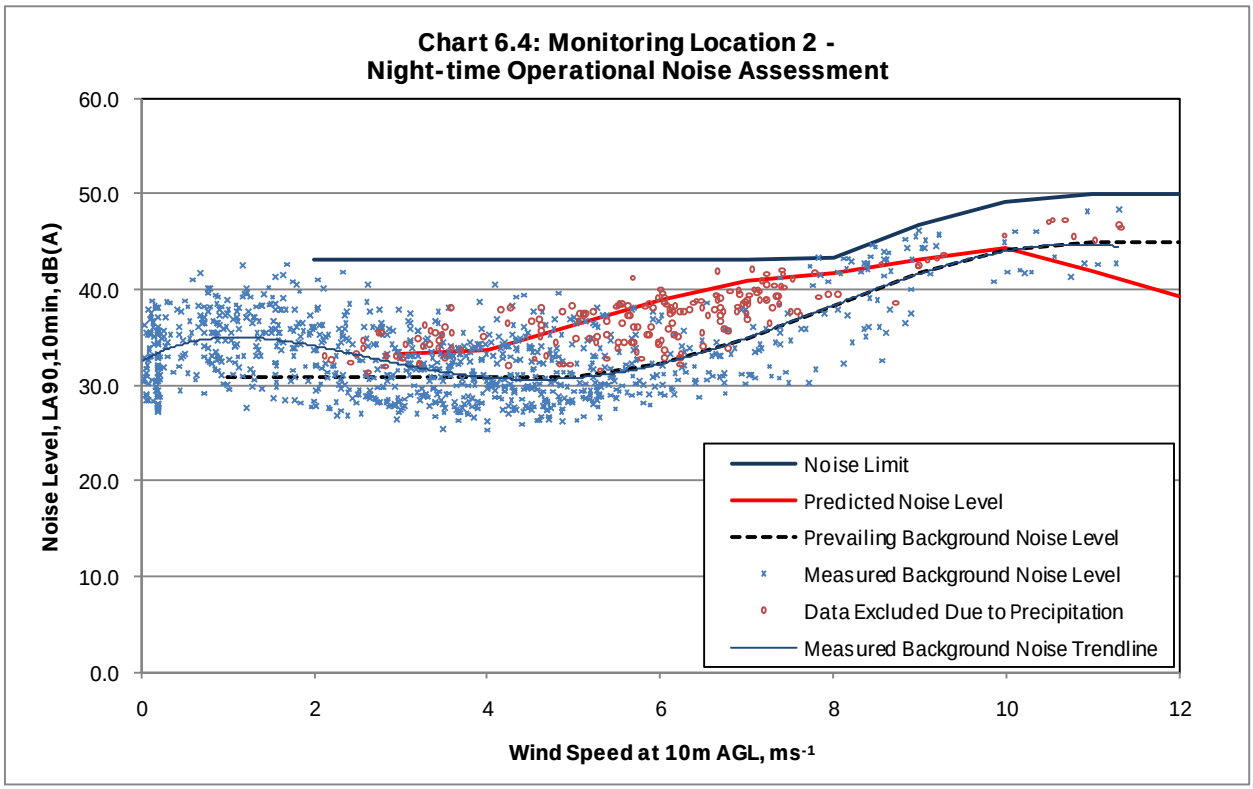
Chart 6.4: Monitoring Location 2 -
Night-time Operational Noise Assessment
Noise Level, LA90,10min, dB(A)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Noise Level
Prevailing Background Noise Level
Measured Background Noise Level
Data Excluded Due to Precipitation
Measured Background Noise Trendline

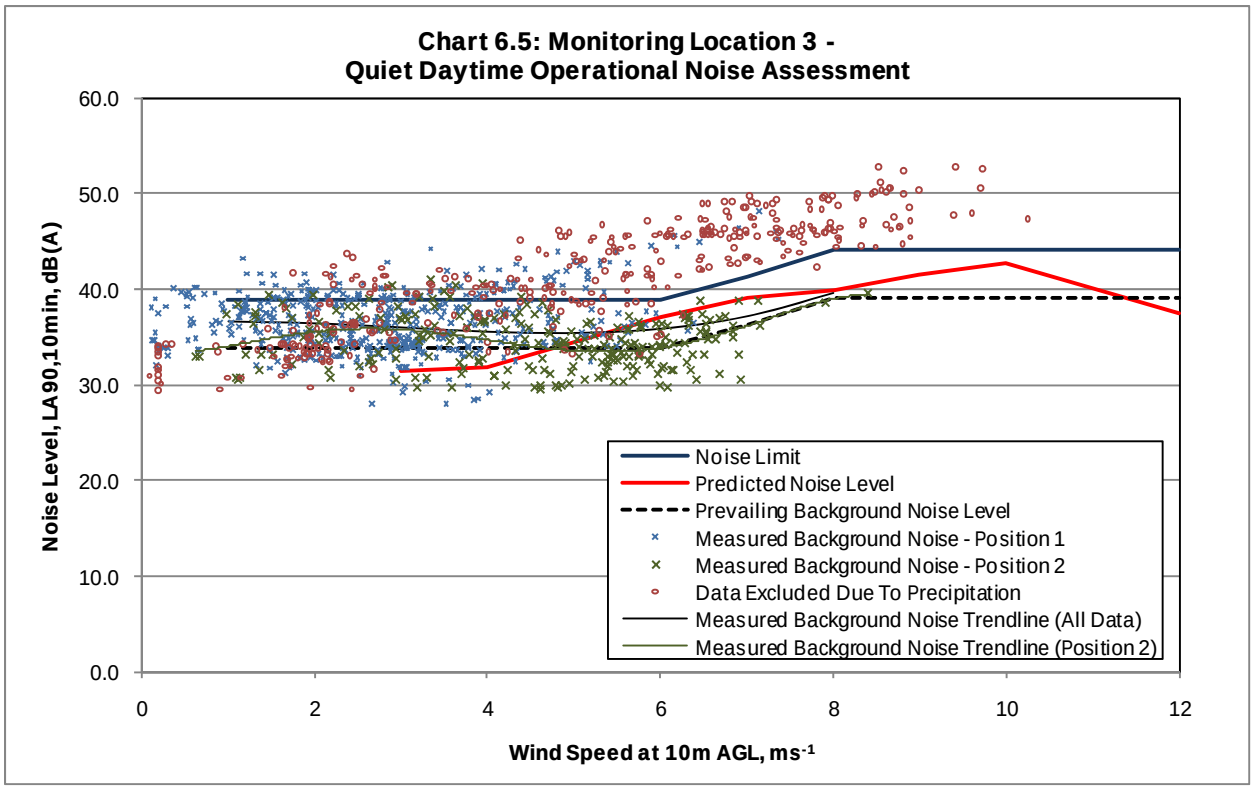
Chart 6.5: Monitoring Location 3 -
Quiet Daytime Operational Noise Assessment
Noise Level, LA90,10min, dB(A)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Noise Level
Prevailing Background Noise Level
Measured Background Noise - Position 1
Measured Background Noise - Position 2
Data Excluded Due To Precipitation
Measured Background Noise Trendline (All Data)
Measured Background Noise Trendline (Position 2)

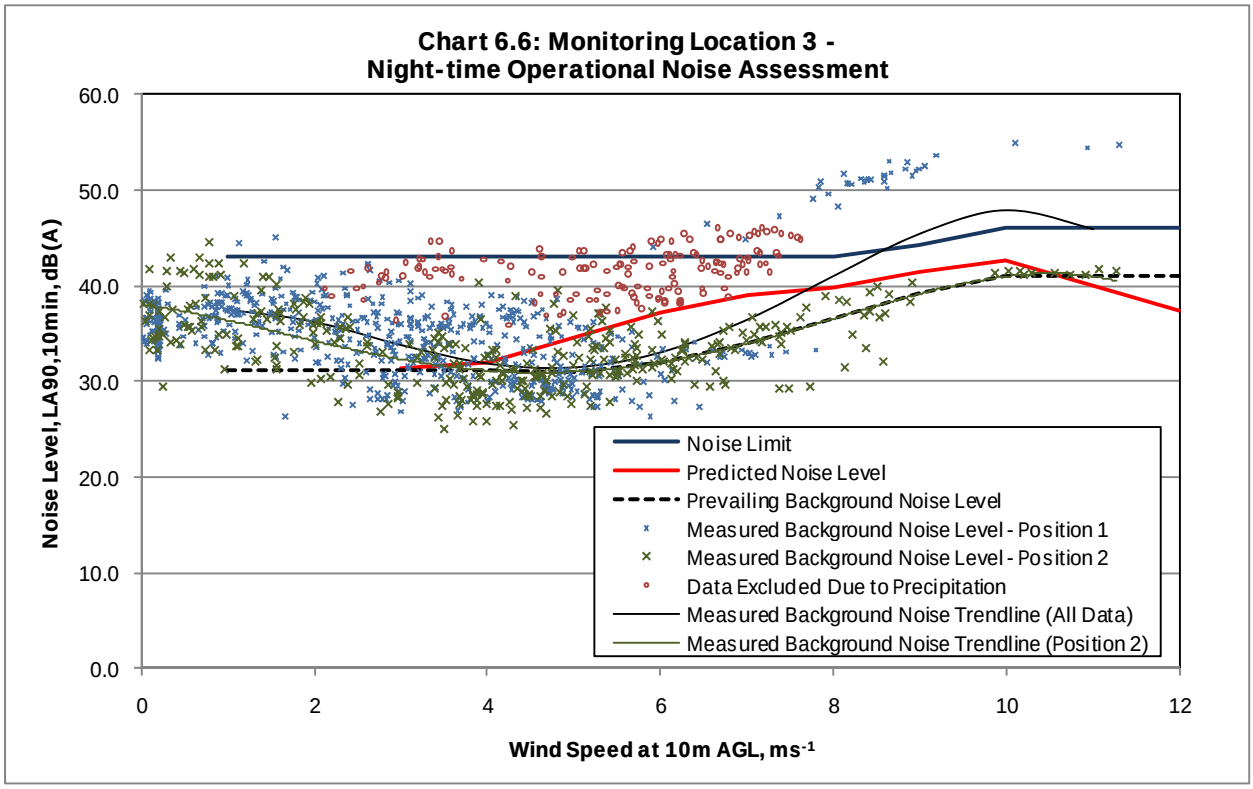
Chart 6.6: Monitoring Location 3 -
Night-time Operational Noise Assessment
Noise Level, LA90,10min, dB(A)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Noise Level
Prevailing Background Noise Level
Measured Background Noise Level - Position 1
Measured Background Noise Level - Position 2
Data Excluded Due to Precipitation
Measured Background Noise Trendline (All Data)
Measured Background Noise Trendline (Position 2)

6.4 Mitigation Measures and Residual Effects

6.4.1 *Operational Noise*

During the testing and certification process to be carried out as a part of the Development, measurements of noise emissions from the turbines will be undertaken, in accordance with BS EN (IEC) 61400-11:2003. This will confirm the actual levels of noise emitted by the turbine in operation. Adjustments to the noise emission levels of a wind turbine are possible by manipulating operational parameters such as the rotational speed and blade pitch settings. In the event that incidences of higher than permitted noise were to occur, then such measures could be implemented during sensitive times (i.e. ETSU-R-97 quiet daytime and night-time periods) to ensure that compliance is achieved.

It is anticipated that a more flexible approach may be appropriate during normal working hours, given that the purpose of the installation is to test and certify a novel turbine design, that the chosen site is designated for the development of renewable energy industries, the existing industrial nature of the area and consequently elevated ambient noise levels. For example, there may be times when it is necessary for operational or testing reasons to operate the turbine in such a way as causes higher noise levels, or unexpected noise levels may occur due to unforeseen circumstances. Such circumstances would be limited as much as is reasonably practicable within the requirements to fully test the turbine, particularly in easterly winds when the turbine would be upwind of the nearest noise sensitive receptors.

Fife Council have indicated during consultation that as an alternative to the enforcement of planning conditions and in the event of being in receipt of noise complaints then they may consider using their statutory nuisance powers, as defined in the Environmental Protect Act 1990 (as amended). They have also indicated however, that they would take into consideration the operational and testing requirements of the Development and the application of any measures taken to minimise the adverse effects of noise (such as those discussed above) in deciding whether a statutory nuisance existed.

6.4.1.1 Residual Operational Noise Effects

Implementation of the operational noise mitigation measures detailed above, if necessary, would ensure that noise immission levels comply with the requirements of ETSU-R-97 or do not constitute a statutory nuisance, as appropriate.

6.4.2 *Construction and Relocation Noise*

It is anticipated that planning conditions specifying restrictions to the hours of working would provide sufficient management of construction noise. The best practice measures detailed below represent examples of additional good practice that would be employed to minimise the effects of construction noise on nearby receptors:

- The site contractors shall publicise the construction programme (e.g. in local newspapers, through mailings to local residents, through an onsite information board at the site access, and on the developer's website) for the commencement and duration of operations, and named contacts for daytime and out of hours.
- The contractors shall be required to select the quietest item of suitable plant available for all site operations where practicable.
- Phasing of the work programme to reduce the combined effects arising from several noisy operations.
- Where necessary and practicable, containing noise from fixed plant and equipment within suitable acoustic enclosures or behind acoustic screens.
- Requiring all sub-contractors appointed by the main contractor to be formally and legally obliged, through contract, to comply with all environmental noise conditions.
- Where practicable, night time working will not be carried out. However, any plant and equipment required for operation at night (23:00 - 07:00) shall be mains electric powered where practicable. Any night time lighting rigs, pumps or other equipment shall be powered using mains electricity or silenced and suitably shielded to ensure

compliance with World Health Organisation (WHO) night time noise criteria at the nearest residential properties, assuming open windows.

Notwithstanding the above, the Control of Pollution Act 1974 provides additional mechanisms for controlling noise from construction activities, including pre-application by the developer under Section 61 for consent to carry out the works, or action by the Local Authority under Section 60 to halt work or to specify noise-control measures that should be employed.

Similar measures would be employed during relocation of the turbine to its offshore location at the end of the five-year testing and certification process.

6.4.2.1 Residual Construction Effects

Application of the above measures to manage construction noise will ensure that effects are minimised as far as is reasonably practicable and that the construction and relocation process is operated in compliance with the relevant legislation.

6.5 Cumulative Effects Assessment

Planning Consent was granted in 2008 for a wind turbine at Methil Docks. Due to the distance between this turbine and the Development (1.7 km), and taking into consideration the effect of wind direction on noise propagation, the likelihood of noise from both turbines simultaneously affecting a particular location to such a degree that ETSU-R-97 limits would be exceeded is considered to be low.

6.6 Statement of Significance

An assessment of noise from the operation of the proposed Development has been carried out. As the relevant guidelines, ETSU-R-97, are expressed in terms of compliance with limits on the level of wind turbine noise considered acceptable, an assessment of compliance rather than significance has been made.

Baseline background noise levels at the nearest noise-sensitive receptors have been established through survey. Theoretical wind turbine noise emissions for the proposed turbine type have been established, and used to make predictions of noise from the operation of the proposed turbine. These predictions have been found to **comply with the requirements of ETSU-R-97**. Mitigation measures have been identified that would ensure compliance. In the event that actual noise emission levels are higher than those assumed.

Noise during construction and relocation of the turbine will be addressed through the application of planning conditions restricting hours of working and the use of good practice measures.

6.7 Glossary of Acoustic Terminology

The following items of acoustic terminology may have been referred to in the preceding chapter. Terms in italics are defined elsewhere in the glossary.

AGL: Above Ground Level

Atmospheric Stability: The degree to which vertical mixing of atmospheric layers occurs. In a stable atmosphere, less mixing occurs than in a neutral or unstable atmosphere. A stable atmosphere can result in a greater variation in wind speed with height *(wind shear)* than neutral or unstable conditions, as there is less interaction between air flows at different levels.

Background Noise: The background noise level is the under lying level of noise present at a particular location for the majority (usually 90%) of a period of time. As such it excludes any short-duration noises, such as individual passing cars (but not continuous traffic), dogs barking or passers-by. Sources of background noise typically include such things as wind noise, traffic and continuously operating machinery (e.g. air conditioning or generators).

Decibel (dB): The decibel is the basic unit of noise measurement. It relates to the pressure created by the sound (Sound Pressure) and operates on a logarithmic scale, ranging upwards

from 0dB. 0dB is equivalent to the normal threshold of hearing at a *frequency* of 1000Hz (20 micro Pascals). Each increase of 3dB on the scale represents a doubling in the Sound Pressure, and is typically the minimum noticeable change in environmental sound level under normal listening conditions. For example, while an increase in noise level from 32dB to 35dB represents a doubling in sound pressure, this change would only just be noticeable to the majority of listeners.

dB(A): Environmental noise levels are usually discussed in terms of dB(A). This is known as the A-weighted sound pressure level, and indicates that a correction factor has been applied, which corresponds to the human ear's response to sound across the range of audible *frequencies*. The ear is most sensitive in the middle range of frequencies (around 1000-3000 Hertz (Hz)), and less sensitive at lower and higher frequencies. The A-weighted noise level is derived by analysing the level of a sound at a range of frequencies and applying a specific correction factor for each frequency before calculating the overall level. In practice this is carried out automatically within noise measuring equipment by the use of electronic filters, which adjust the frequency response of the instrument to mimic that of the ear.

Emission: The sound given (emitted) out by a source.

Façade: A façade noise level is one measured at, or very close to, the façade of a building. These are typically 3dB higher than free-field levels, due to reflection.

Free Field: This term refers to a location where the propagation (movement) of sound is not affected by the presence of obstacles or surfaces which would cause reflections (echoes).

Frequency: The frequency of a sound is equivalent to its pitch in musical terms. The units of frequency are Hertz (Hz), which represents the number of cycles (vibrations) per second.

Immission: The sound arriving at a particular location, e.g. a *noise sensitive receptor.*

$LA_{90,t}$: This term is used to represent the *A-weighted* sound pressure level that is exceeded for 90% of a period of time, t. This is used as a measure of the *background noise* level.

$LA_{eq,t}$: This term is known as the *A-weighted* equivalent, continuous sound pressure level for a period of time, t. It is similar to an average, and represents the sound pressure level of a sound of continuous intensity that would result in an equal quantity of sound energy as a sound which varies in intensity.

Low frequency noise: Noise at the lower end of the range of audible frequencies (20Hz – 20kHz). Usually refers to noise below 250Hz. Should not be confused with infrasound, which is sound below the lowest audible frequency, 20Hz.

Noise: Unwanted sound. May refer to both natural (e.g. wind, birdsong etc) and artificial sounds (e.g. traffic, noise from wind turbines, etc)

Noise contour plot: A diagram showing lines of equal sound levels (isobels) in a similar manner to height contours on an Ordnance Survey map or isobars (lines of equal pressure) on a weather map.

Noise sensitive receptors: Locations that may potentially be adversely affected by the addition of a new source of noise. Can include residential properties, outdoor areas and sensitive species.

Sound power (W): The sound energy radiated per unit time by a sound source, measured in watts (W).

Sound power level (L_w): Sound power measured on the decibel scale, relative to a reference value (W_o) of 10^{-12}W.

Sound pressure (P): The fluctuations in atmospheric pressure relative to atmospheric pressure, measured in Pascals (Pa).

Sound pressure level (L_p): Sound pressure measured on the decibel scale, relative to a sound pressure of 2×10^{-5} Pa (20 micro Pascals).

Tonal element: A characteristic of a sound where the sound pressure level in a particular frequency range is greater than in those frequency ranges immediately above higher or lower. This would be perceived as a humming or whining sound.

Vibration: In this context, refers to vibration carried in structures such as the ground or buildings, rather than airborne noise.

Wind Shear: The variation in wind speed with height above ground.

7 ECOLOGY

7.1 Introduction

This chapter of the ES identifies and evaluates the effects of the proposed Methil Offshore Demonstration Wind Turbine (hereafter referred to as 'the Development') on habitats and species arising from the construction, operation and relocation phases. An assessment of effects on birds is addressed separately in Chapter 8: Ornithology of this ES.

A scoping report was issued to consultees in December 2009 of which Scottish Natural Heritage (SNH), Marine Scotland, and the Scottish Environmental Protection Agency (SEPA) provided responses in relation to ecology. These responses included recommendations with regard to survey and assessment methods and have been taken into account in this assessment.

This assessment includes the following elements:

- Introduction;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Assessment of Potential Effects;
- Mitigation Measures and Residual Effects;
- Cumulative Effect Assessment;
- Summary of Effects; and
- Statement of Significance.

7.2 Assessment Methodology and Significance Criteria

7.2.1 Legislative background

The following guidance, legislation[1] and policies have been considered during the assessment:

- Council Directives on The Conservation of Natural Habitats and of Wild Flora and Fauna, and on Conservation of Wild Birds (commonly known as the Habitats and Birds Directives);
- Wildlife & Countryside Act 1981;
- Nature Conservation (Scotland) Act 2004;
- Protection of Badgers Act 1992;
- Conservation (Natural Habitats &c.) Regulations 1994;
- Scottish Executive Explanatory Guidance for [European Protected] species related activities;
- Scottish Planning Policy[2];
- Planning Advice Note (PAN) 60: Planning for Natural Heritage; and
- Scottish Biodiversity Strategy and associated Implementation Plans.

7.2.2 Assessment Methods

The approach taken to the assessment of ecological impacts follows the guidance document produced by the Institute of Ecology and Environmental Management[3]. These guidelines set out the process for assessment through the following stages:

[1] Including relevant amendments, as appropriate.
[2] Scottish Government (2010) Scottish Planning Policy (SPP) [online] Available at: http://www.scotland.gov.uk/Publications/2010/02/03132605/0 [accessed 25/03/2009]
[3] IEEM (2006) *Guidelines for Ecological Impact Assessment in the United Kingdom*. IEEM

- Describing the ecological baseline through survey and desk study;
- Assigning a value to "Valued Ecological Receptors" (VERs) - These are the designated sites, habitats and species of highest ecological value present on the site;
- Identifying and characterising the potential effects on these VERs based on the nature of construction, operation and relocation activities associated with the proposed development;
- Describing any mitigation, compensation and/or enhancement measures associated with the development;
- Determining the significance of the effects, taking into account mitigation measures where appropriate; and
- Identification of any monitoring requirements.

Value is defined on the basis of the geographic scale given in Table 7.1. Attributing a value to a receptor is generally straightforward in the case of designated sites, as the designations themselves are normally indicative of a value level. For example, a Special Protection Area or Special Area for Conservation designated under the Habitats Directive is implicitly of European (International) importance. For non-designated receptors, the use of guidelines such as the national guidelines for the selection of Sites of Special Scientific Interest can be helpful in attributing a value to a receptor.

Table 7.1 Approach to Valuing Ecological Receptors

Level of Value	**Examples**
International	An internationally designated site (*e.g.* SAC) or site meeting criteria for international designations.
	Species present in internationally important numbers (>1% of biogeographic populations).
National	A nationally designated site (Site of Special Scientific Interest, SSSI, or a National Nature Reserve, NNR), or sites meeting the criteria for national designation.
	Species present in nationally important numbers (>1% UK population).
	Large areas of priority habitat listed on Annex I of the EC Habitats Directive and smaller areas of such habitat that are essential to maintain the viability of that ecological resource.
Regional (NHZ or Local Authority Area)	Species present in regionally important numbers (>1% Eastern Lowlands Natural Heritage Zone population).
	Sites falling slightly below criteria for selection as a SSSI.
Local	Scottish Wildlife Trust Reserves, Local Nature Reserves.
	Areas of semi-natural ancient woodland smaller than 0.25 ha.
	Areas of habitat or species considered to appreciably enrich the ecological resource within the local context.
Negligible	Usually widespread and common habitats and species. Receptors falling below local value are not considered in detail in the assessment process.

Part of the process of attributing value to species receptors involves defining the population to be valued and involves professional judgement in order to identify an ecologically coherent population against which effects on integrity can be assessed. For example, for wide-ranging species such as otter, it may be more appropriate to value the otter population in a whole catchment or even at the Natural Heritage Zone level. For more localised species, including insects and small mammals, value may be attributed to groups of related colonies which function as a meta-population.

The magnitude of effects is predicted quantitatively, where possible, taking into account the duration and reversibility of effects.

The 2006 IEEM guidelines use only two outcomes for the assessment of impacts on valued receptors: "significant" or "not significant"; there are no sub-categories of significance[4]. In this application of the guidance, significance is linked to the geographical scale at which the receptor is valued. In assessing whether an impact is significant, the concept of "ecological integrity" is a guiding principle. This concept can be applied both to designated sites (*e.g.* a Site of Special Scientific Interest) and to defined populations (*e.g.* a local otter population). This concept underpins much of the European legislation in relation to nature conservation. An effect which is likely to impact the ecological integrity of a receptor will be classified as significant. Ecological integrity is defined[5] (in relation to designated sites) as the site's "*coherence, ecological structure and function… that enables it to sustain the habitat, complex of habitats and/or the levels of population of species for which it was classified*."

7.2.2.1 Assessment of Cumulative Effects

A cumulative effect is considered to be an additional effect on ecological receptors arising from the Development in combination with other proposed developments likely to affect the biotic environment.

It is clearly beyond the scope of this document to consider the significance of the effects of all developments around the Firth of Forth. In the context of this assessment, cumulative effects have been more narrowly defined as effects on the specific receptors identified in the baseline section. It should be noted that with this approach, specific cumulative effects will be rare. Examples of cumulative effects in this sense include other coastal developments and activities along the Fife coastline.

The method followed to assess the cumulative effects is the same as that used for the Development in isolation, as outlined above.

7.2.3 Baseline Methods: Desk Study

Statutory designated sites within 5 km of the Development were identified from JNCC/SNH digital datasets using Geographical Information System. Records of notable species and habitats, as well as details of non-statutory designated sites, were sought from the following:

- Scottish Natural Heritage[6];
- National Biodiversity Network Gateway[7];
- MarLIN[8];
- Fife Records Centre;
- Fife Biodiversity Action Plan; and
- UK Biodiversity Action Plan.

In addition local information was provided by land managers and others during the course of site surveys.

7.2.4 Baseline Methods: Habitats

7.2.4.1 Scope of Surveys

The scoping report proposed the scope of surveys to be undertaken in order to inform the ecological assessment and no alterations to this scope were proposed by the relevant consultees. Given the scale and location of the development and the results of nearby ecological surveys, detailed surveys of the local terrestrial, littoral and benthic habitats and

[4] Previous guidance published by the IEEM made use of categories of significance such as minor/moderate/major etc., determined through a matrix combining receptor value and impact magnitude.
[5] ODPM circular 06/2005
[6] www.snh.org.uk/snhi/
[7] NBNGateway 2008 National Biodiversity Network Gateway website online search facility, www.searchnbn.net accessed on 22 January 2008
[8] www.marlin.ac.uk

communities were not considered necessary, nor were detailed surveys of cetaceans and fisheries.

7.2.4.2 Phase 1 Habitat Survey

A Phase 1 Habitat Survey of the Development site (hereafter the 'survey area'), including parts of the Fife Energy Park (FEP) and associated coastline, was conducted during a single site visit on 12th February 2010 in accordance with standard methods[9]. The survey took place outside of the optimum survey period (April–September) but, given the types of habitats recorded on the site, the classification and assessment of the habitats and their constituent species is considered robust. The survey assessed and classified the semi-natural habitats within the survey area and recorded the vascular plants of each habitat type following recognised nomenclature[10]. All habitats, with their dominant plant species codes, were mapped in the field on to large-scale maps.

The survey also sought to determine the presence/absence of non-native, invasive marine species and controlled botanical species (e.g. Japanese knotweed) listed in Schedule 9 Part II of the Wildlife and Countryside Act 1981, as amended.

7.2.5 Baseline Methods: Species

7.2.5.1 General

The potential for habitats and features within the survey area to support notable animal species (including both vertebrate and invertebrates) was assessed during the habitat survey. All habitats and features with such potential, as well as any evidence to suggest or confirm the presence of those species (e.g. prints or direct observation), were recorded. Species-specific surveys are outlined in more detail, below.

7.2.5.2 Otter

The site and surroundings were searched for field signs of otter on the same date as the Phase 1 Habitat Survey. The otter survey followed standard methods[11] and involved systematically searching for field signs[12,13] along the shoreline within 200 m of the turbine location, particularly areas above the mean high water mark where older field signs would not have been disturbed by the tides. The most reliable field sign of otter presence is spraint, which is often left in prominent places as a territorial marker and which can help in the interpretation of use of other structures such as holts and shelters.

7.3 Baseline Conditions

The following sections combine the results of the baseline methods described above to describe the baseline conditions of the site and local environment.

[9] Joint Nature Conservation Committee (2003) *Handbook for Phase 1 habitat survey – a technique for environmental audit.* Peterborough: JNCC.
[10] Botanical Society of Great Britain (BSBI) principally following Kent (1991) and Stace (1997). For simplicity, only the common names of plant species, where available, have been used in this report.
[11] Chanin, P. (2003) *Monitoring the Otter (Lutra lutra)*. Conserving Natura 2000 Rivers Monitoring Series No. 10, Peterborough: English Nature.
[12] Kruuk, H. (2006) *Otters; ecology behaviour and conservation*. Oxford: Oxford University Press.
[13] Conroy, J.W.H., Watt, J., Webb, J.B. & Jones, A. (2005) *A guide to the identification of prey remains in otter spraint,* London: The Mammal Society.

7.3.1 Designated Sites

7.3.1.1 Statutory Designated Sites

The Firth of Forth is a large coastal area stretching from Alloa Inches in the River Forth to Fife Ness and Dunbar in the east and comprises a complex of estuaries, mudflats, rocky shorelines, beaches and saltmarshes. Several large urban areas, including Edinburgh, are adjacent to the site and include areas of heavy industry such as Grangemouth. The Forth is also one of the most important shipping areas in Scotland. Parts of the Firth of Forth are subject to national and international designations for their nature conservation value (Figure 7.1) and full details (including citations) are provided in Appendix A8.1. The following all share the same boundary and the proposed turbine foundations are within it.

- *The Firth of Forth Site of Special Scientific Interest (SSSI)* comprises an extensive mosaic of intertidal and coastal habitats including saltmarsh, sand dune, fen, coastal sluiced saline lagoons, calcareous grassland, neutral grassland, dune grassland and maritime grassland. Extensive mudflats make up much of the intertidal area with areas of sand, shingle, rock and boulders as well as numerous valuable geological features. The mudflats are invertebrate rich and form important feeding grounds for the abundant waders and wildfowl in the Forth.
- *The Firth of Forth Special Protection Area (SPA)* comprises an area in excess of 6,000 ha. It qualifies as an SPA by regularly supporting wintering populations and post-breeding populations of European importance of numerous Annex 1 bird species. It further qualifies by supporting wintering populations of both European and international importance of five migratory bird species. In addition to this the Firth of Forth also qualifies by supporting wintering wildfowl assemblages of European importance.
- *The Firth of Forth Ramsar* qualifies as a site under Criterion 3a by regularly supporting over 20,000 waterfowl in winter. The site supported a 1993/94–97/98 winter peak mean of 95,000 waterfowl, comprising 45,000 wildfowl and 50,000 waders.

There are no other statutory designated sites within 5 km of the Development.

7.3.1.2 Non-statutory Designated Sites

There are no non-statutory designated sites within 2 km of the Development.

7.3.2 Habitats

7.3.2.1 Onshore

The superficial substrate of the majority of the survey area is reclaimed colliery spoil which is subject to repeated severe disturbance from reshaping and heavy industrial activities. Consequently, none of the onshore habitats across the FEP (i.e. excluding all shoreline habitats) were characteristic of coastal environments or are important features of the nearby designated sites and so are considered to be of negligible value and are not considered further.

Ephemeral/short perennial

This substrate has been colonised by common and widespread pioneer and opportunistic plants – all of which are resilient to frequent disturbance – which formed a patchy mosaic with large areas of bare ground. Species recorded frequently or occasionally included ribwort plantain, mugwort, common nettle, rosebay willowherb, bristly oxtongue, weld, common knapweed, mayweeds, thistles, and buddleia. Towards the shoreline, and in other areas where the ground was relatively undisturbed, grasses (mainly couch and bent species) became more prevalent.

Dense and scattered scrub

Buddleia occurred throughout the site as either small individual stems or in more continuous patches. Likewise, bramble was scattered throughout but in places, notably on the banks

around and near the substation in the north of the site, formed dense stands with gorse, willowherbs, and broom.

7.3.2.2 Littoral

The shoreline at the location of the proposed turbine and southwards, including the reshaped coal spoil, has eroded considerably and the littoral zone and upper shoreline has been reinforced with rock revetment to prevent further erosion. The rock revetment is constantly rebuilt and redistributed to combat erosion and extends throughout the littoral zone and is therefore subject to wave action at all times. Consequently, the coastline offers a very limited habitat in which only a very sparse covering of wracks (channelled wrack and twisted wrack) and Irish moss was recorded, as well as sparse patches of periwinkles and occasional limpets, along the middle to lower shore.

Further northwards, the coastline enters the dock yards and is entirely man-made from sheet-piling and concrete, backed by reclaimed spoil and hardstanding. These littoral areas are therefore considered to be of negligible ecological value.

A broad-scale study of the intertidal habitats of the Firth of Forth[14] included the coastline around Methil. Using methods and techniques based on *CCW Handbook for marine intertidal Phase 1 mapping*[15] (now superseded by *The Marine Habitat Classification for Britain and Ireland*[16]), the coastline around Buckhaven and Methil was described as being "*composed of large boulders backed by a rock revetment. The upper shore is barren and the mid shore comprises LR.Ver.Ver* [*Verrucaria maura* on moderately exposed to very sheltered upper littoral fringe rock] *on the boulders, followed by a band of ELR.BPat.Fvesl* [Barnacles, *Patella* sp. and *Fucus vesiculosus F. linearis* on exposed eulittoral rock]." These two biotopes are common and widespread on rocky shores.

7.3.2.3 Subtidal

The subtidal environment in the area of the proposed turbine location was not surveyed but there is evidence to suggest that it comprises mainly sand overlying a soft clay substrate with high levels of contaminants arising from the onshore spoil. There are no plant communities, such as eel-grass beds or algal mats, within the footprint of the turbine location or within adjacent and nearby subtidal areas.

7.3.2.4 Coastal Management

The Fife Energy Park Coastal Erosion and Flood Risk Management Plan[17] established a detailed of set proposals to ensure the long-term protection of the coastline associated with the FEP. The area of coastline within which the Development is located is currently managed with rock-armour revetment and the plan suggests that this will be continued and enhanced in the future.

7.3.3 Species

Species not addressed explicitly below are considered extremely unlikely to occur on the site or to be affected by the Development.

[14] Posford Haskoning (2002) *Broad scale intertidal survey of the Firth of Forth*. Scottish Natural Heritage commissioned Report F01AA407.
[15] Wyn, G., Brazier, P. and McMath, M. (2000) *CCW Handbook for Marine Intertidal Phase 1Survey and Mapping.* Countryside Council for Wales Marine Science Report: 00/06/91. Bangor: Countryside Council for Wales.
[16] Connor, D.W., Allen, J. H., Golding, N., Howell, K. L., Lieberknecht, L. M., Northen, K. O. and Reker, J. B. (2004) *The Marine Habitat Classification for Britain and Ireland* Version 04.05. Peterborough: JNCC.
[17] Scottish Enterprise (2009) *Fife Energy Park Coastal Erosion and Flood Risk Management Plan*.

7.3.3.1 Invertebrates

The timing of the Phase 1 survey precluded the observation of most invertebrates; however, the limited range of semi-natural habitats observed was considered unlikely to support a notable invertebrate assemblage and there are no records of notable invertebrates associated with the site. The invertebrate assemblage is therefore considered to have negligible value and is not considered further.

7.3.3.2 Reptiles

The open mosaic of bare ground and short vegetation across much of the onshore areas offers potential basking and hunting habitat for some reptiles, but the high level of disturbance and lack of other habitats (such as water features, mature vegetation, sheltering locations), as well as a lack of historical records, suggest that reptiles are extremely unlikely to occur on site and therefore have negligible value in the context of the Development and are not considered further.

7.3.3.3 Otter

No evidence of otter was recorded during the survey. The rip-rap formed numerous crevices and overhangs but nonetheless was considered to offer very limited breeding habitat due to the high level of disturbance from anthropogenic and wave/tidal activity. Otters may occasionally use or pass through sub-optimal habitats, for example when dispersing or foraging, but such movements are likely to be very limited in duration and frequency. There are no records to suggest that otters are distributed along the Fife coastline and the presence of Methil Docks – a large, active industrial complex – presents a notable obstacle to dispersion, migration and foraging along this stretch of coastline. No evidence of otters was found within 200 m of the proposed turbine location and there are no records of otter within 2 km of the site.

7.3.3.4 Bats

Previous surveys of the FEP recorded extremely low levels of bat activity and did not identify any bat roosts. The site, including the coastline, provides sub-optimal foraging and roosting habitats and there are no historical records of bats associated with the site. Bats are considered to have negligible value and are not considered further.

7.3.3.5 Fish

The distributions and populations of fish species, including migratory salmon, sea trout, lamprey, and eel, are known to fluctuate annually in the Firth of Forth owing to spatial and temporal variations in the utilisation of the estuary by different species and their different life stages. There is significant trawling activity in the outer Firth of Forth, principally for Norway lobster, and crab, lobster, whelk and clams are also landed commercially within the Firth of Forth. Other estuarine benthic fauna is likely to include polychaete and oligochaete worms, and bivalves such as the common mussel.

7.3.3.6 Marine mammals

The harbour porpoise is regarded as the most abundant cetacean species within the Firth of Forth, although typically only limited numbers are observed each year. Other species that occur regularly, albeit in limited numbers, include minke whale, killer whale, bottlenose dolphin and white-beaked dolphin. There are no records of cetaceans associated with the coastline near to the survey area and none have been recorded during the course of ecological or ornithological surveys.

Two species of pinnipeds, common seal and grey seal, have been recorded within the Firth of Forth and surrounding seas. The main terrestrial locations at which these seals congregate or come ashore are the small islands (e.g. Isle of May) in the Firth of Forth, although the coastline of Fife also supports small breeding colonies. There are no established haul-out sites or records of seals coming ashore near to the survey area and no seals were recorded during

the course of the ecological or ornithological surveys. The lack of records and suitable habitats, coupled with a regime of frequent anthropogenic disturbance from industrial activities and coastal defence works, suggests that these species are unlikely to be present.

7.3.3.7 Non-native marine species

The desk study revealed no records of non-native marine species in the areas and none were recorded during the shoreline survey.

7.4 Valued Ecological Resources

Receptors requiring further detailed assessment are shown in Table 7.2, and the remainder of this chapter focuses on assessment of potential effects on these receptors.

Table 7.2 Valued Ecological Resources included in this assessment.

Ecological Receptor	Value	Reasons and Comments
Firth of Forth SSSI	National	An extensive mosaic of intertidal and coastal habitats which support a rich invertebrate fauna and form important feeding grounds for the waders and wildfowl. An assessment of potential impacts to the birds of the SSSI (and associated SPA/Ramsar) is addressed separately in Chapter 8 – *Ornithology.*
Marine mammals	Regional	The cetaceans and pinnipeds recorded from the Firth of Forth include European Protected Species and/or those considered to be nature conservation priorities. None of these species occur in high numbers or depend (during any life stage) on the local waters and so are included on a precautionary basis but are considered to have potential regional value.
Fish	Local	The Firth of Forth is an important corridor for several migratory fish species which are both BAP targets and qualifying features of the River Teith SAC. Despite their international importance, the Development site is not considered important for any part of the species' lifecycles or commercial fisheries and so can only be considered of local value. All fish species are considered collectively hereafter.
Otter	Local	There is no evidence that this species is present. It is included in the assessment on a precautionary basis. If present, any population within the site would be small or at a very low density and therefore of local importance.

Table 7.3 Valued Ecological Resources not considered further in this assessment.

Ecological Receptor	Value	Reasons
Firth of Forth SPA/Ramsar	International	Designated wholly in recognition of its bird assemblage. Addressed separately in Chapter 8: Ornithology of this ES.

7.5 Assessment of Potential Effects

This section considers each valued ecological receptor in turn, identifying and describing the potential effects in the absence of mitigation during each phase of development i.e.

construction, operation and relocation. Mitigation measures required to reduce the magnitude and significance of potential impacts are presented separately in section 7.6.

7.5.1 Embedded mitigation

The Surface and Coastal Water Management Plan (SCWMP) (provided as Technical Appendix A9.1) describes water management measures to control surface water onshore and drain hardstandings and other structures during the construction and operation of the Development. The SCWMP is therefore considered to be of relevance to ecological receptors and will form part of a Pollution Prevention Plan (PPP) to be implemented for the Development. The PPP will set out best practice to be followed in all aspects of construction, operation and relocation. Therefore, potential impacts to valued ecological receptors arising from pollution, both particulate and chemical, are considered extremely unlikely and are not considered further. Further details about these measures and potential effects are provided in Chapter 9 – *Water Resources and Coastal Hydrology*.

7.5.2 Potential Construction Effects

Construction activities are described in Chapter 3: Project Description of this ES and considered likely to cause two broad types of direct and indirect impact: disturbance and habitat loss.

Effects on habitats as a result of land-take will occur only during construction and include both temporary and permanent loss/damage of both onshore and intertidal habitats; note that the onshore habitats associated with the FEP are considered to have negligible ecological value and so the impacts of habitat loss on these is not considered further. It is anticipated that with a carefully planned method statement, the habitat loss as a result of the construction of the Development, although permanent, would be minimal in extent.

Disturbance-related effects during construction are likely from activities such as drilling, ground and water pollution, and increased pedestrian and plant machinery.

7.5.2.1 Firth of Forth SSSI

None of the habitats or species listed as 'features of special interest' in the SSSI citation is present in or near to the Development and so disturbance to, and losses from, these features is extremely unlikely. Furthermore, given the ongoing shoreline management[17] and nearby industrial activity, any impacts, however unlikely, would fall below current background levels of disturbance and so would be not significant.

7.5.2.2 Fish

The Firth of Forth is an important migratory route for Atlantic salmon, sea trout, sea lamprey, and eel. Disturbance of the habitats associated with coastal areas has the potential to impact associated fisheries[18], particularly where these habitats, such as eel-grass beds, provide important ecological services to fish such as spawning grounds, nurseries, refuge and foraging. There are no such habitats within the Development and those surrounding or further afield are also extremely unlikely to be affected, either directly or indirectly, if the PPP is correctly implemented. Likewise, potential direct effects related to chemical or particulate pollution which may cause physical harm to fish are also considered unlikely assuming implementation of the PPP.

The construction of the turbine foundations will involve drilling boreholes, into which piles will be inserted. Typical percussive pile-driving operations usually generate repeated, acute, high-intensity noise which may be transmitted large distances though water and cause harm to

[18] Tyler-Walters, H. and Arnold, C. (2008) *Sensitivity of intertidal benthic habitats to impacts caused by access to fishing grounds*. CCW Policy Research Report No. 08/13

marine animals[19]. By comparison, bored piling (as proposed) generates a more continuous but lower intensity noise and so it is reasonable to assume that potential negative effects are likely to be considerably reduced; this method of piling may even constitute a preferred method of construction (*cf.* pile-driving)[18] and may be considered effective embedded mitigation.

A conceptual model defines four zones of noise influence on marine mammals[20], although this can be extended to other marine animals, including fish; extending outwards from source these are the zones of hearing loss, responsiveness, masking and audibility. The size of the zones depends on their intensity duration and distance from receptor.

Disturbance to fish arising from construction noise and vibration has been investigated for pile-driving operations[21] but there is limited research into the effects of short-term, small–scale sources such as those associated with the proposed drilling. Fish may detect high-intensity noise over several kilometres, but the impacts on fish – which exhibit a wide range of sensitivities and responses across species and life-stages – are poorly understood. However, based on this limited understanding and the fact that there are no locally-important fisheries or fish habitats, it is reasonable to assume that the nature of the noise associated with development is of a type that is considerably less likely to cause adverse effects and, furthermore, is likely to be within the range created by ongoing coastal defence and industrial work within the area. Therefore, potential impacts to fish would be negligible and are considered not significant.

7.5.2.3 Marine mammals

Effects from habitat loss and disturbance to the pelagic (open water) environment in which marine mammals spend the majority of the time will be negligible in the context of the wider Firth of Forth *i.e.* the obstruction (measured as area or volume) caused by turbine footprint is almost imperceptible as a proportion of the Firth of Forth and will take place in the intertidal zone. Therefore, impacts to marine mammals arising from habitat loss are considered extremely unlikely and not significant.

Marine mammals are social animals with sensitive hearing that they use to communicate and navigate and so noise and vibration arising from construction activities has the potential to affect these animals. The precise level of noise that will be generated by borehole drilling is unknown, as are the thresholds beyond which different species are affected. Whilst the impacts of pile-driving has been investigated in detail for marine mammals[21] and may cause direct harm or adverse behavioural responses at distances extending many kilometres from source[19], the impact of low-intensity noise, such as emitted by borehole drilling, is less well understood. However, as with fish, it is reasonable to assume that the extent, duration and magnitude of the noise associated with the development is of a type that will have only a negligible and reversible impact in marine mammals. Furthermore, such disturbance is likely to be within the range created by ongoing coastal defence and industrial work within the area, thus further reducing potential impacts to a level which is not significant.

Indirect effects arising from changes to prey species (mainly fish and crustaceans) are also considered extremely unlikely and not significant given the predicted lack of impact on fish populations and marine habitats (see above).

[19] Tougaard, J., Madsen, P. T. and Wahlberg, M. (2008) Underwater noise from construction and operation of offshore wind farms. *Bioacoustics* 17: 1–3
[20] Richardson et al. (1995) cited in Thomsen, F., Ludeman, K., Kafeman, R. and Piper, W. (2006) *Effects of offshore wind farm noise on marine mammals and fish*. Germany: COWRIE Ltd, Biola.
[21] Thomsen, F., Ludeman, K., Kafeman, R. and Piper, W. (2006) *Effects of offshore wind farm noise on marine mammals and fish*. Germany: COWRIE Ltd, Biola.

7.5.2.4 Otter

Otters are relatively tolerant of human activities where riparian or shoreline habitats are otherwise suitable. However, the coastline associated with the Development is not only subject to frequent, high levels of disturbance, it also lacks suitable habitats. Furthermore, there are no records or observations of otters along the coastline and so potential impacts to this species arising from both disturbance and habitat loss are therefore considered extremely unlikely and not significant.

7.5.2.5 Non-native species

Non-native marine species can cause significant environmental and economic harm[22] and a high proportion of non-native marine species have been introduced into UK waters by shipping[23]. The *International Convention for the Control and Management of Ships Ballast Water & Sediments*[24] clearly sets out procedures that shipping should follow to prevent the spread of invasive or problem marine species.

The majority of site infrastructure and Development activities will take place on land, including the fabrications and movement of many parts of the turbine, and therefore are extremely unlikely to spread non-native marine species.

The nacelle and blades for the turbine will be transported to Scotland by sea and will be received at Methil Docks whereafter they will be unloaded and transported to the Development site by land. The number of vessels or dockings required to deliver all turbine parts is currently unknown but is likely to be relatively few compared to shipping movements in the whole Firth of Forth, one of the most important shipping channels in the UK, thereby reducing the number of potential contamination events. In addition, the shipping will originate from within Western Europe and so the potential spread of invasive species would be limited to within a biogeographic zone, rather than between them, the latter causing the greatest harm. Furthermore, it is assumed that the relevant shipping authorities and operator will comply with the *International Convention for the Control and Management of Ships Ballast Water & Sediments* thereby further reducing the likelihood of contamination. The potential impacts, although potentially high, arising from the spread of non-natives within or into the local marine environment is therefore considered extremely unlikely and not significant.

7.5.3 Potential Operational Effects

Operational activities are described in Chapter 3: Project Description of this ES and are considered to have the potential only cause disturbance-related effects; impacts arising from habitat loss are expected only occur during construction and so are not considered further here.

Disturbance may arise from increased movements of personnel, vehicles and machinery servicing the operational turbine, as well as from visual and noise disturbance created by the moving parts of the turbine which may be transmitted through both water and air.

7.5.3.1 Fish

The intensity of underwater noise emitted from an operational wind turbine is considerably less than that associated with some construction operations and also may be masked to varying degrees by background noise associated with ongoing coastal and onshore activities such as coastal defence works, shipping movements and heavy plant operations. The noise level is likely to be positively associated with turbine size but the fact that the proposed turbine is not wholly submerged (indeed, at times it may be wholly exposed) will considerably

[22] Carlton, J. T. (1996) Marine bioinvasions: the alteration of marine ecosytems by non-indigenous species. *Oceanography* 9: 36–42.
[23] Eno, N. C., Clark, R. A. and Sanderson, W. G. (eds) (2003) *Non-native marine species in British waters: a review and directory*. Peterborough: JNCC
[24] Details available from http://globallast.imo.org

reduce sound transmittance through water thereby lessening effects on fish. Fisheries near to operational wind farms are unlikely to be significantly affected by operational noise[19] and the impact of turbines is probably restricted to masking communication and orientation signals rather than causing physiological damage or consistent avoidance reactions[25]. Therefore, given that there are no notable fisheries or fish closely associated with the zone of influence of the Development, the potential effects are considered negligible and not significant.

7.5.3.2 Marine mammals

The impacts of continuous, low-intensity noise on marine mammals are relatively poorly understood. However, as with fish, such noise is extremely unlikely to cause direct harm and other impacts, such as behavioural responses, may only be triggered in very close proximity to installations[19] and are unlikely to be deleterious. Operational noise impacts are generally considered less harmful than those arising during construction[26]. Many marine mammals are relatively well accustomed to regular patterns of disturbance, for example from shipping and harbours, and so these intelligent species may be expected to adapt to novel stimuli. The lack of records and observations of marine mammals, coupled with the unlikely nature of effects, suggests that impacts to marine mammals from operational noise would be not significant.

7.5.3.3 Otter

Otters are relatively tolerant of human activities and the low levels of site movements associated with the Development – that will probably be within the background level already present in the FEP – are likely to be within the range to which the species is able to tolerate. Such impacts are therefore considered extremely unlikely and not significant.

7.5.4 Potential Relocation Effects

Potential effects of relocation of the Development are considered likely to be similar in nature to those identified during construction, except that the magnitude of these effects will be much reduced.

Where infrastructure would be left in place, silt traps and bunding features would also be left in place, where this is compatible with the PPP. As a result, the magnitude of all effects associated with relocation is assessed as being negligible and therefore not significant.

7.6 Mitigation Measures and Residual Effects

No additional mitigation measures, other than those embedded in the design of the Development, are proposed as all identified potential effects have been assessed as not significant. Therefore, there are no significant residual effects on any of the valued ecological receptors.

7.7 Cumulative Effect Assessment

No significant cumulative effects are predicted on any of the valued ecological receptors identified in this assessment.

[25] Wahlberg, M. and Westerberg, H. (2005) Hearing in fish and their reactions to sounds from offshore wind farms. *Marine Ecology Progress Series* 288: 295–309.
[26] Madsen, P. T., Wahlberg, M., Tougaard, J. and Lucke, K. and Tyack, P. (2006) Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. *Marine Ecology Progress Series* 309: 279–295

7.8 Summary of Effects

Receptor	Development phase	Effect	Mitigation & Design measures	Impact magnitude and/or likelihood	Significance & confidence
Firth of Forth SSSI	Construction	Small-scale, permanent habitat loss & temporary disturbance (pollution)	Implement PPP. Limited construction footprint	Negligible/Extremely unlikely	Not significant; certain/near certain
Non-native marine species	Construction	Habitat loss loss/disturbance, competitive exclusion and predation. Potentially reversible.	Shipping ballast control	Medium to high negative impact but extremely unlikely	Not significant; certain/near certain
Marine mammals	Construction	Permanent, small-scale habitat loss/disturbance	Implement PPP. Limited construction footprint	Negligible and extremely unlikely	Not significant; certain/near certain
Marine mammals	Construction	Temporary but widespread and reversible disturbance (noise and vibration)	Drilling vs. pile-driving; consider less-sensitive seasons	Negligible impact; unlikely – reflecting lack of current research.	Not significant; probable
Marine mammals	Operation	Permanent (but reversible upon relocation) disturbance (noise, visual and vibration)	Single near-shore turbine limits effects	Limited negative impact; unlikely – reflecting lack of current research.	Not significant; probable
Fish	Construction	Permanent habitat loss/disturbance	Limited construction footprint.	Negligible and extremely unlikely	Not significant; certain/near certain
Fish	Operation	Permanent (but reversible upon relocation) disturbance (noise and vibration)	Single near-shore turbine limits effects.	Limited negative impact; unlikely – reflecting lack of current research.	Not significant; probable
Otter	Construction	Permanent habitat loss	Limited construction footprint.	Negligible and extremely unlikely	Not significant; certain/near certain
Otter	Operation	Permanent (but reversible upon relocation) disturbance (noise and visual)	Within background and species' tolerable levels	Negligible and extremely unlikely	Not significant; certain/near certain

7.9 Statement of Significance

This chapter has assessed the likely significance of the effects of the Development on ecological receptors and, on the basis of currently available information, has determined them all to be not significant.

8 ORNITHOLOGY

8.1 Introduction

This chapter of the Environmental Statement (ES) identifies and evaluates the effects of the proposed Methil Offshore Demonstration Wind Turbine (hereafter referred to as 'the Development') on ornithological interests arising from the construction, operation and relocation phases. An assessment of effects on non-avian ecology is addressed separately in Chapter 7: Ecology of this ES.

This chapter presents the following:

- Introduction;
- Consultations;
- Legislation and Guidance;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Assessment of Potential Effects;
- Mitigation Measures and Residual Effects;
- Cumulative Effect Assessment;
- Potential Effects on European Sites (Natura 2000);
- Summary of Effects; and
- Statement of Significance.

The assessment of potential effects and presentation of this chapter in the Environmental Statement (ES) has been prepared by Arcus Renewable Energy Consulting Ltd (Arcus). Baseline surveys and presentation of the Technical Report, which details the survey methods, results and analysis was prepared by Ove Arup & Partners Ltd (ARUP) and is presented in Appendix A8.1.

8.1 Consultations

A Scoping Report was issued by 2-B Energy to consultees in December 2009. Scottish Natural Heritage (SNH), Marine Scotland, Fife Council Development Services, and the Royal Society for the Protection of Birds (RSPB) provided responses relating to ornithology. A summary of scoping responses is provided in Table 8.1.

ARUP engaged in consultation with SNH and RSPB prior to undertaking the baseline data collection in order to gain agreement on the survey methodology and frequency. Further consultation was undertaken in 2009 to discuss the collision risk assessment methodology. Details of the consultations undertaken are presented in Section 1.4 of Appendix A8.1.

Table 8.1: Summary of scoping responses relating to ornithology

Consultee	Response	Action
SNH	Highlighted that turbine location is in close proximity to the Firth of Forth SPA. Seabirds from the Forth Islands SPA may forage in the area around Methil. Habitats Regulations Appraisal may be applicable.	An appraisal of the potential for likely significant effect on the SPAs is presented.
	Recommended that existing baseline data (e.g. WeBS) be collated.	WeBS Core Count data are presented in Appendix A8.1.
	Need to consider collision during operation and disturbance during construction, including during the breeding season.	Potential construction and operational effects of the Development are presented.
	Recommend post-construction monitoring.	Outline post-construction monitoring proposals are presented.

Consultee	Response	Action
Marine Scotland	Highlighted key environmental concern being the proximity of the Firth of Forth SPA. Require assessment of impacts on intertidal habitat during construction. Stated that proposed bird studies are sufficient to assess the potential impacts. Do not foresee any major impacts that could prevent this development	An appraisal of the potential for likely significant effect on the SPAs is presented. Effects of disturbance to intertidal habitats are considered.
Fife Council Development Services	The assessment should include cumulative assessment with the approved single turbine development to the northeast of this proposal. Consider potential impacts on bird flight paths, nesting and feeding areas and on designated sites.	Cumulative assessment has been undertaken. Detailed assessment of all potential impacts on birds has been undertaken
RSPB	The ES needs to discuss alternative sites. The ES should clearly present the survey methods used and the methods should be suitable for an Appropriate Assessment. Provided advice on the purpose of Appropriate Assessment. Highlighted the proximity of the Firth of Forth SPA and Forth Islands SPA. Noted that the development is outside these SPAs, therefore there are no direct impacts, but designated interests may be affected through disturbance and collision risk. Requested clarification of the position of the turbine in relation to the Firth of Forth SPA to ensure clear understanding of whether direct or indirect impacts would occur. The ES will need to identify all potential impacts on SPA species from both construction and operation. Advised that vantage point watches would be required to inform a collision risk assessment and recommended methods presented in SNH guidelines (2005). Need to consider the cumulative impacts of other developments affecting the Firth of Forth.	Chapter 3 includes details relating to site selection. Full details of survey methods are presented in Appendix A8.1. An assessment of likely significant impact on the SPAs is presented. Figure 7.2 displays the location of the turbine relative to the SPA. The SPA habitats will not be directly affected. An assessment of likely significant impacts on the SPAs is presented. Vantage point watches were undertaken to assess collision risk. Methods were agreed with SNH and RSPB. Cumulative assessment has been undertaken.

8.2 Legislation and Guidance

The Landscape and Natural Heritage section of the Scottish Planning Policy sets out national planning policy considerations and obligations in relation to the conservation of Scotland's natural heritage. It provides guidance on the role of the planning system in safeguarding areas of nature conservation interest, from local, non-statutory sites to statutory sites of international importance. It also draws attention to the importance of protecting and enhancing natural heritage interests outside those designated areas.

The ornithological baseline surveys and assessment have been designed and carried out with reference to a number of legislative and guidance documents. Those pertaining to the potential for impacts on European sites are presented in Section 2 of Appendix A8.1. Key legislative and guidance documents are summarised below:

- Council Directive 79/409/EEC on the Conservation of Wild Birds ("Birds Directive");
- The Convention on Wetlands of International Importance ("Ramsar Convention");
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007;
- The Wildlife and Countryside Act 1981 (as amended);
- Nature Conservation (Scotland) Act 2004;
- Survey Methods for Use in Assessing the Impacts of Onshore Windfarms on Bird Communities 2005[1];
- Birds of Conservation Concern 3 [2];
- Fife Local Biodiversity Action Plan (LBAP) 2nd Edition;
- Scottish Biodiversity Strategy and associated Implementation Plans;
- Birds and Wind Farms: Risk Assessment and Mitigation 2007[3];
- Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas[4]; and
- Guidelines for Ecological Impact Assessment in the United Kingdom 2006[5].

8.3 Assessment Methodology and Significance Criteria

8.3.1 Baseline Methods: Ecological Impact Assessment

The approach taken to the assessment of ornithological impacts follows the guidance document produced by the Institute of Ecology and Environmental Management[5]. These guidelines set out the process for assessment through the following stages:

- Describing the ornithological baseline through survey and desk study;
- Determining the value of receptors – identification of "Valued Ecological Receptors" (VERs);
- Identifying and characterising the potential effects on VERs based on the nature of construction, operation and relocation activities associated with the Development;
- Identifying mitigation, compensation and enhancement measures to avoid, reduce or remedy potential effects;
- Determining the significance of the effects, taking into account the value of the receptor, the nature of the effect and mitigation measures where appropriate; and
- Identification of any monitoring requirements.

[1] Scottish Natural Heritage (SNH) (2005) Survey methods for use in assessing the impacts of onshore windfarms on bird communities. SNH.
[2] Eaton, M.A., Brown, A.F., Noble, D.G., Musgrove, A.J., Hearn, R., Aebischer, N.J., Gibbons, D.W., Evans, A. & Gregory, R.D. (2009) Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man. *British Birds,* 102: pp296–341.
[3] de Lucas, M., Guyonne, F.E. and Ferrer, M. (eds) (2007) Birds and Windfarms: Risk Assessment and Mitigation. Quercus, Madrid.
[4] Scottish Natural Heritage (2006) Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas. SNH.
[5] IEEM (2006) Guidelines for Ecological Impact Assessment in the United Kingdom. IEEM, Winchester.

8.3.1.1 Determining Value

Value is defined in the context of a geographic frame of reference. Examples are provided in Table 8.2. Attributing a value to a receptor is generally straightforward in the case of designated sites, as the designations themselves are normally indicative of a value level. For example, a Special Protection Area (SPA) is implicitly of European (international) importance.

When assigning value to non-designated bird populations, reference is made to established criteria for defining nationally and internationally important populations of a species[6]. Professional judgement is important more important in these cases and must take into account factors such as the rarity, distribution and conservation status of a species.

Species Action Plans (SAPs) have been prepared under the UK Biodiversity Action Plan (UKBAP) or local Biodiversity Action Plan (LBAP) for a number of species that are in serious decline within the UK. The purpose of these SAPs is to guide conservation action, rather than imply a specific value for the species. However, as a guide in this assessment, any priority species listed in the UKBAP or relevant LBAP has been considered of at least local value. Similarly, due to their declining status or restricted distribution, species listed in the amber or red lists of Birds of Conservation Concern[2] are also considered to be of at least local value.

IEEM guidelines recommend that social and economic factors are also considered when valuing receptors. The proposed development area at Methil does not comprise any ornithological features of outstanding social or economic value (*e.g.* a special hide for viewing rare breeding birds, such as osprey). However, there may be some connectivity between seabirds observed at the Development and breeding birds at the Forth Islands, viewed by live-camera at the North Berwick Seabird Centre. This value is inherently incorporated in the overall assessment of potential impacts on the number of birds from the Forth Islands that may be affected by the Development and the social and economic value is not treated as a separate entity in this assessment. The effects on other socio-economic resources of the proposed development are discussed elsewhere in this ES.

[6] This is typically 1% of the national or biogeographic/flyway population respectively.

Table 8.2: Approach to valuing ecological receptors

Level of Value	**Examples**[7]
International	- An internationally designated site (*e.g.* SPA, Ramsar). - The qualifying feature of a SPA. - Species present in internationally important numbers (>1% of biogeographic/flyway populations).
National	- A nationally designated site (SSSI, NNR). - The notified interest of a SSSI. - Species that contribute to the integrity of a SPA but which are not cited as species for which the SPA is designated. - Ecologically sensitive species such as rare birds (<300 breeding pairs in the UK). - Species present in nationally important numbers (>1% UK population). - Species listed on Annex 1 of the EC Birds Directive or breeding species listed on Schedule 1 of the Wildlife and Countryside Act. - Regularly-occurring relevant migratory species which are either rare or vulnerable, or warrant special consideration on account of the proximity of migration routes, or breeding, moulting, wintering and staging areas in relation to the proposed windfarm.
Regional (NHZ[8] or Natural Area)	- Species that contribute to the integrity of a SPA or SSSI but which are not cited as species for which the SPA or SSSI is designated or notified. - Species present in regionally important numbers (>1% regional Eastern Lowalnd NHZ population).
Local	- Priority species in the UKBAP or LBAP. - Other species of conservation interest, *e.g.* red- or amber-listed species in Birds of Conservation Concern (JNCC 2006)[2] not covered above. - LWSs and LNRs designated for bird interests.
Negligible	- All other species, *e.g.* those on the green list that are not present in regionally or nationally important numbers. Receptors falling below local value are not normally considered in detail in the assessment process.

8.3.1.2 Characterising Potential Effects

8.3.1.2.1 Effect Magnitude

In order to characterise the likely change and effect of the proposed development on a VER (whether positive or negative), the magnitude of the change is a key consideration. Magnitude refers to the size of an effect, defined in quantitative terms where possible, and may relate to the area of habitat lost to the development footprint in the case of a habitat receptor, or predicted loss of individuals in the case of a population. Table 8.3 defines five categories of effect magnitude.

[7] SPA: Special Protection Area; Ramsar: site designated under the 1971 Ramsar Convention on Wetlands; SSSI: Site of Special Scientific Interest; NNR: National Nature Reserve; LWS: Local Wildlife Site; LNR: Local Nature Reserve.
[8] NHZ: Natural Heritage Zone.

Table 8.3: Criteria for describing effect magnitude (from Percival 2007)[9]

Effect Magnitude	Description
Very high	Total loss or very major alteration to key elements of the baseline (pre-development) conditions such that the post-development character, composition or other attributes would be fundamentally changed and may be lost from the site altogether. Guide: <20% of population/habitat remains
High	Major loss or major alteration to key elements of the baseline conditions such that the post-development character, composition or other attributes would be fundamentally changed. Guide: 20–80% of population/habitat lost
Medium	Loss or alteration to one or more key elements of the baseline conditions such that post-development character, composition or other attributes would be partially changed. Guide: 5–20% of population/habitat lost
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration would be discernible but the underlying character, composition or other attributes would be similar to pre-development conditions. Guide: 1–5% of population/habitat lost
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation. Guide: < 1% population/habitat lost

SNH guidelines[4] recommend that effects on populations outwith designated sites are assessed within an appropriate biogeographical scale. Effects on breeding bird populations are assessed in a regional context. The appropriate regional biogeographical unit has been identified as the Natural Heritage Zone (NHZ). NHZ classifications represent areas with a high level of biogeographical coherence and are unrelated to administrative boundaries. The proposed development at Methil is located within the Eastern Lowlands NHZ and regional impacts may be assessed in relation to the populations within this area. However, there are few data on bird populations for the majority of species in this NHZ and so there are some limitations to the consideration of impacts on regional populations in this assessment.

In most cases, the potential effects of the Development are in relation to seabirds and waterbirds associated with the Firth of Forth SPA or Forth Islands SPA. In this context, the magnitude of an effect on a species is assessed in terms of the population for which the relevant SPA is designated.

8.3.1.2.2 Effect Characterisation

Factors to be taken into account when characterising effects include:

- Behavioural Sensitivity: some species are more tolerant than others to disturbance effects and the same species may be more tolerant to effects at different times of year. Behavioural sensitivity is determined subjectively based on a species' ecology and behaviour, as well as using documented evidence of responses of birds to wind turbines. As a guide, the following criteria may be applicable:

[9] Percival, S.M. (2007) Predicting the effects of wind farms on birds in the UK: the development of an objective assessment method. In de Lucas, M., Janss, G. & Ferrer, M. (eds.) *Birds and Wind Power: Risk Assessment and Mitigation*. Quercus, Madrid.

- High: Species or populations occupying habitats remote from human activities, or that exhibit strong and long-lasting (guide: ≥20 minutes) reactions to disturbance events.
- Moderate: Species or populations that appear to be warily tolerant of human activities, or exhibit short-term reactions (guide: 5–20 minutes) to disturbance events.
- Low: Species or populations occupying areas subject to frequent human activity and exhibiting mild and brief reactions (including flushing behaviour) to disturbance events.

- Reversibility and Duration: this defines whether or not it is possible for the resource to recover from the effect. An irreversible effect is permanent, or one from which recovery is not possible within a reasonable timescale. A reversible effect is temporary; reversible effects are defined in terms of their duration according to the following timescales:
  - Short term: ≤5 years
  - Medium term: 5-15 years
  - Long term: 15-25 years (*i.e.* up to the lifespan of the development)
- Timing and frequency: an effect may only occur if the change coincides with a certain part of the life-cycle of a receptor – for example, the construction phase might be scheduled such that it does not affect the bird breeding season. The frequency of the effect is also considered – for example, during the operational phase, disturbance due to the presence of vehicles and personnel is likely to be minimal, but during the construction and relocation phases, movement of vehicles and personnel will be more frequent.

Section 3.2 of Appendix A8.1 provides a review of the types of effect that wind farms may have on birds and bird populations.

8.3.1.2.3 Confidence in Predictions

It is important to consider the probability that a change will occur as predicted and to determine the degree of confidence in the assessment of the effect on the receptor. Throughout the assessment process, the degree of confidence in the predictions is expressed as follows:

- Certain/near-certain: probability estimated at 95% chance or higher;
- Probable: probability estimated above 50% but below 95%;
- Unlikely: probability estimated above 5% but less than 50%; and
- Extremely unlikely: probability estimated at less than 5%.

8.3.1.3 Mitigation

Based on the nature of potential effects determined through the processes above, an initial assessment is made as to whether or not the change is likely to have an adverse effect on the integrity or favourable conservation status (see below for definitions) of the receptor's population. If there is likely to be an adverse effect, appropriate mitigation measures are proposed to avoid, reduce or remedy the potential effect.

8.3.1.4 Significance of Effects

Legislation and policy guidance, such as the EIA Regulations[10], require that significant effects are distinguished from others. Having followed the processes defined above to characterise the nature of the effect, a judgement is then made as to the significance of the effect, having taken any proposed mitigation measures and their likelihood of success into account. In accordance with the IEEM and SNH guidelines, a significant effect is defined as an (adverse or positive) effect on the integrity or conservation status of the receptor within the appropriate geographical area. Ecological integrity is defined (in relation to designated sites) in the ODPM circular 06/2005 as a site's "coherence, ecological structure and function... that enables it to sustain the habitat[s] or species for which it was classified". This concept can be applied to

[10] Environmental Impact Assessment (Scotland) Regulations 1999, as amended.

both designated sites and to defined populations (for example a regional breeding population). Favourable conservation status is defined as follows[4]:

- Population dynamics indicate that the species is maintaining itself on a long-term basis as a viable component of its habitats;
- The natural range of the species is not being reduced, nor is likely to be reduced for the foreseeable future; and
- There is (and will probably continue to be) a sufficiently large habitat to maintain its populations on a long-term basis.

An effect can be judged as of concern and potentially significant where it would adversely affect the favourable conservation status of a species, or stop a recovering species from reaching favourable conservation status.

8.3.1.5 Monitoring

Where mitigation measures are proposed to avoid or reduce significant effects, there may be a requirement to implement a monitoring programme to assess the success of the mitigation.

8.3.1.6 Assessment of Cumulative Effects

A cumulative effect is considered to be an additional effect on ornithological receptors arising from the Development in combination with other proposed developments likely to affect the birds or their habitats. For example, the collision risk at different developments affecting a population is added together in order to consider the cumulative collision risk on that population. The method followed to assess the cumulative effects is the same as that used for the Development in isolation, as outlined above.

8.3.2 Baseline Methods: Desk Study

Statutory designated sites within 5 km of the Development were identified using JNCC/SNH digital datasets in a Geographical Information System. Wetland Bird Survey data for the Core Count area from East Wemyss to Leven Power Station for the five-year period 2000-2005 were purchased from the British Trust for Ornithology.

Full details of the data requests and results are provided in Section 8.4 below and in Appendix A8.1.

8.3.3 Baseline Methods: Field Survey

Full details of the surveys carried out and the methods used are presented in Section 4.1 and 4.2 of Appendix A8.1. Field surveys were carried out between September 2006 and September 2007 following SNH guidelines[1] and taking into account consultations with SNH and RSPB during the survey period. The following surveys were carried out:

- Vantage Point Surveys: flight paths and heights of birds were recorded from a single vantage point overlooking the survey area, which was defined as a 330m × 330m square centred on the proposed turbine location. A total of nearly 122 hours of diurnal observations were made, ensuring that minimum recommended total survey effort was met or exceeded for each of the autumn, winter, spring and summer seasons. The data collected provide the baseline information to inform the collision risk assessment.
- Activity Summary Survey: prior to commencing each vantage point survey, the numbers of all birds present within a wider survey area extending 230m-300m from the proposed turbine location were recorded. The data collected provide the baseline information to inform the assessment of potential displacement effects.

8.3.4 Baseline Methods: Collision Risk Assessment

Full details of the method used to estimate the collision risk to target species recorded at the Development are presented in Section 4.3 of Appendix A8.1.

8.4 Baseline Conditions

The following sections combine the results of the baseline methods presented above to describe the ornithological interest of the site and local area. Full details of the desk study results, baseline survey results and collision risk are presented in Section 5 of Appendix A8.1. A summary of the results are presented in this chapter.

8.4.1 Designated Sites

8.4.1.1 Statutory Designated Sites

8.4.1.1.1 Firth of Forth

The Firth of Forth is a large coastal area stretching from Alloa Inches in the River Forth to Fife Ness and Dunbar in the east and comprises a complex of estuaries, mudflats, rocky shorelines, beaches and saltmarshes. The mudflats are invertebrate rich and form important feeding grounds for the abundant waders and wildfowl. The Firth of Forth is notified as a Site of Special Scientific Interest (SSSI), designated as a Special Protection Area (SPA) and Ramsar site, and is covered by a Nature Conservation Order (NCO). Further details of the statutory nature conservation status of the Firth of Forth are provided in Chapter 7: Ecology and in Section 3.1 of Appendix A8.1. Full citations are presented in Appendix A of Appendix A8.1.

The SPA and Ramsar designations are mainly in place due to the internationally and nationally important numbers of wintering waterbirds: red-throated diver, Slavonian grebe, golden plover, bar-tailed godwit, Sandwich tern (on passage), pink-footed goose, shelduck, knot, redshank, turnstone, great crested grebe, cormorant, scaup, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, oystercatcher, ringed plover, grey plover, dunlin and curlew, with large numbers of wigeon, mallard and lapwing also adding to the assemblage. The SSSI citation also specifically mentions teal and regionally important populations of wintering pochard, pintail and purple sandpiper in addition to the species detailed in the SPA and Ramsar qualifications, and important breeding populations of eider, shelduck, ringed plover, fulmar, kittiwake and house martin.

8.4.1.1.2 Forth Islands

The Firth of Forth Islands are located in or near to the Firth of Forth and are designated as a SSSI and SPA. The SPA comprises a number of separate islands or island groups, principally Inchmickery (together with the nearby Cow and Calves) off Edinburgh, Long Craig, Fidra, Lamb and Craigleith together with the Bass Rock off North Berwick, and the much larger Isle of May in the outer part of the Firth. The site also includes additional other small islands. The islands support important numbers of a range of breeding seabirds, in particular terns, auks and gulls. The colony of gannets is the largest on the east coast of the UK. The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

- *The Forth Islands Site of Special Scientific Interest (SSSI)*: the islands hold nationally important numbers of breeding seabirds and together form the largest breeding seabird colony in the Lothians. Craigleith supports the largest puffin colony in the Lothians and the Lamb has the only breeding cormorant colony in the Region. The number of breeding seabirds on these islands is increasing.
- *The Forth Islands Special Protection Area (SPA)*: qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species – Arctic tern (mean between 1992 and 1996 of 540 pairs, 1.2% of the GB population), roseate tern (an average of 8 pairs, 1997 - 2001; 13% of GB population), common tern (an average of 334 pairs, 1997-2001; 3% of GB population) and Sandwich tern (an average of 440 pairs, 3% of GB). The SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: Northern gannet (21,600 pairs, 8.2% of world biogeographic population), European shag (2,400 pairs, 1.9% of N Europe biogeographic population), lesser black-backed gull (1,500 pairs, 1.2% of total L.f. graellsii biogeographic population) and Atlantic puffin (14,000 pairs, 1.5% of total F.a.grabae biogeographic population). The SPA also qualifies under Article 4.2 by

regularly supporting in excess of 20,000 individual seabirds. The site regularly supports 90,000 seabirds (three year mean, 1986 – 1988) including nationally important populations of razorbill, common guillemot, black-legged kittiwake, herring gull, great cormorant, Northern gannet, lesser black-backed gull, European shag, Atlantic puffin, Northern fulmar, Arctic tern, common tern, roseate tern and Sandwich tern.

8.4.1.2 Non-statutory Designated Sites

There are no non-statutory designated sites within 2 km of the Development.

8.4.2 Species

Wetland Bird Survey Core Count data provided by the BTO for the five-year period 2000-2005 are provided in Section 3.3 of Appendix A8.1. The data show that the area covered by the Core Count sector East Wemyss to Leven Power Station is important for the following species, which have over 1% of the SPA qualifying population present: red-throated diver, cormorant, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, oystercatcher, curlew and Sandwich tern.

A total of 37 species were recorded during the activity summary surveys and a further 10 species were recorded during flight activity surveys. Table 8.4 provides a summary of the presence of each of the species recorded. Full details of the survey results are provided in Section 5 of Appendix A8.1.

Table 8.4: Summary of baseline results for each species; PCH = potential collision height

Species	Baseline summary
Teal	A single record of two females flying below PCH parallel to the shoreline. Otherwise, not recorded within the survey area and no records in the WeBS Core Count sector. Collision risk is negligible.
Mallard	Three records: two singles flying below PCH in October and two birds flying at PCH in March. Otherwise, not recorded within the survey area and no records in the WeBS Core Count sector. Collision risk estimated at one bird every >30 years (0.03 bird per year).
Scaup	A single record of one male flying below PCH parallel to the shoreline. Otherwise, not recorded within the survey area. Winter mean peak count of three birds in the WeBS Core Count sector. Collision risk is negligible.
Eider	Recorded in small numbers during almost all surveys on near-shore waters within 100m of the shoreline around the site. Mean number of 13.6 birds within the survey area, with a maximum of 67 in May. A total of 189 bird-flights were recorded, mainly parallel to the shoreline, but none were at PCH, therefore collision risk is negligible. Winter mean peak count of 597 birds in the WeBS Core Count Sector, representing 6.4% of the Firth of Forth SPA cited population.
Long-tailed duck	Recorded in small numbers, infrequently, during the winter and early spring on near-shore waters within 100m of the shoreline around the site. A maximum of 13 birds observed. A total of 15 bird-flights were recorded, mainly parallel to the shoreline, but none were at PCH, therefore collision risk is negligible. Winter mean peak count of 45 birds in the WeBS Core Count Sector, representing 4.3% of the Firth of Forth SPA cited population.
Common scoter	Recorded in small numbers, infrequently, during the winter and early spring on near-shore waters within 100m of the shoreline around the site. A maximum of 12 birds observed in March, although none were observed during the majority of surveys. Just two birds were recorded in flight, but neither were at PCH, therefore collision risk is negligible. Winter mean peak count of 126 birds in the WeBS Core Count Sector, representing 4.4% of the Firth of Forth SPA cited population.
Velvet scoter	Recorded twice during the winter and early spring on near-shore waters within 100m of the shoreline around the site, with a maximum of three birds in March. Six bird-flights were recorded; one of those was at PCH. Collision risk estimated at one bird every >50 years (0.02 bird per year). Winter mean peak count of 13 birds in the WeBS Core Count Sector, representing 2.0% of the Firth of Forth SPA cited population.
Goldeneye	Recorded three times during the winter on near-shore waters within 100m of the shoreline around the site, with a maximum of two birds in January. Two birds were recorded in flight, both below PCH, therefore collision risk is negligible. Winter mean peak count of 139 birds in the WeBS Core Count Sector, representing 4.6% of the Firth of Forth SPA cited population.
Red-breasted merganser	Recorded in small numbers during the winter on near-shore waters within 100m of the shoreline around the site. A maximum of four birds observed. A total of 20 bird-flights were recorded, mainly parallel to the shoreline, but none were at PCH, therefore collision risk is negligible. Winter mean peak count of 14 birds in the WeBS Core Count Sector, representing 2.1% of the Firth of Forth SPA cited population.
Red-throated diver	Recorded in small numbers between September and May on near-shore waters within 100m of the shoreline around the site. A maximum of three birds observed. Just three bird-flights were recorded, but none were at PCH, therefore collision risk is negligible. Winter mean peak count of two birds in the WeBS Core Count Sector, representing 2.2% of the Firth of Forth SPA cited population.
Black-throated diver	A single record of a bird flying below PCH parallel to the shoreline, therefore collision risk is negligible. Otherwise, not recorded within the survey area and no records in the WeBS Core Count sector.

Species	Baseline summary
Fulmar	Recorded infrequently during flight activity surveys between March and July. A total of 14 bird-flights were recorded, mainly parallel to the shoreline, of which five were at PCH. Collision risk was estimated to be approximately one bird every five years (0.19 bird per year).
Manx shearwater	One record of a bird in October flying off-shore below PCH, therefore collision risk is negligible. No other records.
Gannet	Recorded occasionally during flight activity surveys in spring, summer and autumn. A total of 270 bird-flights recorded offshore within the survey area, with the majority of the records (238) on one day in October. 20 birds were recorded at PCH. Collision risk was estimated to be approximately one bird every two years (0.46 bird per year).
Cormorant	Recorded in small numbers during almost all surveys on near-shore waters often within 10m of the shoreline around the site and also roosting or resting on the sea wall and other coastal structures. Maximum count of ten birds in January. A total of 408 bird-flights were recorded, mainly parallel to the shoreline, but just four were at PCH. Collision risk was estimated to be approximately one bird every eight years (0.12 bird per year). Winter mean peak count of 53 birds in the WeBS Core Count Sector, representing 7.8% of the Firth of Forth SPA cited population.
Shag	Recorded in small numbers during almost all surveys on near-shore waters within 100m of the shoreline around the site and also roosting or resting on the sea wall and other coastal structures. Maximum count of seven birds in August. A total of 271 bird-flights were recorded, mainly parallel to the shoreline, but just two were at PCH. Collision risk was estimated to be approximately one bird every 25 years (0.04 bird per year).
Grey heron	A single record of a bird in the survey area in May. No flights recorded, therefore collision risk is negligible.
Peregrine	A pair prospected nesting on a structure near the Development site and some associated flight activity was observed. There were eleven bird-flights recorded within the survey area, six of which were at PCH. The collision risk was estimated at one bird approximately every four years (0.26 bird per year) using precautionary modelling parameters. The breeding history of peregrines at the FEP site is unclear. Technical Appendix A8.1 states that there was evidence of historic nesting within the FEP site. Information from the local Raptor Study Group coordinator (via Alan Leitch pers. comm.) indicates that breeding was reported in 2001 but was not confirmed. The Raptor Study Group representative has monitored the site since 2001 and although peregrine activity has been observed, there has been no breeding.
Oystercatcher	Just one record of a bird using habitat within the survey area in November. There were 424 records of birds in flight moving through the survey area along the coastline between feeding areas. Nine bird-flights were recorded at PCH, resulting in an estimated collision risk of one bird approximately every three years (0.37 bird per year). Winter mean peak count of 157 birds in the WeBS Core Count Sector, representing 2.0% of the Firth of Forth SPA cited population.
Ringed plover	One record of two birds using habitat within the survey area in May. There were just two birds recorded in flight along the coastline, neither of which were at PCH, therefore collision risk is negligible. Not recorded in the Count Sector during the WeBS counts.
Grey plover	A single record of a bird flying below PCH along the coastline, therefore collision risk is negligible. Otherwise, not recorded within the survey area and no records in the WeBS Core Count sector.
Dunlin	A total of nine birds recorded flying below PCH along the coastline, therefore collision risk is negligible. Otherwise, not recorded within the survey area and no records in the WeBS Core Count sector.

Species	Baseline summary
Curlew	A total of nine birds recorded flying below PCH along the coastline, therefore collision risk is negligible. Otherwise, not recorded within the survey area. Winter mean peak count of 21 birds in the WeBS Core Count Sector, representing 1.1% of the Firth of Forth SPA cited population.
Common sandpiper	13 recorded in the survey area in March and one in June. Otherwise, no other records of this species. These were possibly recorded incorrectly on the field recording sheet – the single bird is a possible occurrence of this species, but the flock of 13 common sandpipers (CS) are likely to have been incorrectly recorded using the wrong two-letter species code for common scoter (CX).
Redshank	One record of eight birds using habitat within the survey area in February. There were just three birds recorded in flight along the coastline, none of which were at PCH, therefore collision risk is negligible. Winter mean peak count of 28 birds in the WeBS Core Count Sector, representing 0.6% of the Firth of Forth SPA cited population.
Turnstone	One record of four birds using habitat within the survey area in February. There were no flight records, therefore collision risk is negligible. Winter mean peak count of seven birds in the WeBS Core Count Sector, representing 0.8% of the Firth of Forth SPA cited population.
Kittiwake	Recorded in small numbers in the survey area between June and August, with a maximum of four birds. There were 92 records of birds in flight moving through the survey area along the coastline. Six of the birds were recorded at PCH, resulting in an estimated collision risk of one bird approximately every five years (0.2 bird per year).
Black-headed gull	Birds were recorded resting on the sea wall on most surveys, with a maximum of ten birds recorded within the survey area. Just one bird was recorded flying at PCH, resulting in a negligible collision risk.
Common gull	Birds were recorded resting on the sea wall or within the survey area infrequently, with a maximum of seven birds recorded. Two birds were recorded in flight through the survey area, but neither was at PCH, resulting in a negligible collision risk.
Herring gull	Moderate numbers observed frequently on the water and resting on the sea wall, with a maximum of 410 recorded in September. Herring gull was not recorded as a target species, as significant numbers were not observed in flight through the survey area at PCH. Most flights would be likely to be below PCH, although there is likely to be some low level of collision risk.
Lesser black-backed gull	Moderate numbers observed frequently on the water and resting on the sea wall, with a maximum of 96 recorded in August. Lesser black-backed gull was not recorded as a target species, as significant numbers were not observed in flight through the survey area at PCH. Most flights would be likely to be below PCH, although there is likely to be some low level of collision risk.
Great black-backed gull	Small numbers observed frequently on the water and resting on the sea wall, with a maximum of seven recorded in August. Great black-backed gull was not recorded as a target species, as significant numbers were not observed in flight through the survey area at PCH. Most flights would be likely to be below PCH, although there is likely to be some low level of collision risk.
Sandwich tern	Just one record of a two birds using habitat within the survey area in August. There were 243 records of birds in flight moving through the survey area along the coastline. Eleven of the birds were recorded at PCH, resulting in an estimated collision risk of one bird approximately every two years (0.46 bird per year). Post-breeding mean peak count (1993-98) of 380 birds in the WeBS Core Count Sector, representing 23.5% of the Firth of Forth SPA cited population.
Common tern	Just one record of a two birds using habitat within the survey area in May. There were 65 records of birds in flight moving through the survey area along the coastline during the summer months. Five of the birds were recorded at PCH, resulting in an estimated collision risk of one bird approximately every four to five years (0.22 bird per year).

Species	Baseline summary
Common guillemot	Frequently recorded in small numbers within the survey area, typically between one and eight birds on the water, although a maximum of 27 recorded in May. Five bird-flights recorded below PCH along the coastline, therefore collision risk is negligible.
Razorbill	Infrequently recorded in small numbers within the survey area, typically between one and eight birds on the water. One bird recorded flying below PCH along the coastline in September, therefore collision risk is negligible.
Puffin	A single record of a bird on the water within the survey area in June. No other records.
Woodpigeon	A single record of one bird in the survey area.
Swallow	Four and five birds recorded within the survey area in June. Swallow was not a target species for flight activity surveys.
Rock pipit	Occasional records of single birds on the shoreline within the survey area.
[Yellow wagtail] / grey wagtail	One record of a bird "flitting about" in the survey area in November. As yellow wagtails are summer migrants, it is suspected that this was a mis-identified grey wagtail.
Pied wagtail	Infrequent records of up to four birds within the survey area.
Robin	A single record in January.
Wheatear	A single record of a passage bird in April.
[Chiffchaff]	Several records of one or two birds, mainly in the winter. This species is unlikely to winter at this location; it is suspected that the species code recorded on the field recording sheets (CC) refers to carrion crow (C.).
Carrion crow	Occasional records of small numbers within the survey area.
Linnet	A small flock recorded infrequently within the survey area.

8.4.3 Valued Ecological Receptors

Receptors requiring further detailed assessment are shown in Table 8.5, and the remainder of this chapter focuses on assessment of the potential effects on these receptors.

Table 8.5: Valued Ecological Receptors

Receptor	Value	Reasons and Comments
Firth of Forth SPA/SSSI	International	As there are no direct impacts of the Development on the habitats within the SPA/SSSI, the potential impacts on the SPA/SSSI are considered in terms of the populations of the species for which it is designated (see below). A summary of the potential for likely significant effects on the SPA is also provided. The species notified in the SSSI citation are mostly coincident with the species for which the SPA qualifies. Those additional species in the SSSI citation that are not part of the SPA qualification (either individually or as part of the assemblage) are highly unlikely to be affected by the development, or are considered as species for which the Forth Islands SPA qualifies (see below).
Forth Islands SPA/SSSI	International	As there are no direct impacts of the Development on the habitats within the SPA/SSSI, the potential impacts on the SPA/SSSI are considered in terms of the populations of the species for which it is designated (see below). A summary of the potential for likely significant effects on the SPA is also provided. The species notified in the SSSI citation are coincident with the species for which the SPA qualifies.

Receptor	Value	Reasons and Comments
Eider	National	Species listed in the Firth of Forth assemblage qualification under Article 4.2 by supporting nationally important wintering populations. Present in small numbers within the survey area and frequently observed flying offshore through the survey area.
Long-tailed duck	National	Species listed in the Firth of Forth assemblage qualification under Article 4.2 by supporting nationally important wintering populations. Present in small numbers within the survey area and infrequently observed flying offshore through the survey area.
Red-throated diver	International	Firth of Forth qualifies under Article 4.1 by regularly supporting wintering populations of European importance. Present in small numbers within the survey area.
Fulmar	National	Species listed in the Forth Islands assemblage qualification under Article 4.2 by supporting nationally important populations. Infrequently observed flying offshore through the survey area.
Gannet	International	Forth Islands qualifies under Article 4.2 by regularly supporting populations of European importance. Frequently observed flying offshore through the survey area.
Cormorant	National	Species listed in both the Firth of Forth and Forth Islands assemblage qualifications under Article 4.2 by supporting nationally important wintering and breeding populations respectively. Present in small numbers within the survey area and frequently observed flying offshore through the survey area.
Shag	International	Forth Islands qualifies under Article 4.2 by regularly supporting populations of European importance. Present in small numbers within the survey area and frequently observed flying offshore through the survey area.
Peregrine	National	Annex 1 / Schedule 1 listed species. Pair present near the Development and flight activity observed, but breeding not thought to have occurred.
Oystercatcher	National	Species listed in the Firth of Forth assemblage qualification under Article 4.2 by supporting nationally important wintering populations. Present very infrequently within the survey area, but frequently observed flying through the survey area.
Kittiwake	National	Species listed in the Forth Islands assemblage qualification under Article 4.2 by supporting nationally important populations. Frequently observed flying offshore through the survey area.
Herring gull	National	Species listed in the Forth Islands assemblage qualification under Article 4.2 by supporting nationally important populations. Present in moderate numbers within the survey area.
Lesser black-backed gull	International	Forth Islands qualifies under Article 4.2 by regularly supporting populations of European importance. Present in small numbers within the survey area.
Sandwich tern	International	Firth of Forth qualifies under Article 4.1 by regularly supporting passage populations of European importance. Forth Islands also qualifies under Article 4.1 by regularly supporting populations of European importance. Frequently observed flying offshore through the survey area.
Common tern	International	Forth Islands qualifies under Article 4.1 by regularly supporting populations of European importance. Frequently observed flying offshore through the survey area.

The following species that were recorded during the baseline surveys are not considered in further detail in this assessment, because the data collected have demonstrated that their presence at or near the site is very infrequent or they are species of low conservation value and it is considered that potential effects of the Development on their populations are highly likely to be negligible:

- Teal
- Mallard
- Scaup
- Common scoter
- Velvet scoter
- Goldeneye
- Red-breasted merganser
- Black-throated diver
- Manx shearwater
- Grey heron
- Ringed plover
- Grey plover
- Dunlin
- Curlew
- Common sandpiper
- Redshank
- Turnstone
- Black-headed gull
- Common gull
- Great Black-backed gull
- Common guillemot
- Razorbill
- Puffin
- Swallow
- Rock pipit
- Yellow/grey wagtail
- Pied wagtail
- Robin
- Wheatear
- [Chiffchaff]
- Carrion crow
- Linnet

8.5 Assessment of Potential Effects

This section provides an assessment of the potential effects of the phases of the Development on the species identified as valued ecological receptors in the absence of mitigation during each phase of development i.e. construction, operation and relocation. Mitigation measures required to reduce the magnitude and significance of potential impacts are presented separately in section 8.6. As required under the Habitats Regulations, an assessment of the potential for any likely significant effect on the Firth of Forth SPA and Forth Islands SPA is provided in order to determine whether Appropriate Assessment should be undertaken to ascertain whether or not the proposal would adversely affect the integrity of these European sites.

8.5.1 Embedded mitigation

The Surface and Coastal Water Management Plan (SCWMP) (provided as Technical Appendix A9.1) describes water management measures to control surface water onshore and drain hardstandings and other structures during the construction and operation of the Development. The SCWMP is therefore considered to be of relevance to ornithological receptors and will form part of a Pollution Prevention Plan (PPP) to be implemented for the Development. The PPP will set out best practice to be followed in all aspects of construction,

operation and relocation. Therefore, potential impacts to ornithological receptors arising from pollution, both particulate and chemical, are considered extremely unlikely and are not considered further. Further details about these measures and potential effects are provided in Chapter 9 – *Water Resources and Coastal Hydrology*.

8.5.2 Potential Construction Effects

Construction activities are described in Chapter 3: *Scheme Description* and considered likely to cause two broad types of direct and indirect impact: habitat loss and disturbance.

Effects on habitats as a result of land-take will occur only during construction and include both temporary and permanent loss/damage. The habitat loss as a result of the construction of the Development would be in the specific bored foundation pile locations and at the top of the foreshore section where the bridge link will rest on a concrete pad. The turbine will be located outside the boundary of the Firth of Forth SPA and the access bridge and cabling to shore will not directly impact on the habitats within the SPA.

Disturbance-related effects during construction are likely from activities such as drilling, ground and water pollution, and increased pedestrian and plant machinery activity. This has the potential to result in the displacement of birds from using habitats within the zone of influence of the Development, or to result in altered flight behaviour as birds flying past avoid the source of the disturbance. Birds affected in this way may be directly associated with the Firth of Forth SPA (*i.e.* the birds affected may be within the SPA boundary) or may be indirectly associated with the Firth of Forth SPA or the Forth Islands SPA (*i.e.* birds that have connectivity with either SPA may be subject to disturbance effects that result in impacts on their ability to survive). However, it should be noted that any disturbance effects during construction will be very short-term in nature, lasting only for as long as the construction phase takes place – this is likely to be approximately one month.

8.5.2.1 Eider

Eiders were one of the most consistently recorded birds within the survey area, although the numbers present were relatively small. There was a mean count of 13.6 birds and a maximum of 67 birds, representing 0.14% and 0.7% of the Firth of Forth SPA population respectively. It is therefore considered that the area close to the Development is not critical for this species and there is a considerable amount of more suitable foraging area within the Firth of Forth. Any displacement from the Development is near-certain to have a negligible effect on the population within the Firth of Forth. Eiders were frequently recorded flying through the survey area and it is probable that birds would slightly adjust their flight route to fly further away from the Development area during construction. However, due to the small scale of the Development the energetic consequences to individual birds are near-certain to be negligible.

8.5.2.2 Long-tailed Duck

Long-tailed ducks were infrequently recorded in small numbers within the survey area and were also infrequently recorded flying through the survey area. There was a mean count of 2.9 birds during the non-breeding season (September to April) and a maximum of 13 birds, representing 0.28% and 1.24% of the Firth of Forth SPA population respectively. It is therefore considered that the area close to the Development is not critical for this species and there is a considerable amount of more suitable foraging area within the Firth of Forth. Any displacement from the Development is near-certain to have a negligible effect on the population within the Firth of Forth. As the movement of birds through the survey area was very infrequent, there is no evidence that birds would be subject to adverse energetic consequences as a result of a slightly changing their flight lines.

8.5.2.3 Red-throated Diver

The presence of red-throated diver was only occasionally recorded within the survey area, in very small numbers, therefore it is considered that the area close to the Development is not

important for this species. Just three birds were recorded flying through the survey area, therefore there is no evidence that birds would be subject to adverse energetic consequences as a result of a barrier effect to movement. Any displacement from this area is near-certain to have a negligible effect on the population within the Firth of Forth.

8.5.2.4 Fulmar

Fulmars were infrequently recorded flying through the survey area. There was no evidence that the area around the Development formed an important feeding area for this species, as fulmars feed mainly in the off-shore marine environment. It is probable that birds would slightly adjust their flight line to fly further away from the Development area during construction, but the Development is not located in a regularly used flight route. Due to the small scale of the Development and the low level of flight activity near the turbine, the energetic consequences to individual birds are near-certain to be negligible. The fulmars observed within the survey area could potentially be associated with the Forth Islands SPA population. The available foraging grounds for pelagic species in the Firth of Forth and around the Forth Islands are vast, therefore the potential temporary displacement from a relatively small coastal zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

8.5.2.5 Gannet

Gannets were frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species, as gannets feed mainly in the off-shore marine environment. It is probable that birds would slightly adjust their flight line to fly further away from the Development area during construction, but the Development is not located in a regularly used flight route. Due to the small scale of the Development and low level of flight activity near the turbine, the energetic consequences to individual birds are near-certain to be negligible. The gannets observed within the survey area could potentially be associated with the Forth Islands SPA population. The available foraging grounds for pelagic species in the Firth of Forth and around the Forth Islands are vast, therefore the potential temporary displacement from a relatively small coastal zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

8.5.2.6 Cormorant

Cormorants used habitats within the survey area and were also frequently recorded flying offshore through the survey area. Their main use of the area was for resting on the sea-wall and other coastal structures and foraging near-shore within approximately 10m of the sea-wall. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and taking into consideration the very small numbers present, it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during construction is near-certain to have a negligible effect on the population within the Firth of Forth. Displaced birds would have a substantial amount of alternative available area to use. Cormorants are known to forage up to 35 km away from their breeding sites during the breeding season (Grémillet 1997)[11], therefore birds recorded within the survey area could potentially be associated with the Forth Islands SPA. The available foraging grounds for cormorants in the Firth of Forth are vast, therefore the potential temporary displacement from a relatively small zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

[11] Grémillet, D. (1997) Catch per unit effort, foraging efficiency, and parental investment in breeding great cormorants (*Phalacrocorax carbo carbo*). *ICES Journal of Marine Science* 54: 635–644

8.5.2.7 Shag

Shags used habitats within the survey area and were also frequently recorded flying offshore through the survey area. Their main use of the survey area was for resting on the sea-wall and other coastal structures. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and taking into consideration the very small numbers present, it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during construction is near-certain to have a negligible effect on the local population. Shags are known to forage up to 17 km away from their breeding sites during the breeding season (Wanless *et al.* 2008)[12], therefore birds recorded within the survey area could potentially be associated with the Forth Islands SPA. The available foraging grounds for shags in the Firth of Forth and around the Forth Islands are vast, therefore the potential temporary displacement from a relatively small zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

8.5.2.8 Peregrine

The structures within the FEP site on which the pair of peregrines has prospected for a nesting site in the past are intended to be removed (not as a procedure of this Development). The FEP site and the surrounding areas have been under development and/or have been associated with moderate to high disturbance from humans and vehicles for some time. Peregrines are very tolerant of high disturbance levels in some situations, often nesting close to human settlements (*e.g.* cathedral towers, tower blocks) and in active stone quarries. However, as there has been no confirmed breeding by this species, during the short construction period, it is considered that potential disturbance would not adversely affect peregrines within the area.

8.5.2.9 Oystercatcher

Oystercatchers were frequently recorded flying through the survey area, probably moving between roosts and feeding areas in response to tidal changes. There was only on record of a bird using habitat within the survey area, therefore the area within the zone of influence of the Development is not important as a foraging area for oystercatchers. It is probable that birds would slightly adjust their flight route to fly further away from the Development area during construction. However, due to the small scale of the Development and the relatively small number of birds moving through the survey area, the energetic consequences to individual birds are near-certain to be negligible.

8.5.2.10 Kittiwake

Kittiwakes were fairly frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species, as kittiwakes feed mainly in the off-shore marine environment. It is probable that birds would slightly adjust their flight line to fly further away from the Development area during construction, but the Development is not located in a regularly used flight route. Due to the small scale of the Development and low flight activity near the turbine, the energetic consequences to individual birds are near-certain to be negligible. The kittiwakes observed within the survey area could potentially be associated with the Forth Islands SPA population. The available foraging grounds for pelagic species in the Firth of Forth and around the Forth Islands are vast, therefore the potential temporary displacement from a relatively small coastal zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

[12] Wanless, S., Harris, M. P. & Morris, J.A. (2008) Foraging range and feeding locations of Shags *Phalacrocorax aristotelis* during chick rearing. *Ibis* 133:30-36

8.5.2.11 Herring Gull

Herring gulls used habitats within the survey area, but flight activity in the area at potential collision height was not considered sufficient to warrant including them as a target species. Their main use of the survey area was for resting on the sea-wall and other coastal structures, where small numbers were infrequently recorded for most of the year, with highest numbers present during the late summer/autumn period. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during construction is near-certain to have a negligible effect on the local population. Herring gulls may forage considerable distances from their nest sites, therefore birds recorded within the survey area could potentially be associated with the Forth Islands SPA population. The available foraging grounds for gulls in the Firth of Forth and around the Forth Islands are vast, therefore the potential temporary displacement from a relatively small zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

8.5.2.12 Lesser Black-backed Gull

Lesser black-backed gulls used habitats within the survey area, but flight activity in the area at potential collision height was not considered sufficient to warrant including them as a target species. Their main use of the survey area was for resting on the sea-wall and other coastal structures, where very small numbers were infrequently recorded for most of the year, with larger numbers present only during the late summer/autumn period. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and taking into consideration the small numbers present, it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during construction is near-certain to have a negligible effect on the local population. Lesser black-backed gulls may forage considerable distances from their nest sites, therefore birds recorded within the survey area could potentially be associated with the Forth Islands SPA population. The available foraging grounds for gulls in the Firth of Forth and around the Forth Islands are vast, therefore the potential temporary displacement from a relatively small zone around the proposed Development is near-certain to have a negligible effect on the Forth Islands SPA population.

8.5.2.13 Sandwich Tern

Sandwich terns were frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species. It is probable that birds would slightly adjust their flight route to fly further away from the Development area during construction. However, due to the small scale of the Development the energetic consequences to individual birds are near-certain to be negligible.

8.5.2.14 Common Tern

Common terns were frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species. It is probable that birds would slightly adjust their flight route to fly further away from the Development area during construction. However, due to the small scale of the Development the energetic consequences to individual birds are near-certain to be negligible.

8.5.3 Potential Operational Effects

Operational activities are described in Chapter 3: *Scheme Description* and considered likely to cause three broad types of direct and indirect impact: disturbance, barrier effect to movements and collision.

Disturbance many arise from increased movements of personnel, vehicles and machinery servicing the operational turbine, as well as from visual and noise disturbance created by the moving parts of the turbine. Species with low tolerance for such disturbance may be displaced from the area. Section 3.2.1 of Appendix A8.1 provides a summary of the factors influencing displacement due to disturbance.

The presence of turbines may cause an obstruction to bird flight, forcing birds to fly above or around the structure. This has a potential for population disturbance by increasing energy expenditure of individuals, particularly where regularly used flight paths between important sites for feeding, roosting, etc are affected. On a small scale the impact of barrier effects on bird populations has been found to be not significant. However the cumulative effect of numerous wind farms, or extensive sites could have a negative effect on populations.

Collision would occur when a bird flying through the rotor swept area is struck by a moving rotor. Collision of a bird with operational turbine rotors is almost certain to result in the death of the bird. The loss of individuals from a species with a low population density and low reproductive rate, such as raptors, may cause a greater negative impact on the population than the loss of individuals from species occurring at typically higher population densities and higher reproductive rates (*e.g.* oystercatcher). The frequency and likelihood of collisions depends on a number of factors relating to the biology of birds (often species-specific), the local landscape, and the structure of the turbine. Section 3.2.2 of Appendix A8.1 provides a summary of the factors influencing collision risk. The turbine tower is of a steel lattice construction, which may offer opportunities for birds to perch on. Collision risk may be increased for birds that are attracted to perch on the tower, although those birds below 45m above sea level would be below the sweep of the rotors and would be unlikely to be at risk when flying onto or off the tower. The majority of the steel supports would be at an angle to the horizontal, therefore the tower is not expected to provide opportunities that would attract birds to nest on the structure. Most species would be unlikely to perch on the tower, although those species currently resting on terrestrial habitats within the FEP site may do so: cormorant, shag and gulls.

For this assessment, an arbitrary threshold of 1% increase in baseline mortality for the population assessed has been set as a trigger for further, more detailed consideration of the effects of collision mortality. An increase of less than 1% in baseline mortality has been judged as highly likely to be a negligible effect on the population and is not assessed in more detail.

The effects of operational disturbance and the risk of collision may be considered mutually exclusive *i.e.*, a bird that avoids the windfarm area due to disturbance will not be at risk of collision with the turbine rotors at that time. However, a bird may initially avoid the windfarm (due to disturbance) but habituate to it over time, and would then be at risk of collision.

Where sufficient flight activity at Potential Collision Risk Height (PCH) has been recorded for individual species, collision risk modelling has been conducted and presented in Section 4.3 of Appendix A8.1.

8.5.3.1 Eider

Eiders were consistently present within the survey area, although the numbers recorded were less than 1% of the Firth of Forth population. The area close to the Development is not critical for this species and there is a considerable amount of more suitable foraging area within the Firth of Forth. Any displacement from this area as a result of the presence of the operational turbine is near-certain to have a negligible effect on the population within the Firth of Forth.

Eiders were frequently recorded flying through the survey area and it is probable that birds would slightly adjust their flight route to fly further away from the operational turbine. However, due to the small scale of the Development the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to eiders was estimated to be negligible, as all records were of birds flying below potential collision height.

8.5.3.2 Long-tailed Duck

Long-tailed ducks were infrequently present within the survey area in small numbers. The area close to the Development is not important for this species and there is a considerable amount of more suitable foraging area within the Firth of Forth. Any displacement from this area as a result of the presence of the operational turbine is near-certain to have a negligible effect on the population within the Firth of Forth.

Long-tailed ducks were infrequently recorded flying through the survey area. It is probable that birds would slightly adjust their flight route to fly further away from the operational turbine. However, long-tailed ducks tend to forage more distantly off-shore, therefore there is unlikely to be a regular flight route through the Development area. Due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to long-tailed ducks was estimated to be negligible, as all records were of birds flying below potential collision height.

8.5.3.3 Red-throated Diver

Red-throated divers were only occasionally recorded within the survey area, in very small numbers, therefore it is considered that the area close to the Development is not important for this species. Any displacement from this area is near-certain to have a negligible effect on the population within the Firth of Forth.

Just three birds were recorded flying through the survey area, therefore there is no evidence that birds would be subject to adverse energetic consequences as a result of a barrier effect to movement.

The collision risk to red-throated divers was estimated to be negligible.

8.5.3.4 Fulmar

Fulmars were infrequently recorded flying through the survey area. There was no evidence that the area around the Development formed an important feeding area for this species, therefore the effects of operational disturbance are negligible.

It is probable that birds would slightly adjust their flight route to fly further away from the operational turbine, but the Development is not located in a regularly used flight route – the fulmar is mainly a pelagic species foraging in off-shore, rather than near-shore areas. Due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to fulmars was estimated to be one bird approximately every eight years (0.12 bird per year) and a collision is therefore unlikely to occur during the maximum five-year operational phase of the Development. This represents an increase in baseline mortality rate of less than 1% for the Forth Islands SPA and is therefore considered to be negligible.

8.5.3.5 Gannet

Gannets were frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species, therefore the effects of disturbance are negligible.

It is probable that birds would slightly adjust their flight route to fly further away from the operational turbine, but the Development is not located in a regularly used flight route – the gannet is mainly a pelagic species foraging in off-shore, rather than near-shore areas. Due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to gannets was estimated to be one bird approximately every two years (0.48 bird per year, or two to three birds during the maximum operational phase of the Development). This represents an increase in baseline mortality rate of less than 1% for the Forth Islands SPA and is therefore considered to be negligible.

8.5.3.6 Cormorant

Cormorants used habitats within the survey area and were also frequently recorded flying offshore through the survey area. Their main use of the area was for resting on the sea-wall and other coastal structures and foraging near-shore within approximately 10m of the sea-wall. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and taking into consideration the very small numbers present, it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during the operational phase is near-certain to have a negligible effect on the population within the Firth of Forth. Displaced birds would have a substantial amount of alternative available areas to use. Birds recorded within the survey area could potentially be associated with the Forth Islands SPA. The available foraging grounds for cormorants in the Firth of Forth are vast, therefore the potential displacement from a relatively small zone around the proposed Development during the operational phase of up to five years is near-certain to have a negligible effect on the Forth Islands SPA population.

It is probable that birds would slightly adjust their flight lines to fly further away from the operational turbine. However, due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to cormorants was estimated to be one bird approximately every 25 years (0.04 bird per year) and a collision is therefore unlikely to occur during the maximum five-year operational phase of the Development. Birds may perch on the turbine tower, but if so, this species is more likely to use the lower parts of the tower, below the rotor sweep. The potential effect of collision risk on the nationally important Firth of Forth SPA or Forth Islands SPA populations of cormorants is therefore considered to be negligible.

8.5.3.7 Shag

Shags used habitats within the survey area and were also frequently recorded flying offshore through the survey area. Their main use of the survey area was for resting on the sea-wall and other coastal structures. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and taking into consideration the very small numbers present, it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during the operational phase is near-certain to have a negligible effect on the local population. The birds recorded within the survey area could potentially be associated with the Forth Islands SPA. The available foraging grounds for shags in the Firth of Forth and around the Forth Islands are vast, therefore the potential displacement from a relatively small zone around the proposed Development during the operational phase of the Development is near-certain to have a negligible effect on the Forth Islands SPA population.

It is probable that birds would slightly adjust their flight lines to fly further away from the operational turbine. Due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to shags was estimated to be one bird approximately every 50 years (0.02 bird per year) and a collision is therefore unlikely to occur during the maximum five-year operational phase of the Development. Birds may perch on the turbine tower, but if so, this species is more likely to use the lower parts of the tower, below the rotor sweep. The

potential effect of collision risk on the Forth Islands SPA population of shags is therefore considered to be negligible.

8.5.3.8 Peregrine

The structures within the FEP site on which a pair of peregrines has prospected for a nesting site in the past are intended to be removed (not as a procedure of this Development). The FEP site and the surrounding areas have been under development and/or have been associated with moderate to high disturbance from humans and vehicles for some time. Peregrines are very tolerant of high disturbance levels in some situations, often nesting close to human settlements (*e.g.* cathedral towers, tower blocks) and in active stone quarries. This moderate to high baseline human activity is unlikely to change substantially during the construction of the Development. As there has been no confirmed breeding by this species, it is considered that potential disturbance would not adversely affect peregrines within the area.

Birds prospecting for a nesting site or active near the Development will be at risk of collision. Based on the observations carried out at the site over the course of one year, the collision risk was estimated, using a precautionary avoidance rate, to be one bird approximately every four years. Over the five-year operational phase of the Development, this collision risk may result in the loss of one bird. This level of mortality is unlikely to have more than a minor adverse effect on the regional peregrine population. The peregrine is on the green list of Birds of Conservation Concern as its national population is stable and/or increasing and is not considered to be threatened. If one adult is lost from the population during the five-year operational phase, the potential productivity of of one breeding attempt would also be lost. However, it is probable that replacement of the individual would occur and the long-term effect of the collision risk is likely to be inconsequential.

It should also be noted that the collision risk estimate presented is highly precautionary. The avoidance rate used in the calculation was set at 95%, yet for many species of raptor, the avoidance rate is higher. Most of the observed flights of peregrine occurred over the landward side of the survey area. The turbine will be located in the near-shore area on the seaward side of the sea wall, where it has been established that there are very few prey species to hunt and there were fewer flight-lines observed; therefore peregrine are less likely to fly in the area swept by the rotors, resulting in a much lower collision risk than that estimated by the model. Furthermore, as the structures that peregrines have used as a perch and have prospected as a potential breeding site will be removed from the FEP site (not as a procedure of this Development), flight activity in the area is likely to be considerably reduced during the operation of the Development. As a result, it is considered unlikely that a collision would occur during the operational phase of the Development and the magnitude of the effect is assessed as negligible.

8.5.3.9 Oystercatcher

Oystercatchers were frequently recorded flying through the survey area, probably moving between roosts and feeding areas in response to tidal changes. There was only on record of a bird using habitat within the survey area, therefore the area within the zone of influence of the Development is not important as a foraging area for oystercatchers. The potential effect of operational disturbance is therefore negligible.

It is probable that birds would slightly adjust their flight route to fly further away from the Development area during the operational phase. Although there were frequent records of oystercatchers flying through the survey area, the maximum number recorded was 50 birds and there was no evidence of regular movement of large numbers of birds between feeding and roosting sites. In terms of the Firth of Forth population, the numbers involved were relatively small. Due to the small scale of the Development and the relatively small number of birds moving through the survey area, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to oystercatchers was estimated to be one bird approximately every eight years (0.12 bird per year) and a collision is therefore unlikely to occur during the maximum

five-year operational phase of the Development. This represents an increase in baseline mortality of less than 1% in the baseline mortality for the Firth of Forth SPA and is therefore considered to be negligible.

8.5.3.10 Kittiwake

Kittiwakes were fairly frequently recorded flying through the survey area. There was no evidence that the area around the Development formed an important feeding area for this species, therefore the effects of operational disturbance are negligible.

It is probable that birds would slightly adjust their flight route to fly further away from the operational turbine, but the Development is not located in a regularly used flight route – the kittiwake is mainly a pelagic species foraging in off-shore, rather than near-shore areas. Due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to kittiwakes was estimated to be one bird approximately every nine years (0.11 bird per year) and a collision is therefore unlikely to occur during the maximum five-year operational phase of the Development. This represents an increase in baseline mortality rate of less than 1% in the baseline mortality for the Forth Islands SPA and is therefore considered to be negligible.

8.5.3.11 Herring Gull

Herring gulls used habitats within the survey area, but flight activity in the area at potential collision height was not considered sufficient to warrant including them as a target species. Their main use of the survey area was for resting on the sea-wall and other coastal structures, where small numbers were infrequently recorded for most of the year, with highest numbers present during the late summer/autumn period. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during the operational phase is near-certain to have a negligible effect on the local population. The birds recorded within the survey area could potentially be associated with the Forth Islands SPA. The available foraging grounds for herring gulls in the Firth of Forth and around the Forth Islands are substantial, therefore the potential displacement from a relatively small zone around the proposed Development during the operational phase of the Development is near-certain to have a negligible effect on the Forth Islands SPA population.

No regular flight route of herring gulls was detected, therefore there are not likely to be any effects on the population as a result of barrier to movements. Birds may perch on the turbine tower, resulting in an increased risk of collision, although it is probable that the magnitude of the effect would be negligible or low in the context of the regional population.

8.5.3.12 Lesser Black-backed Gull

Lesser black-backed gulls used habitats within the survey area, but flight activity in the area at potential collision height was not considered sufficient to warrant including them as a target species. Their main use of the survey area was for resting on the sea-wall and other coastal structures, where very small numbers were infrequently recorded for most of the year, with larger numbers present only during the late summer/autumn period. This species will be habituated to a certain degree to human and vehicular disturbance within the FEP site and taking into consideration the small numbers present, it is probable that birds would either continue to rest on structures close to the Development, or would be able to use areas elsewhere for resting. The area around the Development is not used by large numbers of foraging birds, therefore it is concluded that any displacement from this area during the operational phase is near-certain to have a negligible effect on the local population. The birds recorded within the survey area could potentially be associated with the Forth Islands SPA. The available foraging grounds for lesser black-backed gulls in the Firth of Forth and around

the Forth Islands are vast, therefore the potential displacement from a relatively small zone around the proposed Development during the operational phase of the Development is near-certain to have a negligible effect on the Forth Islands SPA population.

No regular flight route of lesser black-backed gulls was detected, therefore there are not likely to be any effects on the population as a result of barrier to movements. Birds may perch on the turbine tower, resulting in an increased risk of collision, although it is probable that the magnitude of the effect would be negligible or low in the context of the regional population.

8.5.3.13 Sandwich Tern

Sandwich terns were frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species, therefore the effects of disturbance are negligible.

It is probable that birds would slightly adjust their flight route to fly further away from the operational turbine. However, due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to Sandwich terns was estimated to be one bird approximately every four years (0.24 bird per year, or one to two birds during the maximum operational phase of the Development). This represents an increase in baseline mortality rate of less than 1% for both the Firth of Forth SPA and Forth Islands SPA and is therefore considered to be negligible.

8.5.3.14 Common Tern

Common terns were frequently recorded flying through the survey area, but there was no evidence that the area around the Development formed an important feeding area for this species, therefore the effects of disturbance are negligible.

It is probable that birds would slightly adjust their flight route to fly further away from the operational turbine. However, due to the small scale of the Development, the energetic consequences to individual birds are near-certain to be negligible.

The collision risk to common terns was estimated to be one bird approximately every eight years (0.12 bird per year), and a collision is therefore unlikely to occur during the maximum five-year operational phase of the Development. This represents an increase in baseline mortality rate of less than 1% for the Forth Islands SPA and is therefore considered to be negligible.

8.5.4 Potential Relocation Effects

Potential effects of dismantling the Development for relocation are considered likely to be similar in nature to those identified during construction, except that the magnitude of these effects will be reduced due to the shorter timescale of operations.

8.6 Mitigation Measures and Residual Effects

The proposed Development is located in the near-shore area of the seaward side of the sea wall. If located within the FEP on the landward side of the sea wall, the potential for effects on waterbirds associated with the Firth of Forth SPA and Forth Islands SPA would be lower. This has been considered in the design of the proposal, but other constraints such as proximity to housing have prevented the location of the turbine on land within the FEP. However, as described above, the potential effects of the Development in its proposed location on birds have all been assessed as negligible and such mitigation is not considered necessary.

There are no breeding birds in close vicinity to the Development and there are very few birds at any time of year making any use of the habitats on land, in the intertidal area, or off-shore within the zone of influence of the Development. No additional mitigation measures, other than those embedded in the design of the Development, are proposed, as all identified

potential effects have been assessed as not significant. There are no significant residual effects on any of the valued ecological receptors.

8.7 Cumulative Effect Assessment

The cumulative assessment considers the potential for effects of the Development on birds in combination with other similar developments in the wider area. As presented in the Landscape and Visual Assessment of this ES, four other developments are considered here:

- Little Raith Wind Farm – a development of 9 wind turbines near Lochgelly approximately 18.5 km south west of the Development;
- The Hydrogen Office turbine at Methil Docks – a single wind turbine located just over 1 km northeast of the Development adjacent to part of the Firth of Forth SPA;
- Lochelbank Wind Farm – a development of 12 wind turbines located near Glenfarg in Perth and Kinross approximately 28.8 km north west of the Development; and
- Westfield Wind Farm – a development of 5 wind turbines located near Kinglassie approximately 15 km west of the Development.

Of these consented and/or constructed developments, only the consented Hydrogen Office turbine at Methil Docks is likely to have potential effects on the ornithological interests of the Firth of Forth SPA in combination with this Development of a single demonstrator turbine at Methil. The other three developments are located in areas sufficiently distant from the Firth of Forth that they would not contribute to any cumulative effect on birds in combination with this Development.

In their response to Scoping, the RSPB highlighted the need to consider the Round 3 and Scottish Territorial Waters offshore wind energy developments in the outer Forth. However, it is not possible to take such proposed developments fully into account in this assessment, as no baseline information is available regarding the potential effects. It should be noted that this Development is scheduled for an operational phase of a maximum of five years. Considering the likely timescales involved in the planning application and construction phase of offshore developments in the Firth of Forth, it is likely that this Development would have completed its operational phase before any offshore developments in the Forth are operational.

The potential for cumulative collision risk effects are considered in Table 8.6. The collision risk figures for the Hydrogen Office turbine are taken as the values presented in the revised ornithological assessment for that development, specifically for the location of a EWT DW750 turbine in Cell B3. Only those species assessed as having some collision risk at the Hydrogen Office and/or some collision risk at this Development are included in the cumulative assessment below. Any other VERs considered in this ornithology chapter can be assumed to have no cumulative effect additional to that described above in the assessment for each species.

Table 8.6: Cumulative Collision Risk Assessment

Receptor (baseline % mortality)	**Collision Risk at Hydrogen Office turbine (birds/year)**	**Collision Risk at this Development (birds/year)**	**Cumulative Collision Risk (birds/year)** **SPA population (FoF/FI)*** **% increase in baseline mortality for SPA population (FoF/FI)***	**Cumulative Assessment**
Cormorant (37%)	0.97	0.04	1.01 682/400 0.40/0.68	Magnitude: Negligible Not Significant
Shag (16%)	0.23	0.02	0.25 NA/4800 NA/0.03	Magnitude: Negligible Not Significant
Oystercatcher (7.5%)	2.94	0.12	3.06 7846/NA 0.52/NA	Magnitude: Negligible Not Significant
Kittiwake (16.5%)	11.09	0.11	11.20 NA/16800 NA/0.40	Magnitude: Negligible Not Significant
Sandwich tern (8%)	0.56	0.24	0.80 1617/880 0.62/1.14	Magnitude: Negligible[+] Not Significant
Common tern (8%)	0.04	0.12	0.16 NA/668 NA/0.23	Magnitude: Negligible Not Significant

*FoF = Firth of Forth; FI = Forth Islands; NA = not applicable

[+] The cumulative collision risk for Sandwich tern is marginally over a 1% increase in baseline mortality for the Forth Islands SPA breeding population. However, as there is a questionable link between the Forth Islands birds and the birds recorded at the development sites considered, the loss of up to one bird per year is highly unlikely to threaten the integrity of the SPA.

In all other cases, the magnitude of the cumulative collision risk is assessed as negligible and not significant, because there is a collision risk resulting in less than a 1% increase in baseline mortality for the SPA populations. It is concluded that the cumulative collision risk of the two developments would not result in any significant effects.

8.8 Potential Effects on European Sites (Natura 2000)

Under the Habitats Regulations (48), where an authority concludes that a development proposal unconnected with the nature conservation management of a Natura 2000 site is likely to have a significant effect on that site, it must undertake an appropriate assessment of the implications for the conservation interests for which the area has been designated. The need for appropriate assessment extends to projects outwith the boundary of the site in order to determine their implications for the interest protected within the site.

8.8.1 Firth of Forth SPA

The assessment provided above considers the potential effects of the construction, operation and relocation of the Development on each of the species for which the Firth of Forth qualifies

as a SPA. For all species, the assessment concludes that the magnitude of the potential effects on the species' populations are negligible. In this regard, it is concluded with reasonable certainty that the integrity of the Firth of Forth SPA would not be adversely affected.

Although located adjacent to the Firth of Forth SPA (Figure 7.2, Chapter 7: Ecology of this ES), the Development will not directly affect the habitats within the SPA.

8.8.2 Forth Islands SPA

The assessment provided above considers the potential effects of the construction, operation and relocation of the Development on each of the species for which the Forth Islands qualifies as a SPA. For all species, the assessment concludes that the magnitude of the potential effects on the species' populations are negligible. In this regard, it is concluded with reasonable certainty that the integrity of the Forth Islands SPA would not be adversely affected.

8.9 Summary of Effects

Development phase	Receptor	Effect	Mitigation & Design measures	Impact magnitude and/or likelihood	Significance & confidence
Construction/ Relocation	Eider Long-tailed duck Red-throated diver Cormorant Shag Herring gull Lesser black-backed gull	Temporary (approximately one month), reversible, small-scale displacement of small numbers of individuals from sub-optimal foraging and resting areas	None required	Negligible/Extremely unlikely	Not significant; certain/near certain
Construction/ Relocation	Peregrine	Temporary (approximately one month), reversible, disturbance to breeding birds	None required	Negligible/Extremely unlikely	Not significant; certain/near certain
Construction/ Relocation	Eider Long-tailed duck Red-throated diver Cormorant Shag Oystercatcher Sandwich tern Common tern	Temporary (approximately one month), reversible, small-scale disruption to flight movements of small numbers of birds along the coastline, resulting in reduced survival or breeding productivity due to adverse energetic consequences	None required	Negligible/Extremely unlikely	Not significant; certain/near certain

Development phase	Receptor	Effect	Mitigation & Design measures	Impact magnitude and/or likelihood	Significance & confidence
Operation	Eider Long-tailed duck Red-throated diver Cormorant Shag Herring gull Lesser black-backed gull	Temporary (≤5 years), reversible small-scale displacement of small numbers of individuals from sub-optimal foraging and resting areas	None required	Negligible/Extremely unlikely	Not significant; certain/near certain
Operation	Eider Long-tailed duck Red-throated diver Cormorant Shag Oystercatcher Sandwich tern Common tern	Temporary (≤5 years), reversible small-scale barrier to flight movements of small numbers of birds along the coastline resulting in reduced survival or breeding productivity due to adverse energetic consequences	None required	Negligible/Extremely unlikely	Not significant; certain/near certain
Operation	Fulmar Gannet Cormorant Shag Oystercatcher Kittiwake Sandwich tern Common tern	Temporary (≤5 years), reversible collision risk to birds moving along the coastline	None required	Negligible/Extremely unlikely	Not significant; certain/near certain
Operation	Peregrine	Temporary (≤5 years), reversible collision risk	None required	Negligible/Unlikely	Not significant; near certain
Construction/ Operation/ Relocation	Firth of Forth SPA	Potential effects as described above for qualifying species	None required	Negligible and extremely unlikely	Not significant; certain/near certain No adverse effect on integrity

Development phase	Receptor	Effect	Mitigation & Design measures	Impact magnitude and/or likelihood	Significance & confidence
Construction/ Operation/ Relocation	Forth Islands SPA	Potential effects as described above for qualifying species	None required	Negligible and extremely unlikely	Not significant; certain/near certain No adverse effect on integrity

8.10 Statement of Significance

This chapter has assessed the likely significance of the effects of the Development on ornithological receptors and, on the basis of currently available information, has determined them all to be not significant.

It is considered that there would be no adverse effects on the integrity of the Firth of Forth SPA and the Forth Islands SPA as a result of the construction, operation and relocation of the Development, alone or in combination with other similar developments.

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9 WATER RESOURCES AND COASTAL HYDROLOGY

9.1 Introduction

This chapter of the Environmental Statement (ES) identifies and evaluates the effects of the proposed Methil Offshore Demonstration Wind Turbine (hereafter referred to as 'the Development') arising from the construction, operation and relocation phases on the water resources and coastal hydrology.

9.2 Assessment Methodology and Significance Criteria

This assessment has involved the following elements, further details of which are provided in the sections below:

- Consultation with relevant statutory and non-statutory bodies;
- Desk study, including review of available maps and published information;
- Evaluation of potential effects;
- Evaluation of potential cumulative effects;
- Evaluation of the significance of these potential effects; and
- Identification of measures to avoid and mitigate the potential effects.

9.2.1 Legislative Background

The following guidance and policy has been considered during the assessment:

- Water Framework Directive (2000/60/EC)[1]. The Water Framework Directive (WFD) establishes a framework for the protection, improvement and sustainable use of all water environments;
- Paragraphs 196 – 211, Flooding and Drainage of the Scottish Planning Policy[2]. This Policy states that new developments should not materially increase the probability of flooding elsewhere, add to the area of land which requires protection by flood prevention measures or affect the ability of the functional flood plain to attenuate the effects of flooding by storing flood water; and
- Coast Protection Act 1949[3]: the construction, alteration or improvement of any works on, under or over any part of the seashore lying below the level of mean high water springs require authorisation from the Secretary of State (including the deposit or removal of any object or materials from the seashore below the level of mean low water springs).

9.2.2 Pollution Prevention Guidance Notes (PPGs)

- Produced by the Scottish Environmental Protection Agency (SEPA), Pollution Prevention Guidance Notes (PPGs) give advice on statutory responsibilities and good environmental practice. Each PPG addresses a specific industrial sector or activity. The following guidelines are of relevance:
- PPG2: Above ground oil storage tanks[4];
- PPG4: Disposal of sewage where no mains drainage is available[5];

[1] European Parliament (2000). "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" ("The Water Framework Directive") [online] Available at: http://ec.europa.eu/environment/water/water-framework/index_en.html. [accessed 22/07/2009]
[2] Scottish Government (2010) Scottish Planning Policy (SPP) [online] Available at: http://www.scotland.gov.uk/Publications/2010/02/03132605/0 [accessed 25/03/2009]
[3] Coast Protection Act (1949) [online] Available at: http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1949/cukpga_19490074_en_1 [Accessed 24/02/2010]
[4] SEPA (no date provided). PPG2: "Above ground oil storage tanks" [online] Available at: http://publications.environment-agency.gov.uk/pdf/PMHO0204BHTN-e-e.pdf?lang=_e. [accessed 20/11/2009]
[5] SEPA (no date provided). PPG4: "Treatment and disposal of sewage where no foul sewer is available" [online] Available at: http://publications.environment-agency.gov.uk/pdf/PMHO0706BJGL-E-E.pdf. [accessed 13/01/2010]

- PPG6: Working at construction and demolition sites[6];
- PPG14: Marinas and Craft[7];
- PPG18: Managing fire water and major spillages[8]; and
- PPG21: Pollution incident response planning[9].

Other relevant guidance comprises the following:

- PAN 51: Planning, Environmental Protection and Regulation;
- PAN 61: Planning and Sustainable Urban Drainage Systems[10];
- PAN 69: Planning and Building Standards Advice on Flooding;
- PAN 79: Water and Drainage;
- The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR)[11];
- SEPA 'CAR Practical Guide'[12];
- The Construction Industry Research and Information Association (CIRIA) Environmental Good Practice on Site (C650) (2005)[13]. C650 provides guidance on how to avoid causing environmental damage when on a construction site;
- CIRIA Control of Water Pollution from Construction Sites (C532) (2001)[14]. C532 provides guidance on how to plan and manage construction projects to control water pollution;
- Consultation; and
- Information and advice in response to consultation has been provided by a range of organisations during the assessment, and this is summarised in Table 9.1.

Table 9.1: Consultation Responses

Consultee	**Key Points in Response**
Scottish Natural Heritage (SNH)	SNH recommended that further thought is given to the possibility of effects on coastal processes.
Scottish Environmental Protection Agency (SEPA)	SEPA noted that impacts on watercourses, lochs, groundwater, other water features and sensitive receptors, such as water supplies, need to be assessed (within the EA). SEPA also noted that the ES should consider the cumulative impacts of this and other developments on the coastal hydrology of the area.
Fife Council (Environmental Health)	Information provided on private water supplies.
The Meteorological Office	Data was obtained from the Meteorological Office on regional climatic averages.
National River Flow Archive	Data was obtained from the National River Flow Archive on precipitation levels at a gauging station on the River Leven.

[6] SEPA (no date provided). PPG6: "Working at construction and demolition sites" [online] Available at: http://publications.environment-agency.gov.uk/pdf/PMHO0203AUDJ-e-e.pdf [accessed 22/09/2209]
[7] SEPA (no date provided). PPG14: " Marinas and Craft" [online] Available at: http://www.ni-environment.gov.uk/ppg14.pdf [accessed 11/02/2010]
[8] SEPA (no date provided). PPG18: "Managing fire water and major spillages" [online] Available at: http://publications.environment-agency.gov.uk/pdf/PMHO600BBUD-e-e.pdf. [accessed 22/09/2209]
[9] SEPA (no date provided). PPG21: "General Pollution Incident Response Planning" [online] Available at: http://publications.environment-agency.gov.uk/pdf/PMHO0309BPNA-e-e.pdf. [accessed 22/09/2009]
[10] PAN61 "Planning and Sustainable Urban Drainage Systems" [online] Available at: http://www.scotland.gov.uk/Publications/2001/07/pan61. [accessed 22/09/2009]
[11] OPSI (2005). The Water Environment (Controlled Activities) (Scotland) Regulations 2005. Available at: http://www.opsi.gov.uk/legislation/scotland/ssi2005/ssi_20050348_en.pdf [accessed on 18/12/2009]
[12] SEPA (2008). Controlled Activities Regulations - A Practical Guide.
[13] CIRIA (2005). "Environmental Good Practice on Site (C650)" [online] Available at: http://www.ciria.org.uk. [accessed 22/09/2009]
[14] CIRIA (2001). "Control of Water Pollution from Construction Sites (C532)" [online] Available at: http://www.ciria.org.uk. [accessed 22/09/2009]

9.3 Desk Study

The desk study included:

- Identification of catchments, watercourses, springs and water features;
- Collation of data provided through consultations;
- Collation of tidal range data; and
- Collation of flood plain information and water quality data.

Reference was made to the following sources of information:

- The Ordnance Survey (OS) 1:50,000 Landranger Map (Sheet 59);
- British Geological Service (BGS) Hydrogeological Map of Scotland;
- SEPA River Basin Management Plans (Interactive Map)[15]; and
- SEPA Indicative River and Coastal Flood Map (Scotland)[16].

9.3.1 Assessment of Significance

The significance of the potential effects of the Development has been classified by taking into account sensitivity of receptor and magnitude of potential effect, combined with the likelihood of an event occurring. The Development, for the purposes of this assessment, has been taken to be as described in Chapter 3: *Project Description* of this EA, including the Surface and Coastal Water Management Plan, which is provided as Technical Appendix A9.

The **sensitivity** of the receiving environment is defined as its ability to absorb an effect without perceptible change and can be classified as either low, moderate or high. The sensitivity is dependent on factors such as the quality of local receiving waters, their purpose (e.g., whether used for drinking, fisheries, etc.) and existing influences, such as land use and are outlined in the following paragraphs.

9.3.1.1 High Sensitivity

A 'high sensitivity' receptor is classified as either:

- Large, medium or small waterbody with a SEPA water quality classification of "High" or "Good";
- The hydrological receptor and downstream environment will struggle to attenuate natural fluctuations in hydrochemistry and cannot absorb further changes without fundamentally altering its baseline characteristics / natural processes;
- The hydrological receptor is of high environmental importance or is designated as national or international importance, such as SAC's and SSSI's;
- The hydrological receptor is designated for supporting ecological interest;
- The hydrological receptor acts as an active floodplain or other flood defence;
- The hydrological receptor is protected under the Bathing Waters (Scotland) Regulations 2008;
- The hydrological receptor will support abstractions for public water supply or private water abstractions for more than 25 people;
- Areas containing geological or geomorphological features considered to be of national importance (e.g. SSSI's); and / or
- Local groundwater constitutes a valuable resource because of its high quality and yield. Aquifer(s) of local or regional value. Statutorily designated nature conservation sites (e.g. SAC's and SSSI's) dependent on groundwater.

[15] SEPA River Basin Management Plans [online] Available at: http://www.sepa.org.uk/water/river_basin_planning.aspx [accessed 15/01/2010]
[16] SEPA Indicative River & Coastal Flood Map [online] Available at: http://www.multimap.com/clients/browse.cgi?X=337500.420235205&Y=700000.605253392&width=550&height=450&client=sepa&gride=337025.420235205&gridn=699577.605253392&scale=50000&coordsys=gb&nosnap=true&overlay=layer2&greyscale=true&in.x=19&in.y=21 [accessed 20/07/2009]

9.3.1.2 Moderate Sensitivity

A 'moderate sensitivity' receptor is classified as either:

- Large, medium or small waterbody with a SEPA water quality classification of "Moderate";
- The hydrological receptor and downstream environment will have some capacity to attenuate natural fluctuations in hydrochemistry but cannot absorb some changes without fundamentally altering its baseline characteristics / natural processes;
- The hydrological receptor is of regional environmental importance;
- The hydrological receptor does not act as an active floodplain or other flood defence;
- The hydrological receptor is not used for recreational use;
- The hydrological receptor does support abstractions for public water supply or private water abstractions for less than 25 people;
- Areas containing geological features of designated regional importance including Regionally Important Geological Sites (RIGS), considered worthy of protection for their historic or aesthetic importance; and / or
- Aquifer(s) of limited value (less than local) as water quality does not allow potable or other quality sensitive uses. Exploitation of local groundwater is not far-reaching. Local areas of nature conservation known to be sensitive to groundwater impacts.

9.3.1.3 Low Sensitivity

A 'low sensitivity' receptor is classified as either:

- Large, medium or small waterbody with a SEPA water quality classification of "Poor" or "Bad";
- The hydrological receptor and downstream environment will have capacity to attenuate natural fluctuations in hydrochemistry but can absorb some changes without fundamentally altering its baseline characteristics / natural processes;
- The hydrological receptor is not of regional, national or international environmental importance;
- The hydrological receptor is not designated for supporting freshwater ecological interest;
- The hydrological receptor does not act as an active floodplain or other flood defence;
- The hydrological receptor is not used for recreational use;
- The hydrological receptor does not support abstractions for public water supply or private water abstractions.
- Geological features or geology not protected and not considered worthy of specific protection; and / or
- Poor groundwater quality and/or very low permeability make exploitation of groundwater unfeasible. Changes to groundwater not expected to affect local ecology.

The **magnitude** of the predicted effects is determined by the timing, scale, size and duration of the potential effect resulting from the Development. The magnitude of potential effects can be classified as negligible, minor, moderate or major and are outlined in the following paragraphs.

9.3.1.4 High Magnitude

- Short or long term major shift in hydrochemistry or hydrological conditions sufficient to negatively change the ecology of the receptor. This change would equate to a downgrading of a SEPA water quality classification by two classes e.g. from "High" to "Moderate";
- A sufficient material increase in the probability of flooding onsite and offsite, adding to the area of land which requires protection by flood prevention measures or affect the ability of the functional flood plain to attenuate the effects of flooding by storing flood water (in accordance with SPP7);
- Major (greater than 50 %) or total loss of a geological receptor or coastal habitat site, or where there would be complete severance of a site such as to fundamentally affect the integrity of the site (e.g. blocking hydrological connectivity);
- Major permanent or long term negative change to groundwater quality or available yield;
- Major permanent or long term negative change to geological receptor; and /or

- Changes to quality or water table level will negatively alter local ecology or will lead to flooding issue.

9.3.1.5 Moderate Magnitude

- Short or long term non-fundamental changes to the hydrochemistry or hydrological environment, resulting in a change in ecological status. This change would equate to a downgrading of a SEPA water quality classification by one class e.g. from "High" to "Good";
- A moderate increase in the probability of flooding onsite and offsite, adding to the area of land which requires protection by flood prevention measures or affect the ability of the functional flood plain to attenuate the effects of flooding by storing flood water (in accordance with SPP7);
- Loss of part (approximately 15 % to 50 %) of a geological receptor or peat habitat site, major severance, major effects to its integrity as a feature, or disturbance such that the value of the site would be affected, but could still function;
- Changes to the local groundwater regime may slightly affect the use of the receptor;
- Yield of existing supplies may be reduced or quality slightly deteriorated; and /or
- Fundamental negative changes to local coastal habitats may occur, resulting in impaired functionality.

9.3.1.6 Minor Magnitude

- Detectable non-detrimental change to the baseline hydrochemistry or hydrological environment. This change would not negatively change the SEPA water quality classification;
- A marginal increase in the probability of flooding onsite and offsite, adding to the area of land which requires protection by flood prevention measures or affect the ability of the functional flood plain to attenuate the effects of flooding by storing flood water (in accordance with SPP7);
- Detectable but non-material effect on the receptor (up to 15 %) or a moderate effect on its integrity as a feature or where there would be a minor severance or disturbance such that the functionality of the receptor would not be affected; and / or
- Changes to groundwater quality, levels or yields do not represent a risk to existing baseline conditions or ecology.

9.3.1.7 Negligible Magnitude

- No perceptible changes to the baseline hydrochemistry or hydrological environment. No change to the SEPA water quality classification;
- No increase in the probability of flooding onsite and offsite; and
- Slight or negligible change from baseline condition of geological resources. Change hardly discernible, approximating to a 'no change' in geological condition.

The significance of the unmitigated effect is therefore defined as shown in Table 9.2.

Table 9.2: Unmitigated Significance Criteria

Magnitude	**Sensitivity**		
	Low	**Moderate**	**High**
Negligible	Negligible	Negligible	Negligible
Minor	Negligible	Minor	Moderate
Moderate	Minor	Moderate	Moderate/Major
Major	Minor	Moderate/Major	Major

The **likelihood** of an event occurring is then included and classified as unlikely, possible or likely.

Measures are set out within the Surface and Coastal Water Management Plan (SCWMP) which can be found in Technical Appendix A9. They comprise methods and works that are established and effective measures to which 2-B Energy will be committed through the development consent. There is sufficient confidence in the measures set out in the SCWMP for them to be treated as part of the Development for the purposes of this assessment. Accordingly, the assessment of significance of effects of the proposed Development is considered with the inclusion of the SCWMP. Where, for each predicted effect assessed in accordance with Table 9.2, an effect is considered to be significant then mitigation measures are considered and the residual effects assessed in terms of Table 9.3

Finally, the residual (or overall) significance after mitigation is a function of the unmitigated significance combined with the likelihood of an event occurring (with mitigation in place); as shown in Table 9.3.

Table 9.3 Residual Significance Criteria after Mitigation

Unmitigated Significance	**Likelihood**		
	Unlikely	**Possible**	**Likely**
Negligible	Negligible	Negligible	Negligible
Minor	Negligible	Negligible	Minor
Moderate	Negligible	Minor	Moderate
Major	Minor	Moderate	Major

Conclusions will therefore state whether residual significance will be major, moderate, minor or negligible, once appropriate mitigation has been implemented. This assessment relies on professional judgment to ensure that the effects are appropriately assessed. Effects of moderate or major significance are considered to be significant.

9.3.2 Assessment of Cumulative Effects

A cumulative effect is considered to be an additional effect on hydrological resources arising from the Development in combination with other proposed developments likely to affect the hydrological environment. At distances greater than 5 kilometres (km), it is considered that schemes are unlikely to contribute to a cumulative hydrological effect due to attenuation and dilution over distance of potentially polluting chemicals. Therefore, for the purposes of the assessment of potential cumulative effects on the immediate catchment and hydrological regime, only proposed developments within approximately 5 km of the Development have

been considered. These developments have been identified through consultation with the relevant local authorities and statutory consultees, as outlined in Table 9.1 and discussed in more detail in Section 9.6. The methodology followed to assess the cumulative effects is the same as that used for the Development in isolation.

9.4 Baseline Conditions

9.4.1 Topography and Land Use

The turbine is to be located in an area of seabed to the south west of Quay 2, as shown in Figure 1.2 of this ES. The centre of the turbine is approximately 20 m from the crest of the existing slope into the sea in an area that is shown to be within the Scottish Enterprise ownership boundary. The sea revetment in this area has not been repaired or re-instated but it is understood that proposals by Scottish Enterprise to re-construct formal coastal defences to protect the site will be implemented in due course.

The elevation of the site is approximately 8 m Above Ordnance Datum (AOD) and it is assumed that ground level at the turbine location will be 3 m to 5 m below Ordnance Datum.

9.4.2 Climate

The BGS Hydrogeological Map of Scotland 1:625,000, shows the Average Annual Rainfall (AAR) to be between 1200 mm and 1600 mm per annum. The National River Flow Archive (NRFA)[17] report AAR at the Leven gauging station (on the Leven), approximately 2.2 km north of the Development, as 948 mm.

9.4.3 Tides

The strong flood and ebb currents, with maximum velocities of 0.9 m/s and 0.5 m/s on spring and neap tides respectively (Hydrographic Office, 1975), within the Firth of Forth tend to be deflected by the rocky headlands and are considered to have minimal influence on beach development. Typical tidal flow direction within the Firth of Forth is presented in Figure 9.1. Typical tidal flows adjacent to the Fife Energy Park are between 0.25 m/s and 0.5 m/s during mean neap and spring tides respectively.

The east coast of Scotland has been classified as a macrotidal area which experiences semi-diurnal tides with high water occurring approximately once every 12.4 hours. A summary of tide levels for Methil has been provided in Table 9.4[18].

Table 9.4: Typical Tide Levels at Methil

	Level (mCD)	**Level (mODN)**
Highest Astronomic Tide (HAT) level	+6.2	+3.3
Mean High Water Spring (MHWS) tide level	+5.5	+2.6
Mean High Water Neap (MHWN) tide level	+4.3	+1.4
Mean Sea Level (MSL)	+3.1	+0.2
Mean Low Water Neap (MLWN) tide level	+1.9	-1.0
Mean Low Water Spring (MLWS) tide level	+0.7	-2.2
Lowest Astronomic Tide (LAT) level	-0.2	-3.1

9.4.4 Waves

The Firth of Forth is characterised by two types of waves, those originating from outside the area (swell waves) and those generated within the region by active wind processes (locally generated wind waves). Swell waves tend to be generated in the North Sea and travel into the Firth of Forth from a northerly or easterly direction.

[17] The National River Flow Archive [online] Available at: http://www.nwl.ac.uk/ih/nrfa/station_summaries/017/002.html [accessed 19/01/2010]
[18] UK Hydrographic Office Admiralty Tide Tables 2008

Within the Firth of Forth significant wave heights greater than 4 m are most common from between 000° and 120° as more extreme wind conditions prevail from the northeast and east. Approximately 60 % of swell conditions are experienced from between 020° and 060°. Fife Energy Park is sheltered from waves approaching from between 045° and 090° by the headland at Elie Ness. The northern end of Fife Energy Park is protected from waves approaching from between 045° and 090° by Methil Harbour breakwater[19] see Figure 12.1 the Admiralty Chart.

9.4.1 Solid Geology

The solid geology map shows that the underlying solid strata in the vicinity of the near shore turbine position belong to the Upper Coal Measures. This sequence typically comprises red cross-bedded sandstones above; red, purple, yellow and green siltstones, mudstones, seatclays and thin sandstones below. There are no coal seams recorded within this sequence. The strata are generally indicated to dip 10° in a south easterly direction. The Buckhaven Fault, with an indicated downthrow to the south of 70 m, is shown to run under the area 400 m to the north.

9.4.2 Superficial Geology

BGS Digital Mapping shows that artificially made ground is present across the majority of the Development and underlies the onshore ancillary structures. Previous borehole investigations, undertaken by Posford Haskoning[20] and Ironside Farrar[21], indicate that made ground can reach depths of up to 35 m in proximity to the colliery spoil heap, approximately 220 m south west of onshore ancillary structures. Borehole records in proximity to the quay indicate between 0.9 m and 3.85 m of superficial deposits, mainly comprising colliery spoil material, likely to have been transported into the sea in surface water runoff from the adjacent spoil heap. There is some evidence of colliery spoil amongst the silty sand in the 2 m of superficial marine deposits.

9.4.3 Surface Water Hydrology

No onshore surface water features, such as burns or drainage channels, exist within 500 m of the Development.

9.4.4 Hydrogeology

The BGS Hydrogeological Map of Scotland (Digital Edition) shows the site to be underlain by rocks described as locally important aquifers. The aquifers underlying the site are described as

“aquifers in which flow is dominantly in fissures and other discontinuities”.

The SEPA Groundwater Vulnerability Map shows the majority of the Development to be underlain by rocks that fall within Scenario 4 (class 4b), and is vulnerable to those pollutants not readily absorbed or transformed and vulnerable to individual pollution events.

During the previous site investigation by Posford Haskoning, groundwater was only encountered at one borehole at depths greater than 2 m.

9.4.5 Designations

One hydrological designation exists within a 2 km radius of the Development site (this is shown on Figure 7.1):

- The Firth of Forth is an area of Site of Special Scientific Interest (SSSI) and lies directly adjacent to the Development. The Firth of Forth SSSI is designated for Westphalian rock

[19] Scottish Enterprise, September 2009, Fife Energy Park Coastal Erosion and Flood Risk Management Plan,
[20] Posford Haskoning. August 2004. *Kvaerner Fabrication Yard Coastal Assessment*.
[21] Ironside Farrar. January 2007. *Fife Energy Park, Phase 3 Geo-environmental Report*.

layer sequences on the coast at Buckhaven, illustrating the palaeogeography and palaeoenvironment of the area during Upper Carboniferous.

9.4.6 Private and Public Water Supplies

Consultation highlighted no active private water supplies within 1 km of the Development site.

9.4.7 Fisheries

The distributions and populations of fish species, including migratory salmon, sea trout, lamprey, and eel, are known to fluctuate annually in the Firth of Forth owing to spatial and temporal variations in the utilisation of the estuary by different species and their different life stages. There is significant trawling activity in the outer Firth of Forth, principally for Norway lobster, and crab, lobster, whelk and clams are also landed commercially within the Firth of Forth. Other estuarine benthic fauna is likely to include polychaete and oligochaete worms, and bivalves such as the common mussel.

9.4.8 Flooding

The Indicative River and Coastal Flood Map (Scotland)[22] shows that sections the Development are located adjacent to areas which have a 0.5 % or greater annual risk of coastal inundation. No onshore ancillary structures, such as construction compounds, are located in areas at risk of coastal inundation.

9.4.9 Information Gaps

The information available for this assessment is considered to be sufficient to assess the potentially significant effects on water resources.

9.5 Assessment of Potential Effects

The proposed works, the effects of which have been assessed, is the Development as described in Chapter 3: *Scheme Description* of this EA. This includes features described in the Surface and Coastal Water Management Plan provided as Technical Appendix A9.

9.5.1 Site Sensitivity

The following sensitivities of the components of the hydrology system to the potential effects have been identified and are outlined in Table 9.5.

[22] SEPA The Indicative River and Coastal Flood Map [online] Available at: http://www.multimap.com/clients/browse.cgi?X=337000.420235205&Y=700000.605253392&width=550&height=450&client=sepa&gride=337025.420235205&gridn=699577.605253392&scale=25000&coordsys=gb&nosnap=true&overlay=layer2&greyscale=true&down.x=12&down.y=17 [accessed 02/02/2010]

Table 9.5: Receptors Sensitivity to Possible Effects

Receptor	Possible Effects	Sensitivity	Comment
Coastal Water Environment	Increased run-off, erosion and sedimentation, and pollution as a result of construction groundworks and chemical handling/storage.	Moderate	Considered moderate sensitivity due to the moderate attenuation capacity of the receptors with regard to hydrocarbon-based construction materials and chemicals and the previous SEPA water quality classification of Class C "unsatisfactory" for the 5 km coastal stretch of Methil Docks.
Groundwater	Pollution as a result of construction groundworks and chemical handling/storage.	Low	Considered low sensitivity as no potable groundwater abstractions are supported within 1.5km of the Development. The Aquifer is of limited value (less than local) and has poor groundwater quality.
Geology	Increased run-off, erosion and sedimentation, and pollution as a result of construction groundworks and chemical handling/storage.	Moderate	Considered moderate sensitivity as the receptor has been subjected to various sources of chemical pollution as a result of heavy industry at Methil Docks.

The effect on the receptors highlighted in Table 9.4 has been considered for the construction, operation and relocation phases of the Development.

9.5.2 Embedded Mitigation

The Surface and Coastal Water Management Plan (SCWMP) (provided as Technical Appendix A9) describes water management measures to control surface water onshore and drain hardstandings and other structures during the construction and operation of the Development. This will form part of a Pollution Prevention Plan (PPP) to be implemented for the Development.

9.5.3 Good Practice

Good practice will be followed in all aspects of construction, operation and relocation, specifically through a PPP.

The PPP will set out measures to be employed to avoid or mitigate potential effects for all phases of the Development, and will also include an Incident Plan to be followed should a pollution event occur. This plan will be produced following consultation and agreement with SEPA and all appropriate personnel working on the site will be trained in its use. The Construction Project Manager will have specific responsibility for implementation of the PPP.

Method statements will also be applied, which will follow the principles laid out in relevant SEPA Pollution Prevention Guidelines.

9.5.4 Potential Construction Effects

The nature and magnitude of effects that could result from construction activities, as described in Chapter 3: *Scheme Description* this EA, are assessed below.

9.5.4.1 Chemical Pollution

Potential risks include the spillage or leakage of chemicals, fresh concrete, fuel or oil, during use or storage on site. These pollutants have the potential to adversely affect the

surrounding geology and coastal hydrology, and hence effects on the biodiversity of receptors.

Measures such as absorbent spill pads, impermeable geosynthetic membranes and other measures highlighted within the SCWMP will effectively limit the uncontained release of chemicals from onshore elements of the Development to minor fugitive releases. All onshore machinery will be equipped with drip pans to contain minor fuel spillage or equipment leakages.

The machinery and vessels used to install the turbine foundations are a potential chemical pollution source. While all machinery and vessels are considered potential spill sources, the likelihood of a spill is remote as a spill could only occur if there is a breach in the area of the fuel tank. Bunding will be placed between the crane hardstanding area and the shoreline to prevent fuel and oil transfer into the Firth of Forth in the event of a fuel or oil tank breach in any machinery used in the installation of the turbine.

Therefore, chemical pollution effects on all hydrological receptors (including the Firth of Forth SAC and SSSI) have the potential to be of negligible magnitude and therefore (in accordance with Table 9.2) of **negligible** significance.

9.5.4.2 Sedimentation and Erosion

Erosion and sedimentation can occur from excavations, de-watering, ground disturbance, overburden stockpiling and piling of foundations. Sediment generated during the installation of the turbine foundation has the potential to impact on water quality and reduce oxygen concentrations (if sediments are organically enriched) and, hence, impact upon aquatic ecology in the Firth of Forth.

Sediment also has the potential to disperse into the Firth of Forth during the installation of the turbine foundation. Before the excavation of the turbine foundation, an insulating metal jacket will be sunk into the seabed (approximately 20 m from the shoreline) to enclose the working area. This enclosure will be dewatered and any sediment removed and stockpiled onshore before the piled foundations are installed. Due to the industrial history of Methil Docks, any sediment removed during the excavation of the turbine foundation will be tested in accordance with The Environmental Protection Act 1990 (Amendment) (Scotland) Regulations 2001[23] before being used within the ongoing groundworks relating to the Energy Park, if this is not appropriate, or any contaminants found the waste would be removed from the site by a licenced contractor.

Measures described in the SCWMP will effectively prevent sediment entering the Firth of Forth during the installation of the ancillary onshore components. Works will be conducted during periods of low tide and dry weather, therefore limiting the potential of sediment dispersing into the Firth of Forth. For these reasons, the magnitude of this effect will be negligible. Given the moderate sensitivity and negligible magnitude of effect, the significance of effects associated with erosion and sedimentation is considered to be **negligible**, in accordance with Table 9.2.

Erosion and sedimentation from the onshore elements of the Development has limited potential to impact upon groundwater as excavation depths for hardstanding are less than 1 m depth into made ground. As such, there will negligible magnitude of effect, the significance of effects associated with erosion and sedimentation on groundwater is considered to be **negligible**.

9.5.4.3 Migration of Pollutants from Contaminated Land

Previous studies by Posford Haskoning and Ironside Farrar have identified areas of potentially contaminated land within the made ground surrounding the Development. A trial pit (TP12)

[23] (1990) "The Environmental Protection Act, Part II" [online] Available at: http://www.opsi.gov.uk/legislation/scotland/ssi2001/20010099.htm. [accessed 24/08/2009]

dug at the approximate location of the onshore ancillary structures indicated elevated concentrations of zinc.

The cable trench route has been designed to avoid impinging upon areas of land identified as having contaminant concentrations above the relevant guidelines, such as lead hotspots in proximity to the north eastern boundary of the mining spoil heap. All excavations will be conducted during periods of dry weather to reduce the possibility of contaminants leaching into the surrounding coastal waters.

In 2007, Arup[24] excavated trial trenches and boreholes approximately 75 m northeast of the proposed onshore elements of the Development. Laboratory analysis concluded that no elevated concentrations of metals or inorganic contaminants within the soils. Contaminant levels were not considered to pose a significant detrimental risk to the water environment, including groundwater.

Should potentially contaminated land be encountered during excavations, it will be tested and appropriate action taken in accordance with The Environmental Protection Act 1990 (Amendment) (Scotland) Regulations 2001. A nominated construction engineer will ensure that brownfield sites standard health and safety precautions are adopted and followed.

Effects associated with contaminated land are, therefore, considered to be of **minor** magnitude and significance, in accordance with Table 9.2.

9.5.4.4 Flooding

A feasibility report was completed for Buckhaven in 2007 by Halcrow Group Limited[25] which recommended that remediation works be undertaken for the existing flood defences, adjacent to the Development. The re-profiled revetment will be stable under storm events with a 2 % annual probability of occurrence (1 in 50 year return period), reducing the associated flood risks to the Development.

The access route and a small area of hardstanding are the only onshore elements of the Development which are located within areas described as having a 0.5 % or greater annual risk of coastal inundation, according to The SEPA Indicative River and Coastal Flood Map (Scotland)[26]. As a precautionary measure, all onshore elements of the Development will be constructed with an element of flood protection in the event of coastal ingress.

The impermeable nature of the made ground on-site and the underlying geology means that, in the baseline scenario, there will be relatively low infiltration and relatively high run-off rates, and hence the addition of the Development would have a minimal impact upon infiltration and run-off rates.

The magnitude of the effects identified above is negligible, and hence the significance of effects associated with run-off and flood risk is **negligible**.

9.5.4.5 Alteration of Current Flow Pathways

The installation of the turbine foundations has the possibility to impact upon the natural flow of water currents in the Firth of Forth, possibly leading to sediment scouring and ultimately impacts upon aquatic ecology. Typical tidal flows adjacent to the Development are between 0.25 m/s and 0.5 m/s during mean neap and spring tides respectively. Sediment transport around the coast at Development is strongly to the south west, with sediment having a

[24] Arup & Partners Scotland Ltd. 2007. Fife Energy Park, Methil. Proposed Slipway Development. Geotechnical and Geoenvironmental Interpretive Report.
[25] Halcrow Group Limited. 2007. *Fife Energy Park Coastal Erosion and Flood Risk Management Plan*
[26] SEPA The Indicative River and Coastal Flood Map [online] Available at: http://www.multimap.com/clients/browse.cgi?X=337000.420235205&Y=700000.605253392&width=550&height=450&client=sepa&gride=337025.420235205&gridn=699577.605253392&scale=25000&coordsys=gb&nosnap=true&overlay=layer2&greyscale=true&down.x=12&down.y=17 [accessed 02/02/2010]

tendency not to be retained on the coast[27,28]. Sediment is driven towards the southwest by waves from the North Sea.

The turbine is to be located in an intertidal area, meaning the area is not submerged under water during low tide. During low tide there will be no effect on coastal currents. Considering the relatively small volume of the installed turbine foundations (approximately 20 m^3) and the wide spacing of each metal support beam, it is considered that the Development will have a negligible effect on the natural coastal currents during high tide and will not lead to sediment scouring to the southwest of the turbine foundations. Given the moderate sensitivity and negligible magnitude of effect, the significance of effects associated with the alteration of current flow pathways is considered to be **negligible**, in accordance with Table 9.2.

9.5.5 Potential Operational Effects

Potential medium and long term effects associated with Development infrastructure such as turbine bases and hardstandings could potentially include:

- Further erosion and sedimentation;
- Alterations to natural flow pathways; and
- Risk of a pollution event.

These effects have been discussed in relation to the construction phase, and as there would be substantially less activity during operation, and as there is unlikely to be any ground disturbance during operation, the magnitude of these effects is similarly reduced. Any changes during construction would continue through operation, as the majority of infrastructure would remain in place. This will be further reduced through adopting best practice design and construction, as set out in the SCWMP, such as retaining silt traps, and adherence to a PPP, as discussed above. As a result, the magnitude and significance of all effects associated with operation of the Development are assessed as being **negligible.**

9.5.6 Potential Relocation Effects

Potential effects of the relocation of the turbine are similar in nature to those during construction, as some ground-work would be required to remove turbine foundations. These effects would be substantially lesser in magnitude than during construction, however, and would be controlled by a PPP, as discussed above. Where infrastructure would be left in place, silt traps and bunding features would also be left in place, where this is compatible with the PPP. As a result, the magnitude and significance of all effects associated with the relocation are assessed as being **negligible**.

9.6 Cumulative Effect Assessment

The greatest potential for cumulative effects arises when the construction phase of a cumulative development overlaps with the construction phase of the Development. Cumulative effects are considered to have the potential to be significant only where such an overlap may exist. As a result, the potential for cumulative effects on surface water resources from the Development in combination with the construction of new industrial developments at Fife Energy Park. Scottish Enterprise have consent for construction of an industrial unit within the Energy Park north east of the Development. To assess a worst case scenario, it is considered that the construction phase of any new industrial development may coincide with the construction phase of the Methil Wind Turbine Demonstration Project. The primary cumulative hydrological effect is likely to be an increase in flow rates during the construction phase associated with increased run-off from new hardstanding area of the developments. As noted above, these are considered to be of negligible magnitude for the Development. If

[27] Fife Council, 1998, *Shoreline Management Plan of Fife, Volume I – Core Report*. Fife Council, 1998, *Shoreline Management Plan of Fife*, Volume II – Atlas. Fife Council, 1998, *Shoreline Management Plan of Fife*, Volume III – Supporting Document

[28] HR Wallingford, 1997, Coastal Cells in Scotland, Scottish Natural Heritage Research Survey and Monitoring Report No.56

water management measures are implemented at those sites similar to those described in the WMP (in line with normal practice and as would be required by SEPA), the magnitude of cumulative effects will be negligible and, therefore, of **negligible** significance.

Consequently, cumulative effects on estuarine water resources from the two developments would be **negligible**

9.7 Mitigation Measures and Residual Effects

No additional mitigation measures above embedded design and construction good practice measures identified in Chapter 3: Project Description of this ES and the SCWMP are proposed as all identified potential effects have been assessed as being of negligible significance. There are no significant residual hydrological effects.

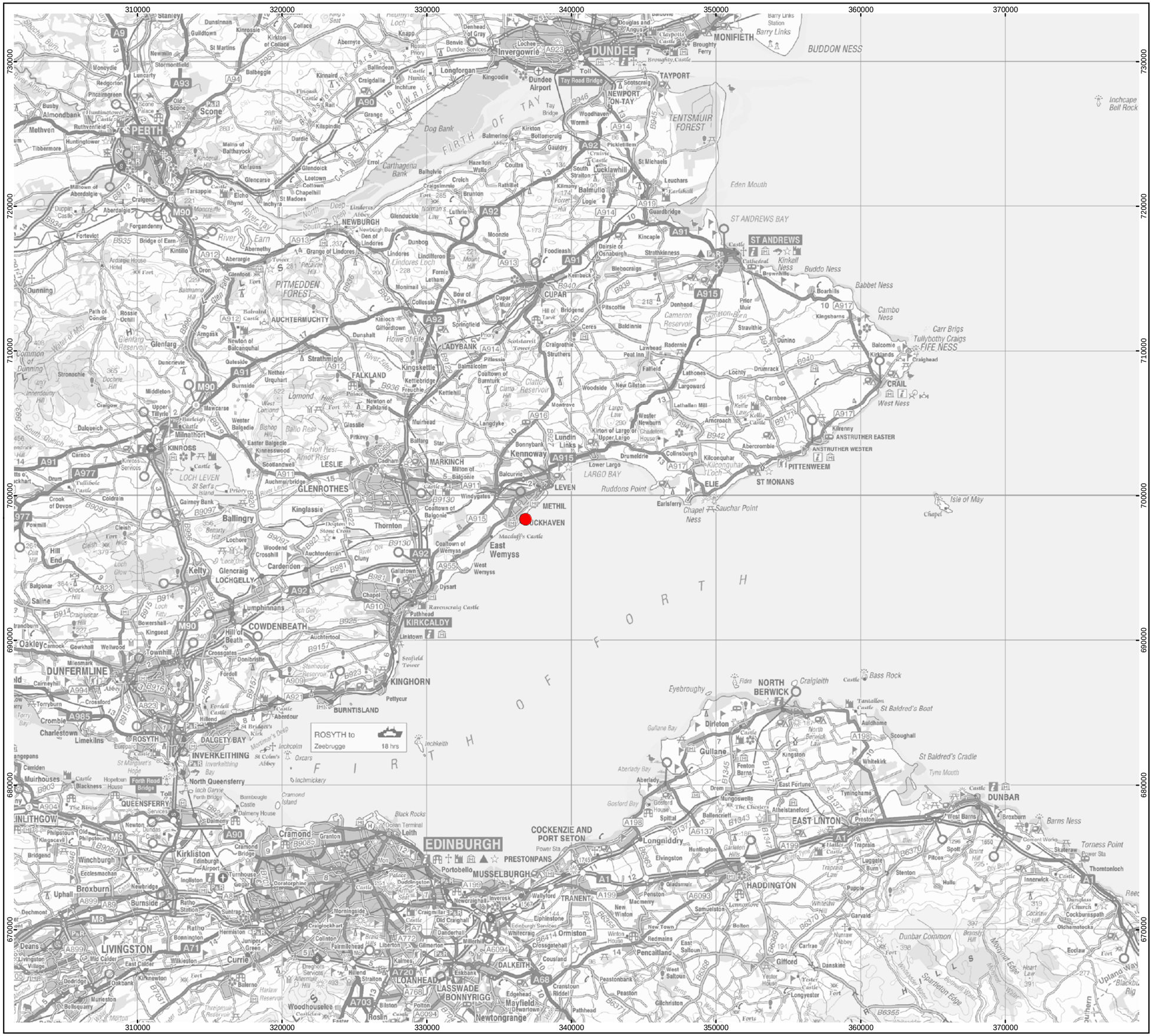
9.8 Proposed Monitoring

The following monitoring will be carried out:

- Monitoring requirements will be detailed in the PPP and overseen by the Construction Project Manager;
- During construction, regular inspections of the site drainage and flood retention walls will be carried out to ensure that sediment and debris do not accumulate to present a flood risk or damage the ecology of the hydrological environment (further detail of likely monitoring is provided in Appendix A9: SCWMP; and
- Continual liaison with SEPA will be carried out during the construction and relocation stages.

9.9 Statement of Significance

This chapter has assessed the likely significance of effects of the Development, including its Surface and Coastal Water Management Plan, on coastal hydrology. All potential effects have been assessed as being of negligible significance (not significant).



2-B Energy

arcus

Key

- Proposed Turbine Location

1:250,000 Scale @ A3

0 5 10 km

N

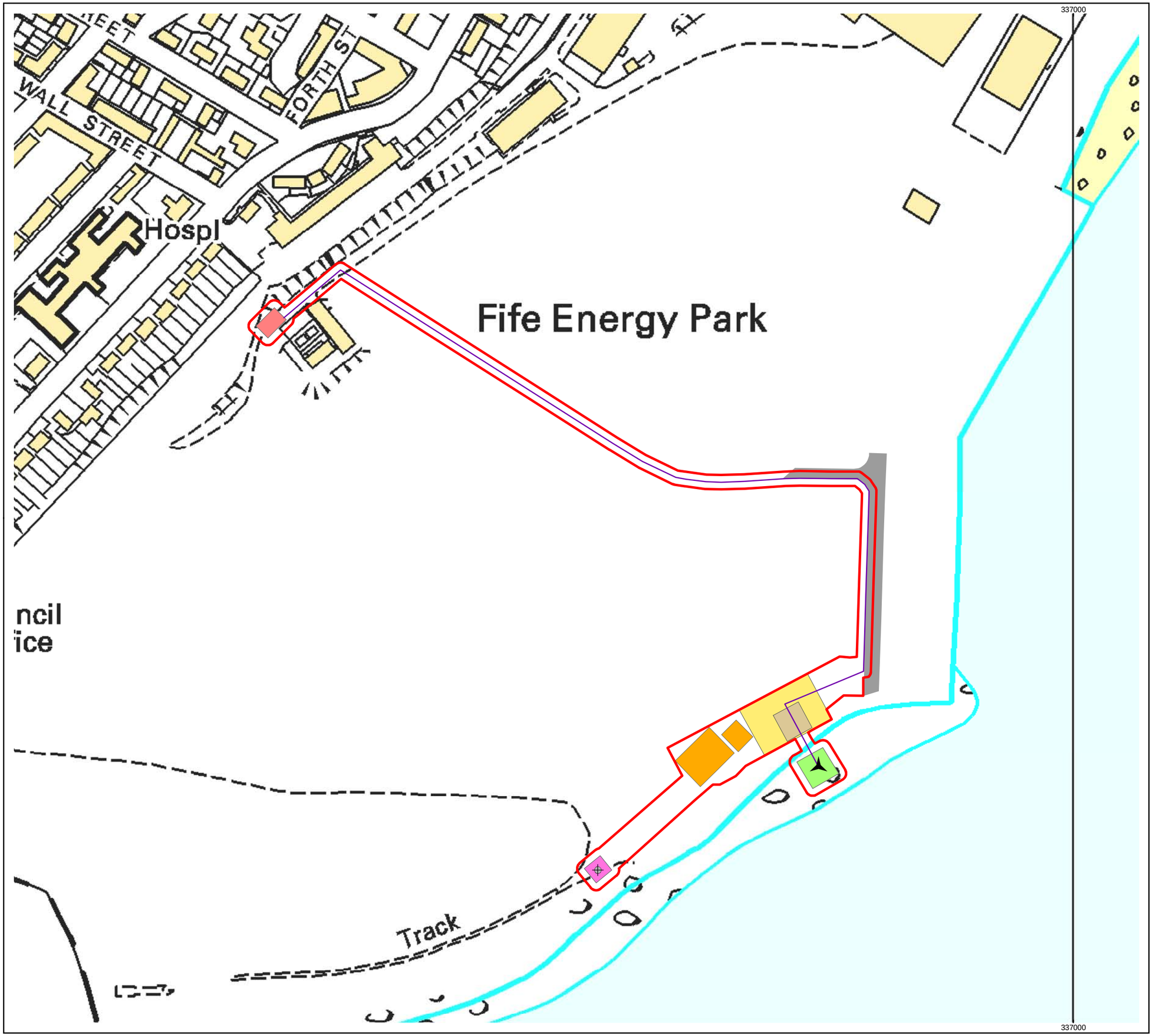
Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/010 | Revision: A

Date: 17/02/2010

Site Location
Figure 1.1

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Wind Monitoring Mast
- Site Boundary
- Cable Route
- Transformer
- Common User Access Road
- Wind Mast Foundation
- Turbine Foundation
- Building
- Construction Pad
- Construction Hardstanding

Turbine Location
OSGB-36: 336824 mE, 698397 mN
WGS-84: 56.174015 °N, -3.019113 °W

1:2,500 Scale @ A3

0 50 100 m

N

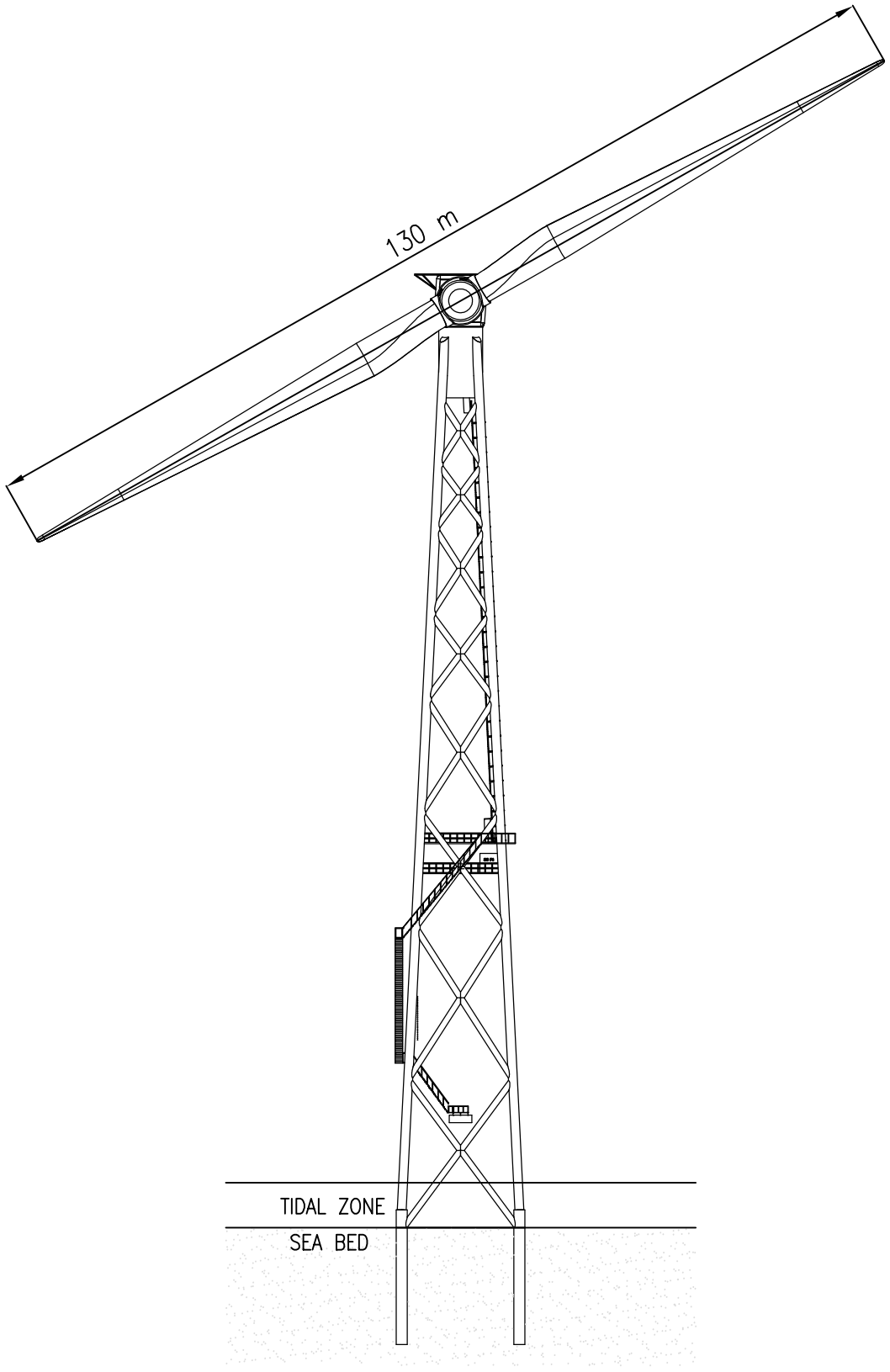
Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/062 | Revision: A

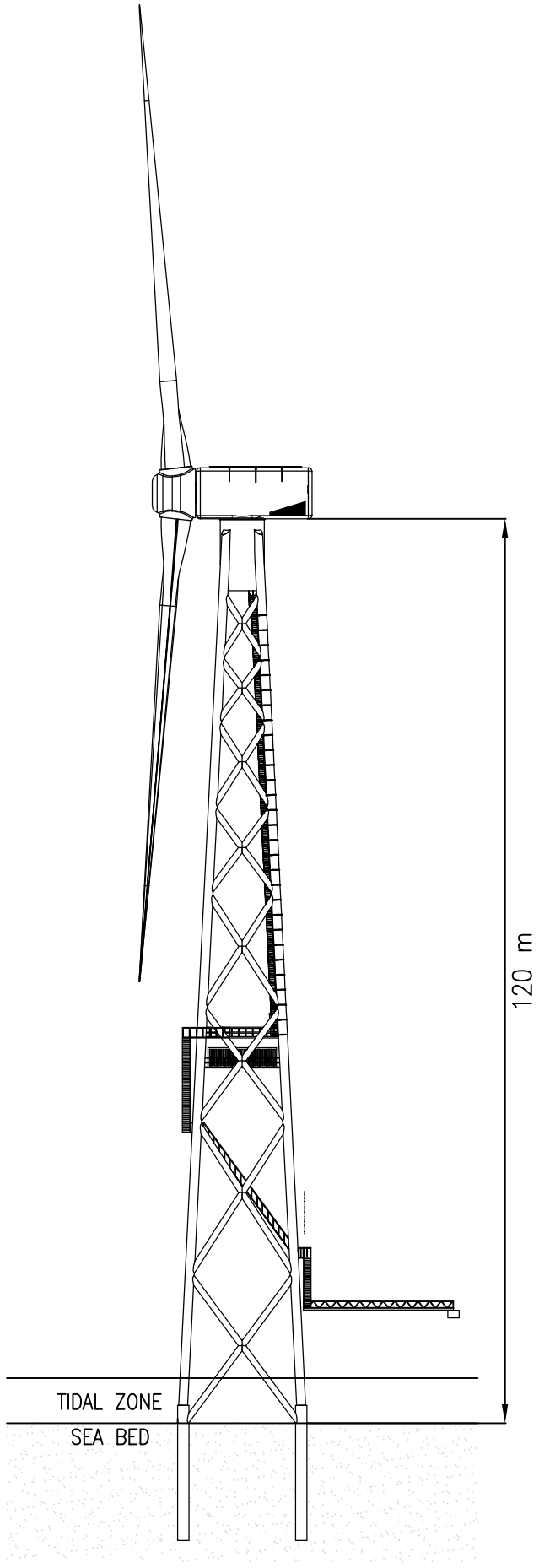
Date: 16/02/2010

Site Layout
Figure 1.2

Methil Offshore Demonstration Wind Turbine Environmental Statement



FRONT VIEW
SCALE 1:850



SIDE VIEW
SCALE 1:850

2-B Energy
arcus

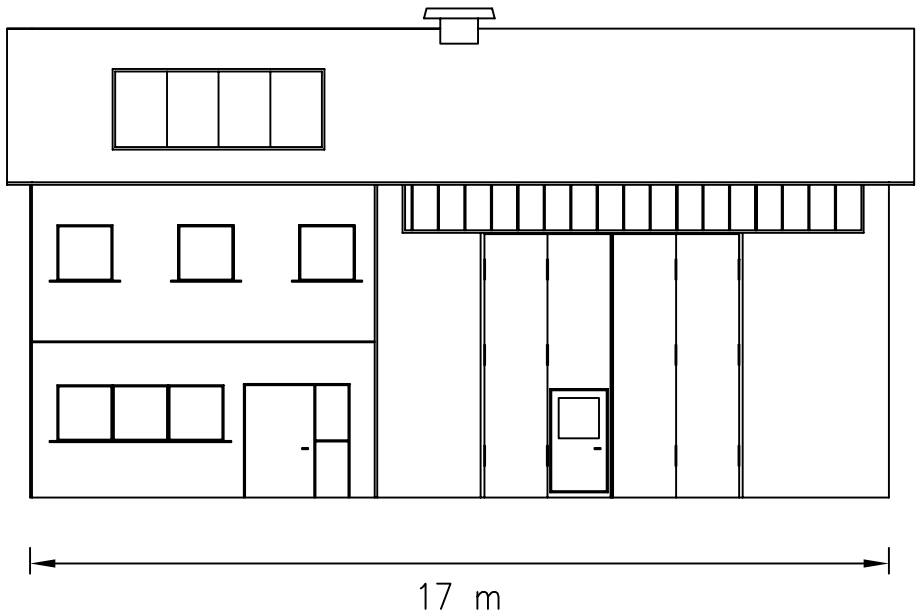
NOT FOR CONSTRUCTION

Produced By: SC
Reviewed By: PM
Approved By: FM

Ref: 323/ES/070	Revision: A
Date: 18/03/2010	

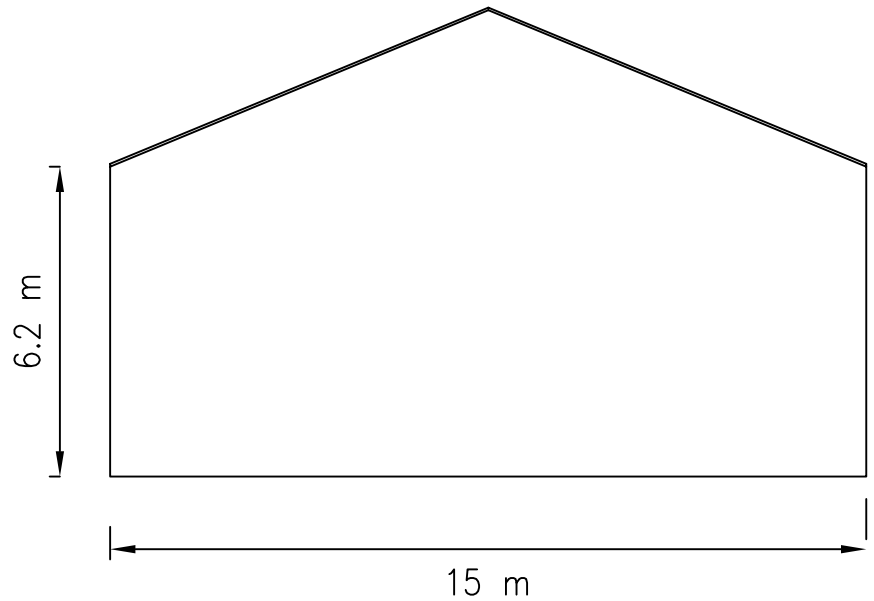
Wind Turbine
Figure 3.1

Methil Offshore Demonstration
Wind Turbine
Environmental Statement



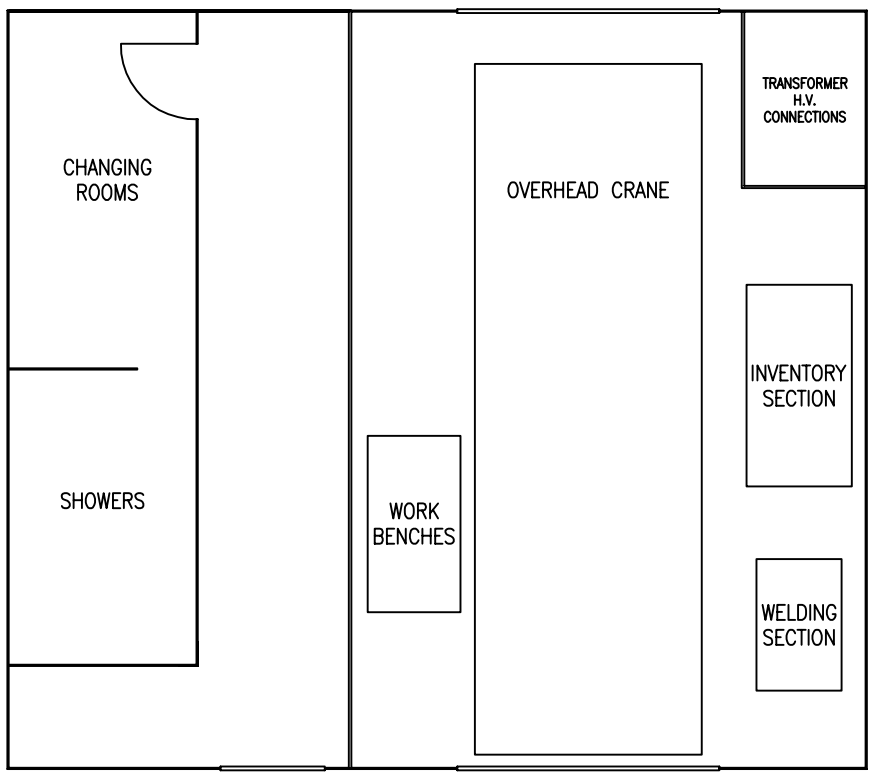
FRONT ELEVATION

SCALE = 1:150



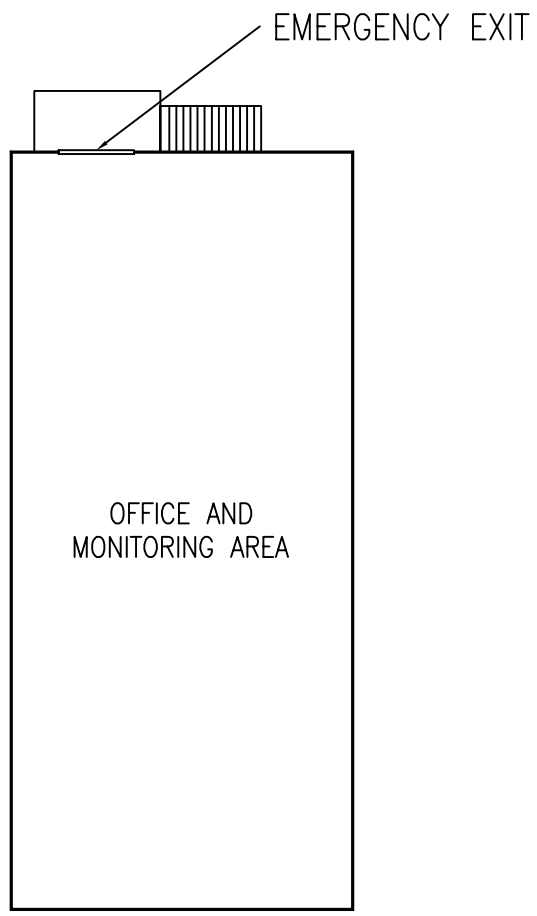
SIDE ELEVATION

SCALE = 1:150



PLAN: LOWER LEVEL

SCALE = 1:150



PLAN: UPPER LEVEL

SCALE = 1:150

2-B Energy

arcus

NOT FOR CONSTRUCTION

Produced By: SC
Reviewed By: PM
Approved By: FM

Ref: 323/ES/068 | Revision: A

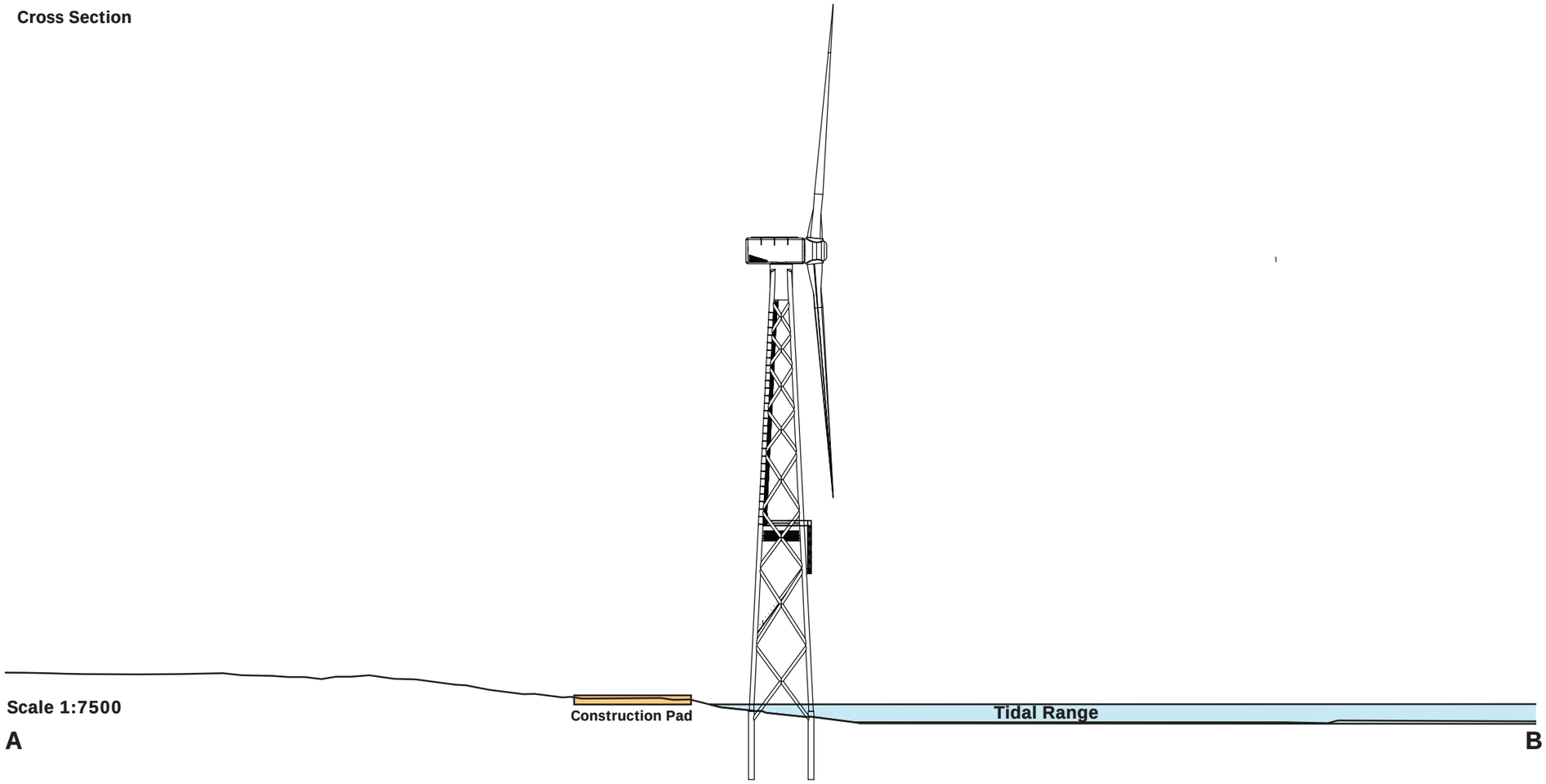
Date: 18/03/2010

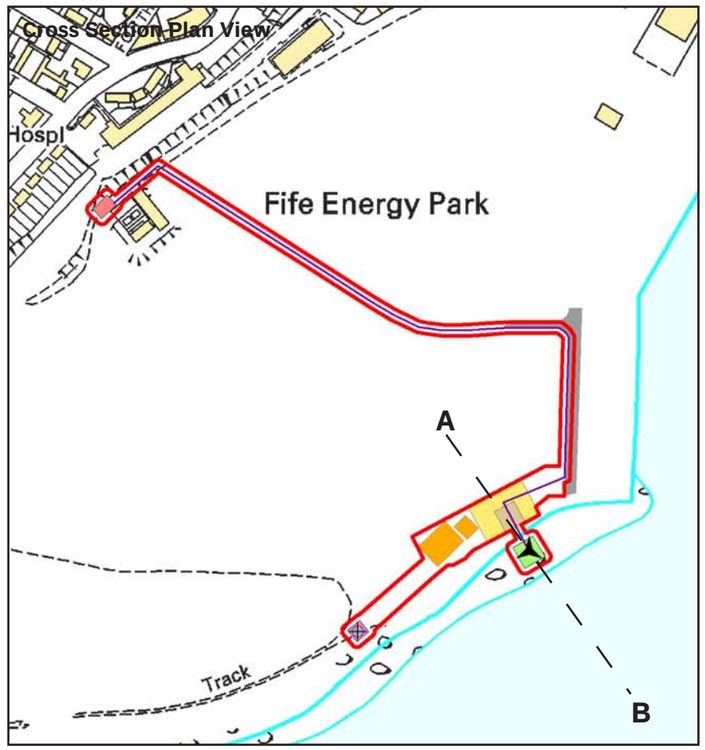
Control Building

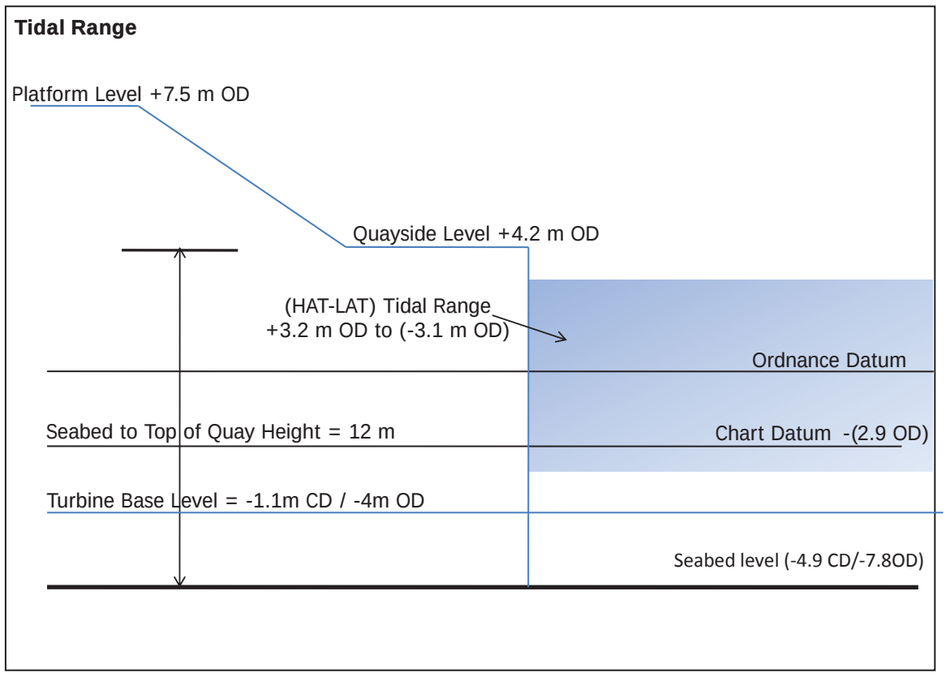
Figure 3.2

Methill Offshore Demonstration Wind Turbine Environmental Statement

Cross Section







2-B Energy

arcus

Key

- Proposed Turbine Location
- Site Boundary
- Common User Access Road
- Wind Station Foundation
- Turbine Foundation
- Building
- Construction Pad
- Construction Hardstanding

Produced: PM
Reviewed: SC
Approved: FM

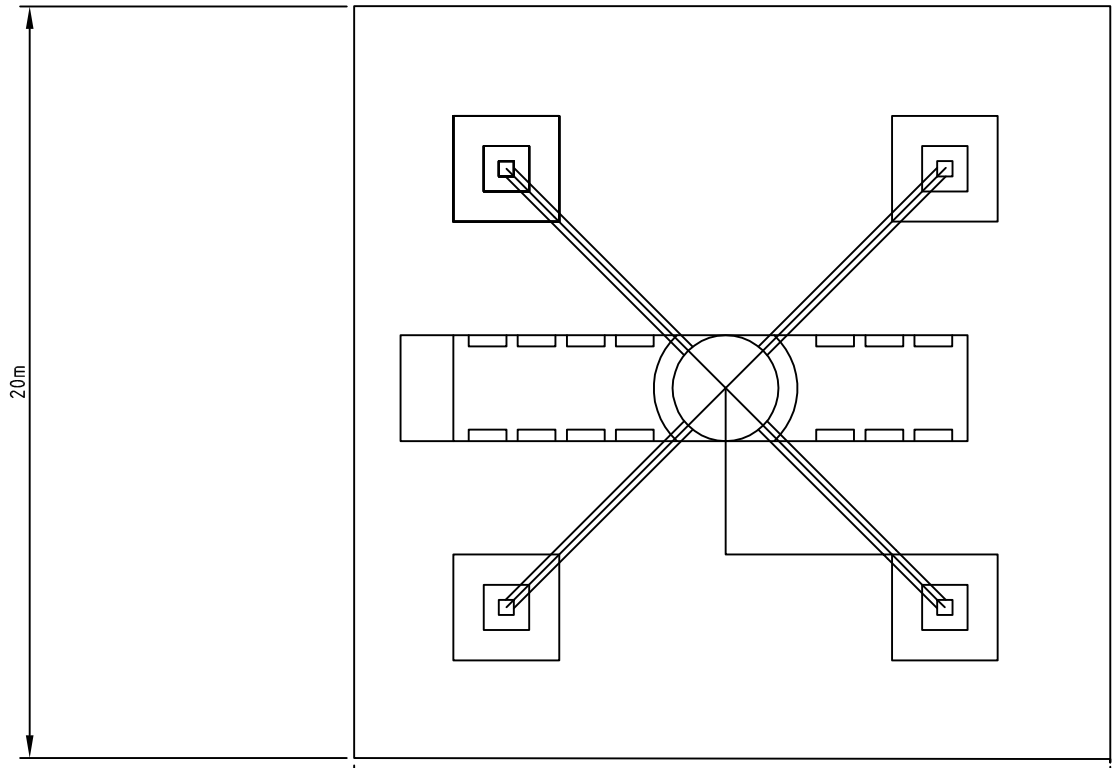
Ref: 323/ES/061 | Revision: A

Date: 13/03/2010

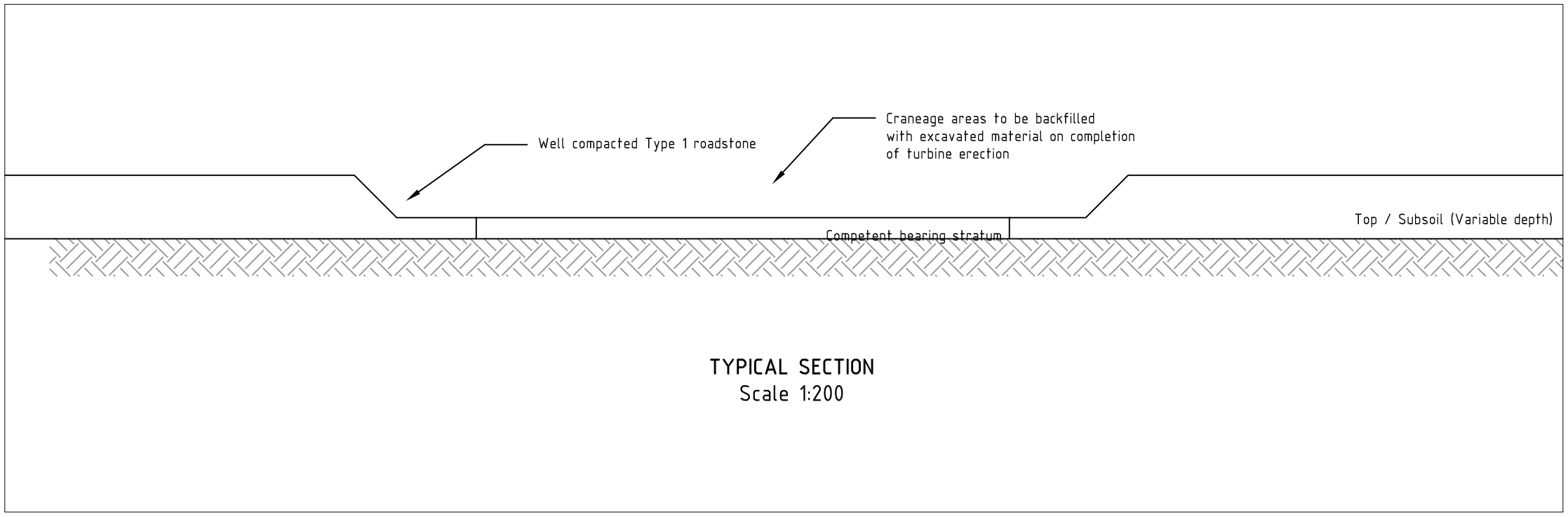
Cross Section

Figure 3.3

Methil Offshore Demonstration Wind Turbine Environmental Statement



TYPICAL PLAN
Scale 1:200



TYPICAL SECTION
Scale 1:200

NOTES:

1. Craneage areas are to be accurately levelled.
2. If no suitable bearing stratum is found then piling will be required

NOT FOR CONSTRUCTION

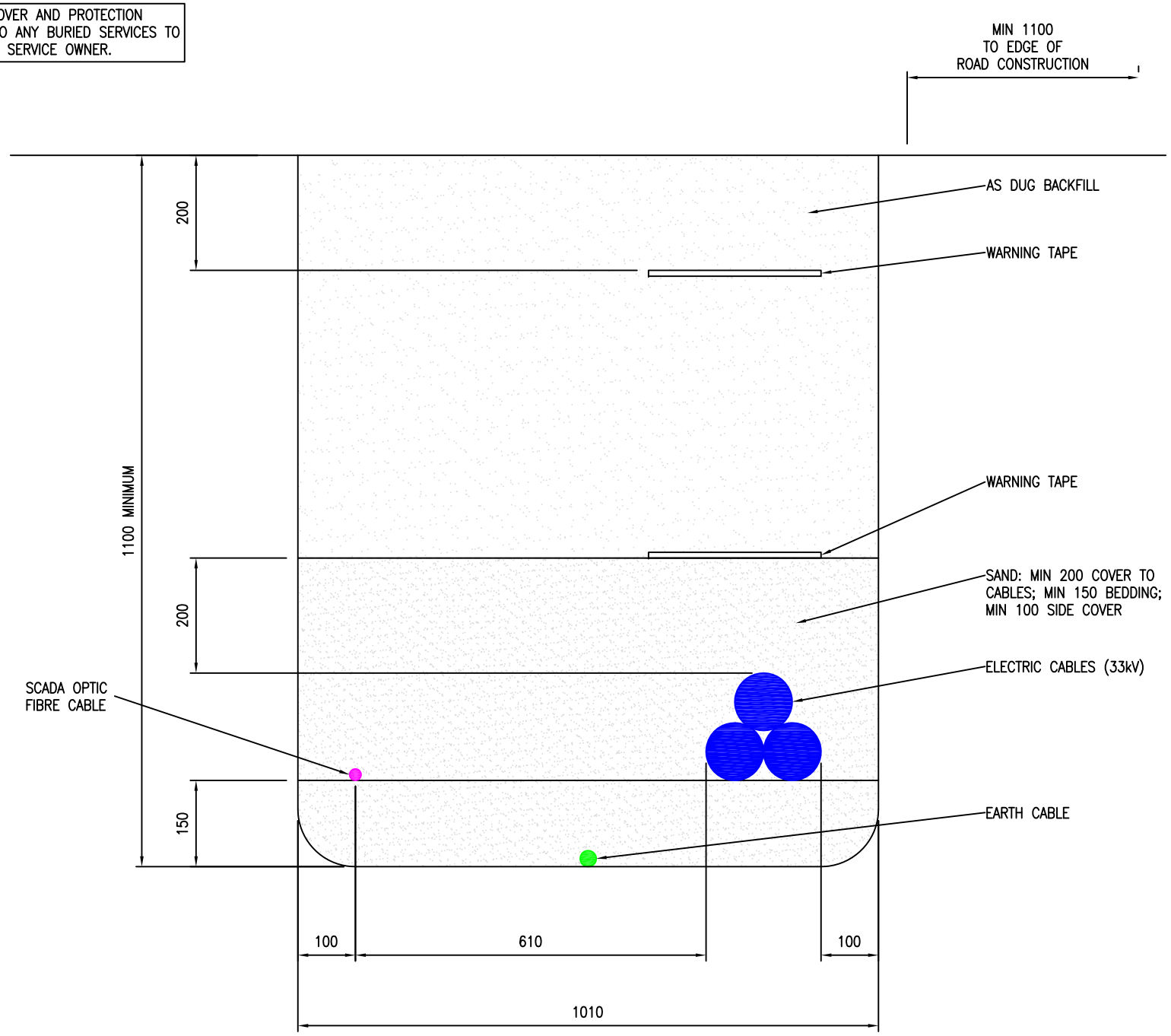
Produced By: PM
Approved By: DL

Ref: 323/ES/065	Revision: B
Date: 13/03/2010	

Typical Crane Harstanding
Figure 3.4

Methil Offshore Demonstration Wind Turbine Environmental Statement

NB– MINIMUM COVER AND PROTECTION REQUIREMENTS TO ANY BURIED SERVICES TO BE AGREED WITH SERVICE OWNER.



CABLE TRENCH DETAIL (1:10)

NOTES:

NOT FOR CONSTRUCTION

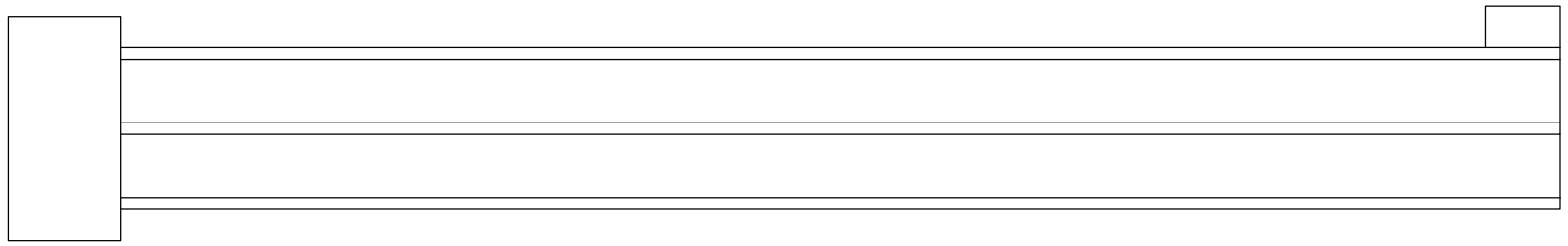
Produced By: PM
Approved By: FM

Ref: 323/ES/064 | Revision: A

Date: 13/03/2010

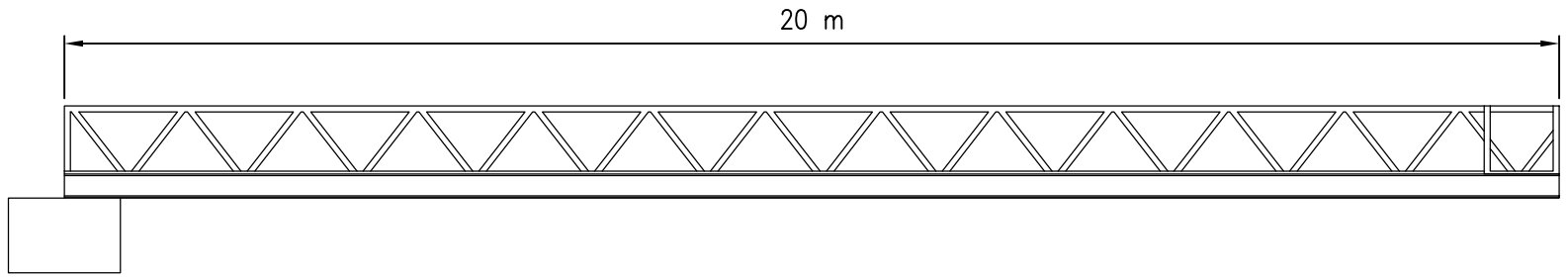
Typical Cable Trench
Figure 3.5

Methil Offshore Demonstration Wind Turbine Environmental Statement



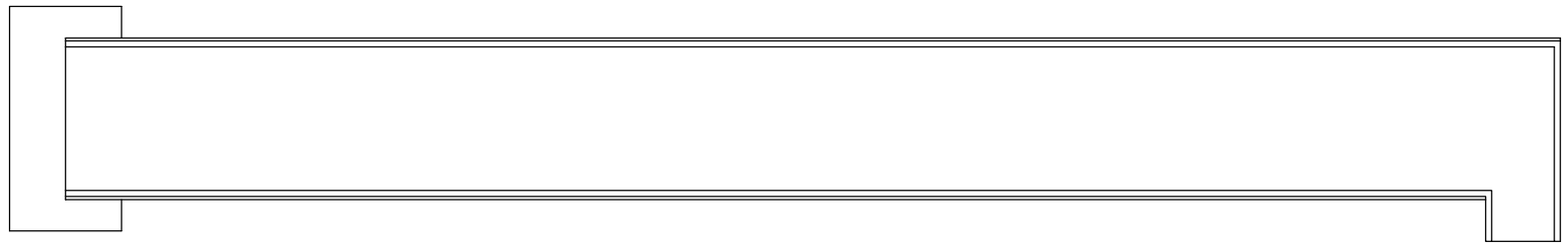
BELOW BRIDGE VIEW

SCALE 1:100



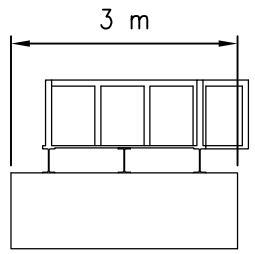
SIDE ELEVATION

SCALE 1:100



ABOVE BRIDGE VIEW

SCALE 1:100



FRONT ELEVATION

SCALE 1:100

NOTES:

NOT FOR CONSTRUCTION

Produced By: SC
Reviewed By: PM
Approved By: FM

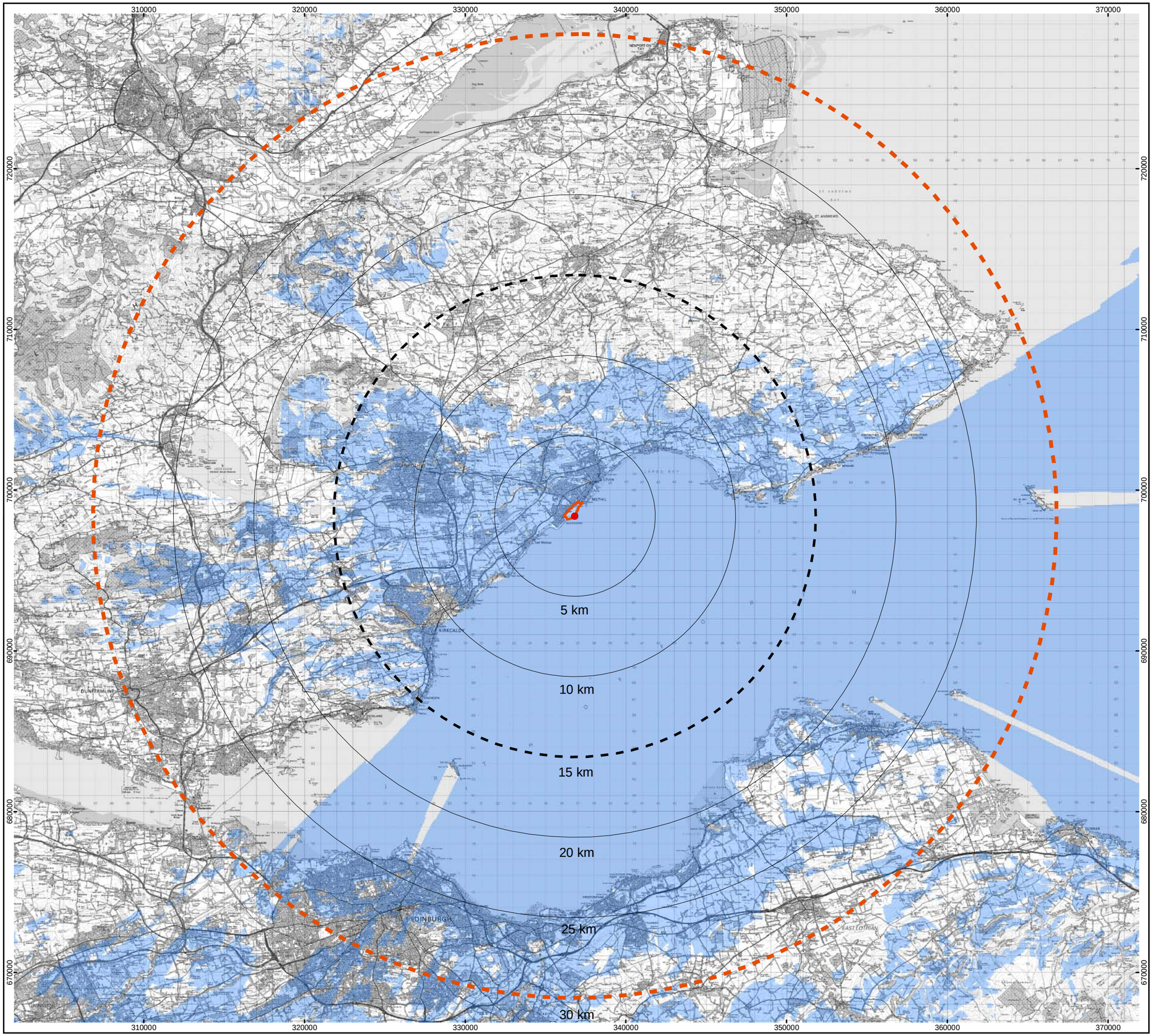
Ref: 323/ES/069 | Revision: A

Date: 17/03/2010

Bridge Detail

Figure 3.6

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- 30 km Study Area
- 5, 10, 20, 25 km Study Area
- 15 km Study Area
- Fife Energy Park
- Theoretical Visibility

1:225,000 Scale @ A3

0 5 10 km

N

Produced: GC
Reviewed: PM
Approved: FM

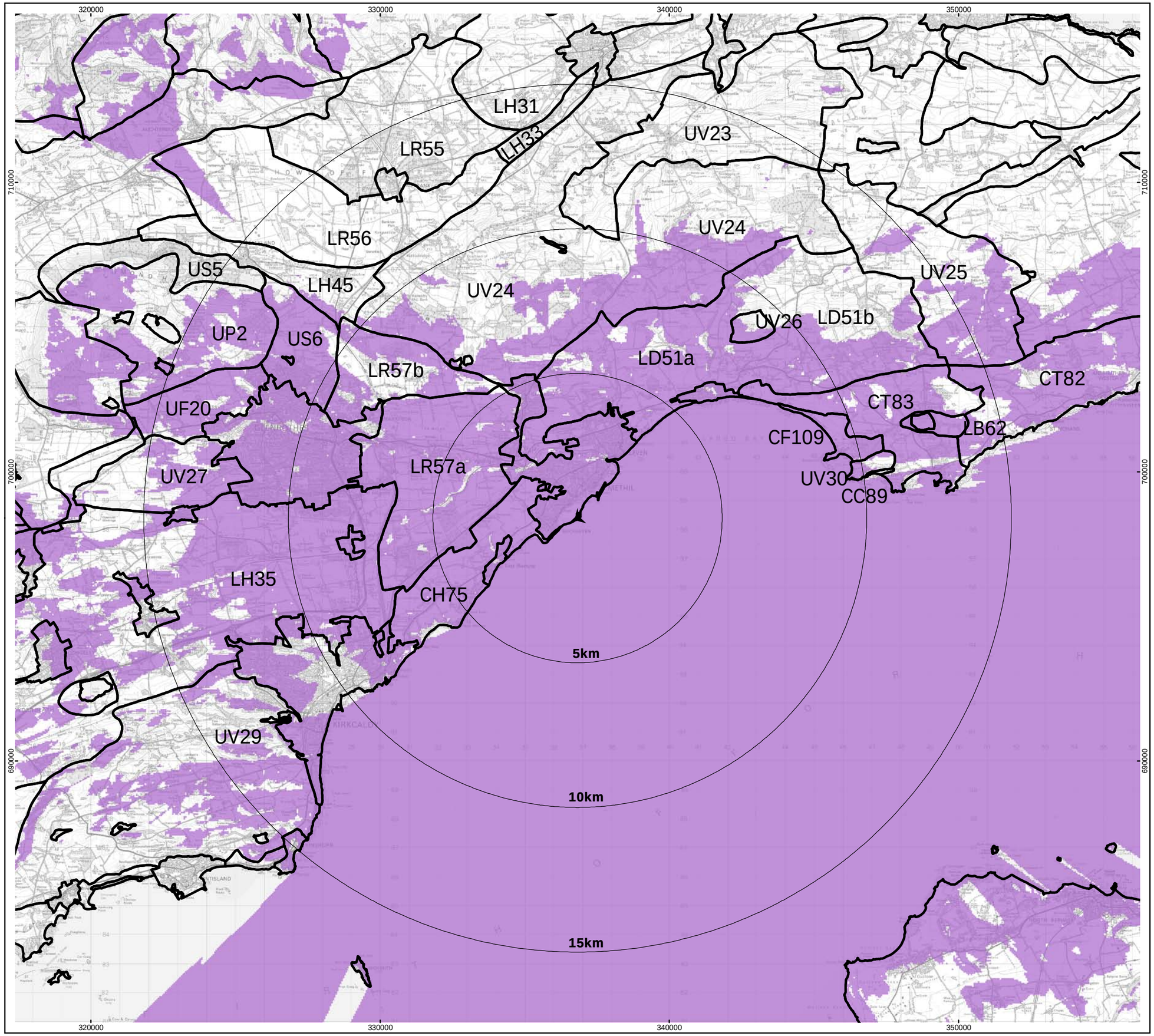
Ref: 323/ES/004 | Revision: A

Date: 22/03/2010

30 km Study Area and Blade-Tip Zone of Theoretical Visibility

Figure 5.1

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Landscape Character Area
- Turbine Visible

Note: All Landscape Receptor Codes refer to Chapter 5: Landscape and Visual Assessment within Volume I of this Environmental Statement

1:125,000 Scale @ A3

0 2.5 5 km

N

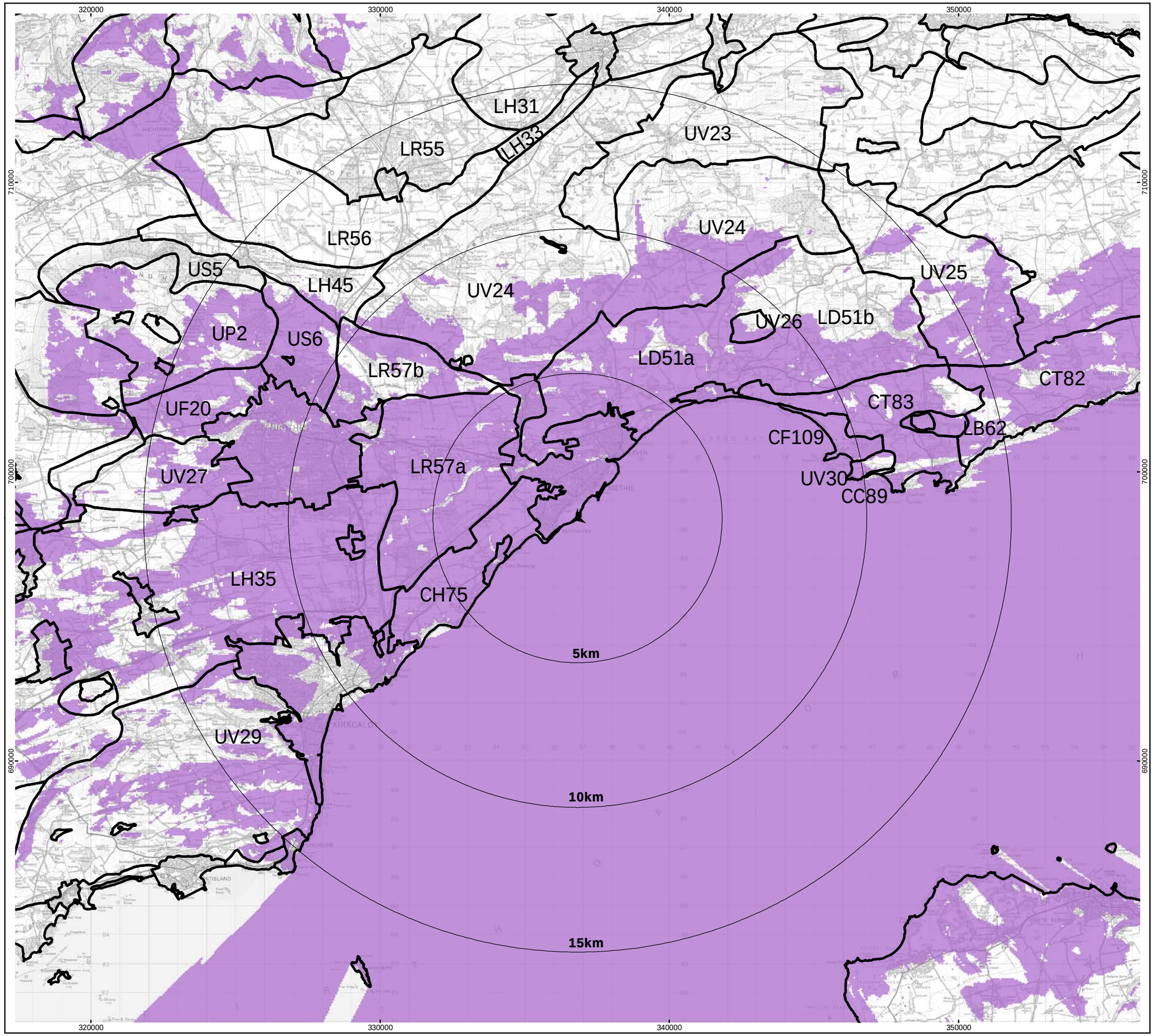
Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/054 | Revision: A

Date: 25/02/2010

ZTV with Landscape Character Types
Figure 5.10

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Landscape Character Area
- Turbine Visible

Note: All Landscape Receptor Codes refer to Chapter 5: Landscape and Visual Assessment within Volume I of this Environmental Statement

1:125,000 Scale @ A3

0 2.5 5 km

N

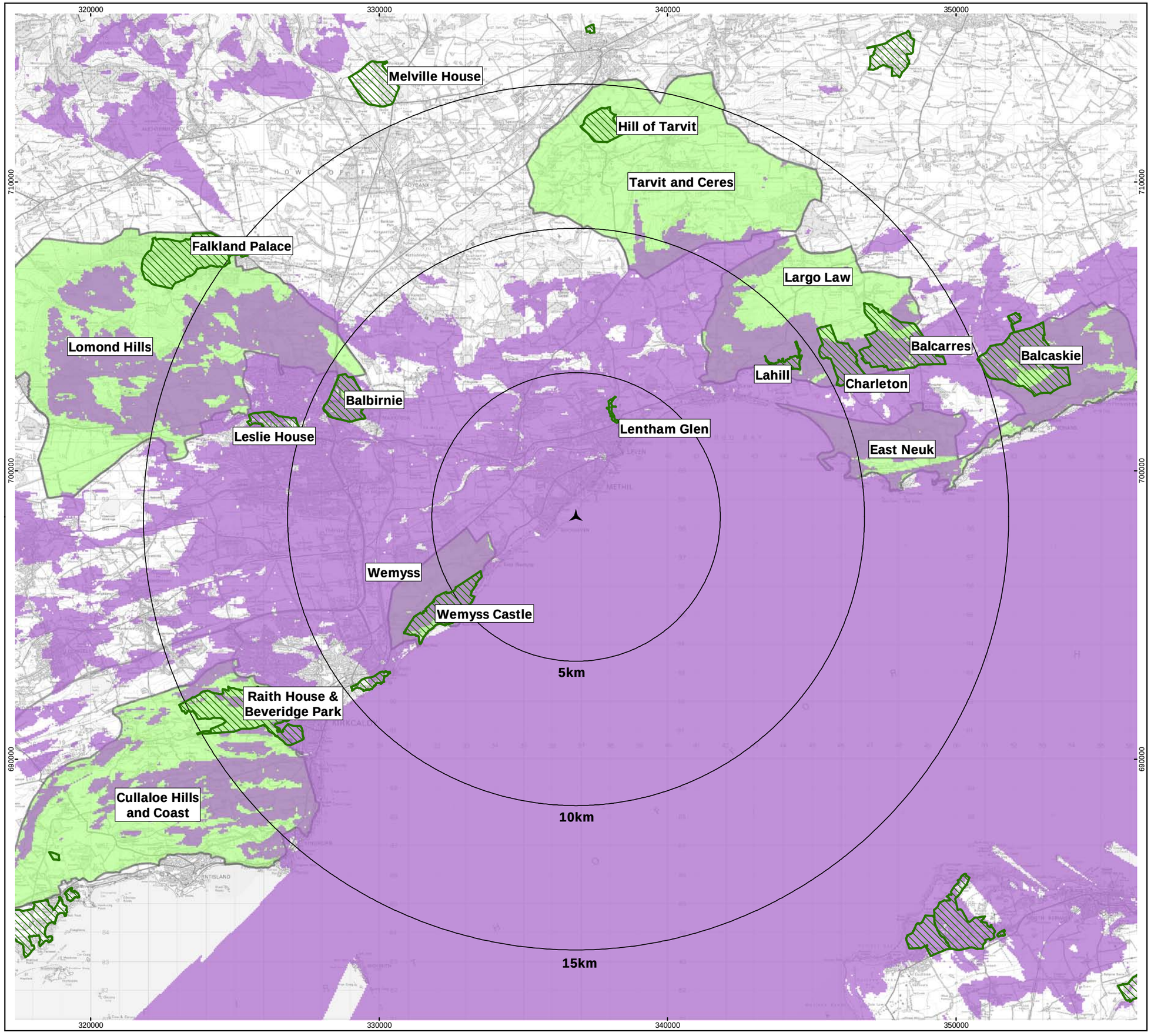
Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/054 | Revision: A

Date: 25/02/2010

ZTV with Landscape Character Types
Figure 5.10

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Inventory Garden and Designed Landscape
- Candidate Special Landscape Area
- Turbine Visible

1:125,000 Scale @ A3

0 2.5 5 km

N

Produced: PM
Reviewed: SC
Approved: FM

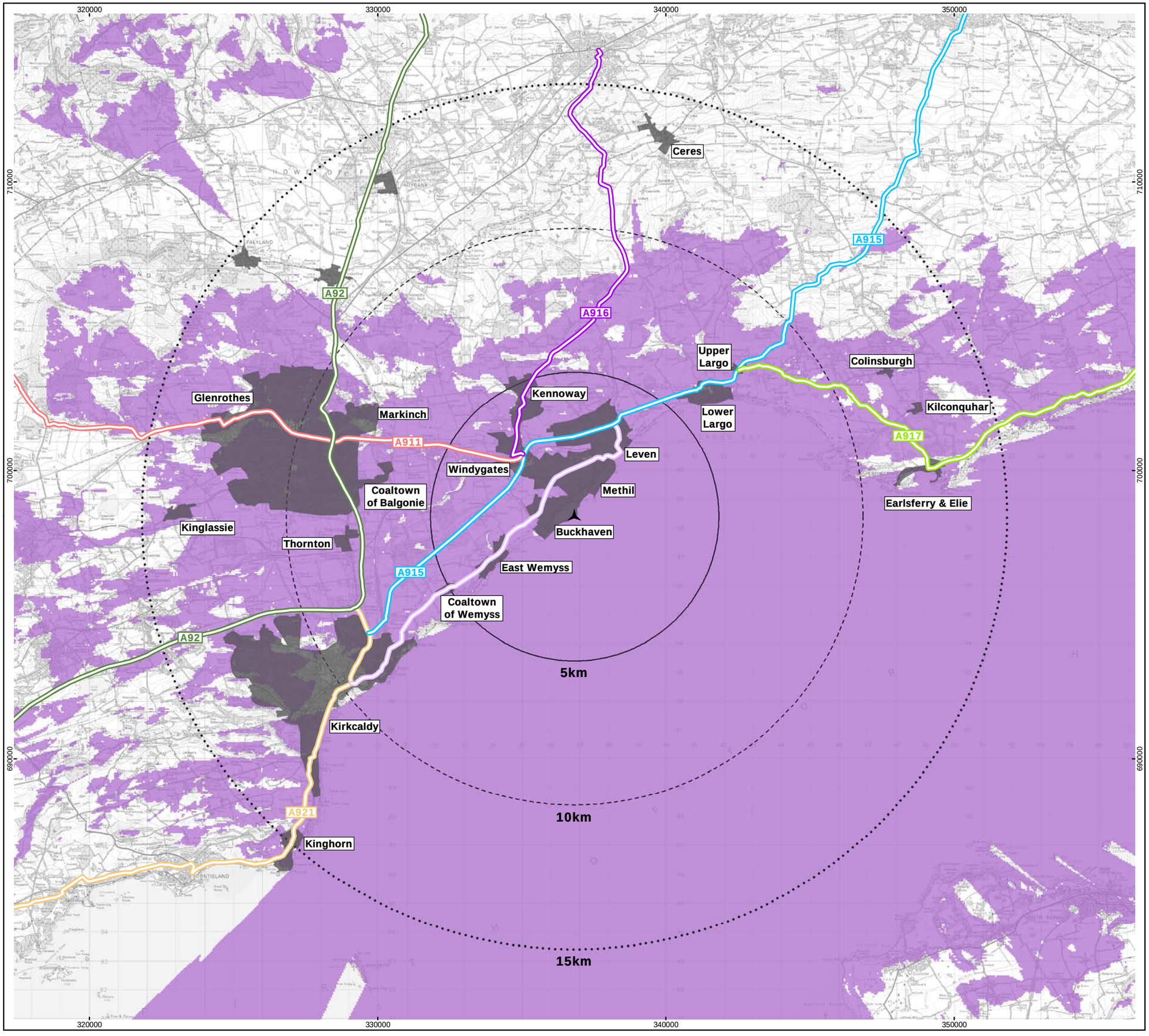
Ref: 323/ES/056 | Revision: A

Date: 25/02/2010

Landscape Planning Designations

Figure 5.11

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Settlement
- A92
- A911
- A915
- A916
- A917
- A921
- A955
- Turbine Visible
- 5km Radius of Site
- 10km Radius of Site
- 15km Radius of Site

1:125,000 Scale @ A3

0 3 6 km

N

Produced: PM
Reviewed: SC
Approved: FM

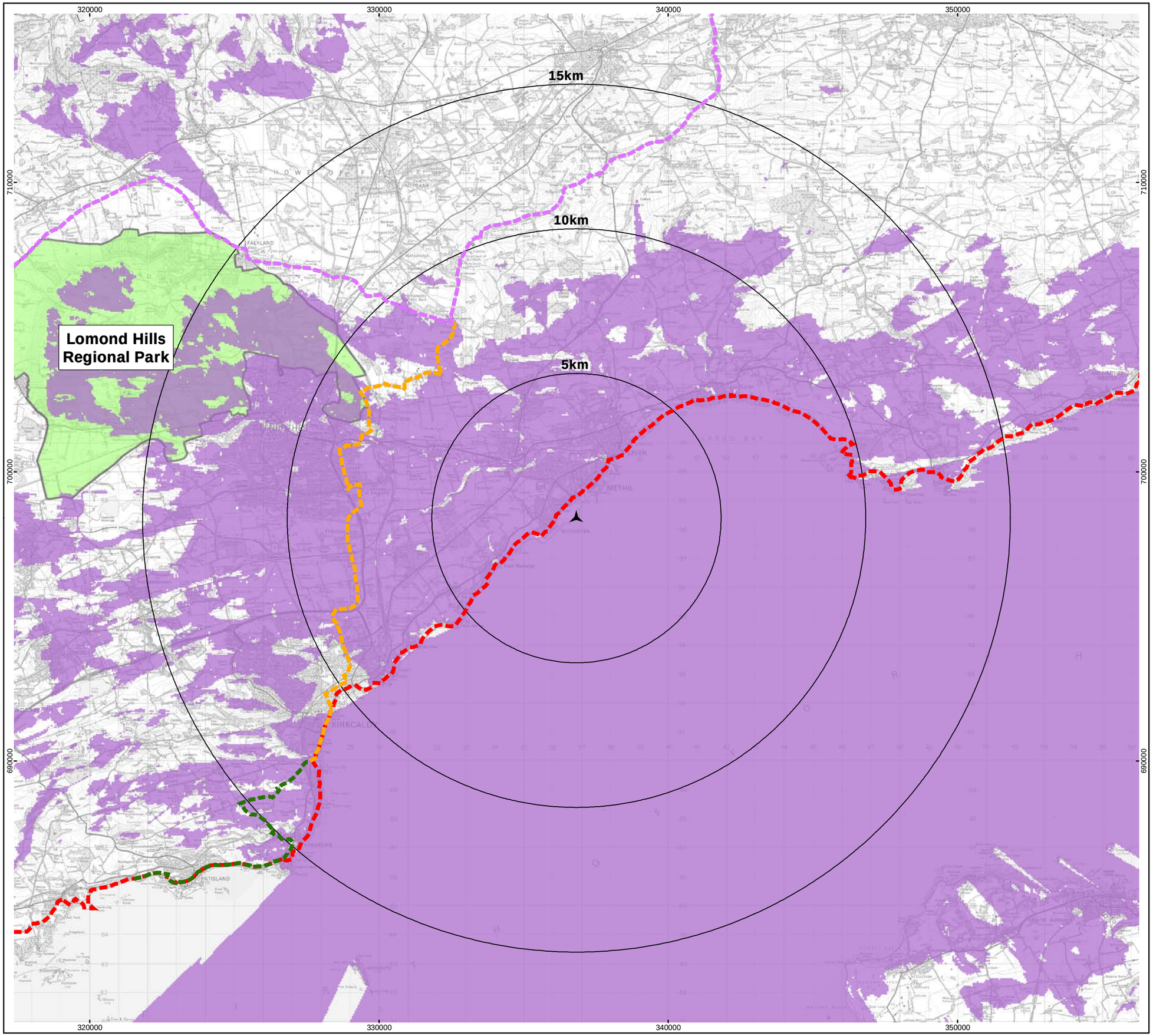
Ref: 323/ES/055 | Revision: A

Date: 19/02/2010

ZTV with Settlements and Roads

Figure 5.12

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Fife Coastal Path
- National Cycle Route 1
- National Cycle Route 63
- National Cycle Route 76
- Turbine Visible
- Regional Park

1:125,000 Scale @ A3

0 2.5 5 km

N

Produced: PM
Reviewed: SC
Approved: FM

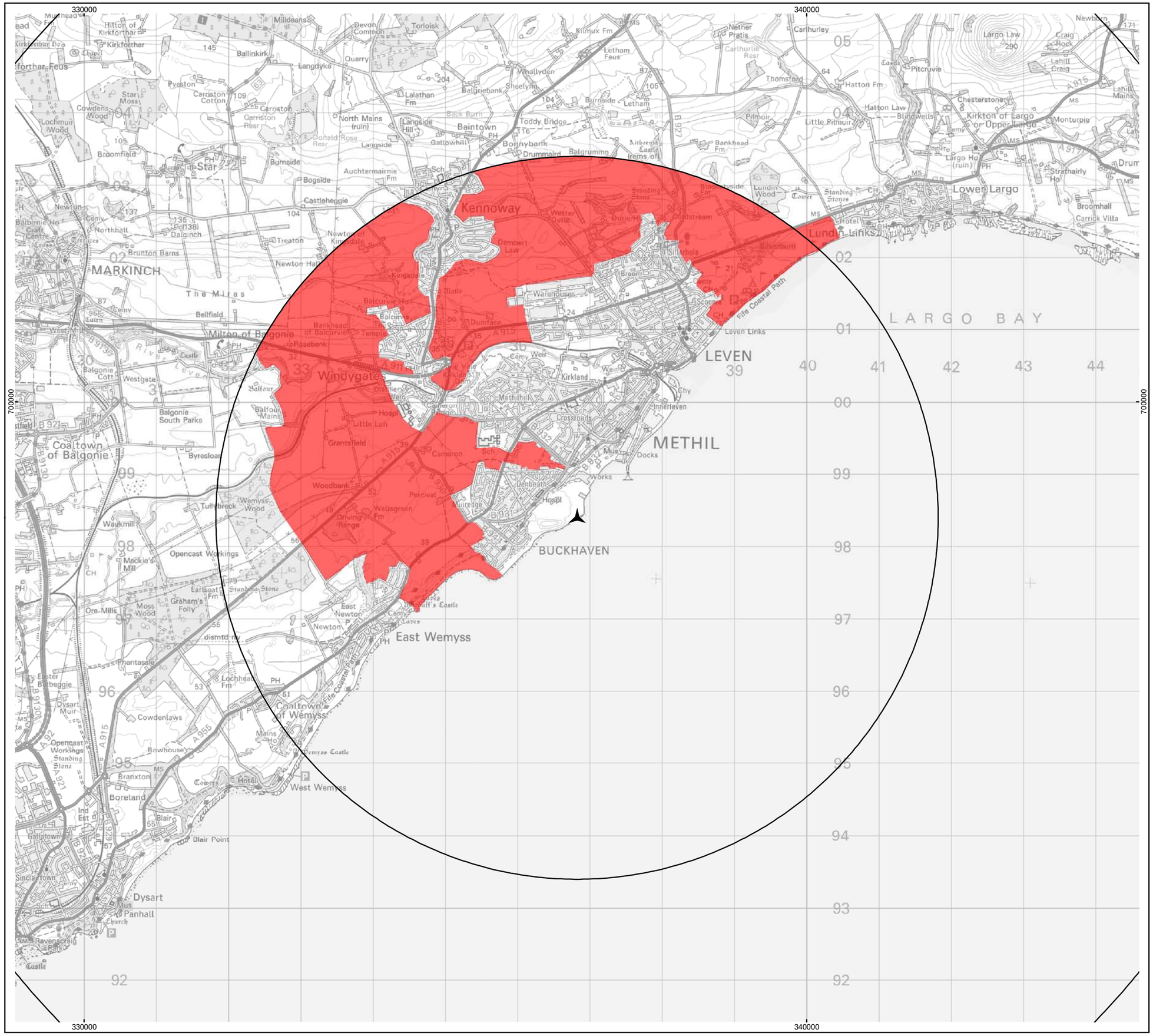
Ref: 323/ES/055 | Revision: A

Date: 25/02/2010

ZTV with Routes and Attractions

Figure 5.13

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

⅄	Proposed Turbine Location
🟥	Significant Effects on Landscape Character
☐	5km Radius of Site

1:50,000 Scale @ A3

0 1 2 km

N

Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/052
Revision: A
Date: 25/02/2010

Extent of Significant Effects on Landscape Character

Figure 5.14a

Methil Offshore Demonstration Wind Turbine Environmental Statement

2-B Energy

arcus

Key

Proposed Turbine Location

🟥 Significant Effects on Visual Receptor

1:50,000 Scale @ A3

0 1 2 km

N

Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/053
Revision: A
Date: 25/02/2010

Extent of Significant Effects on Visual Receptors

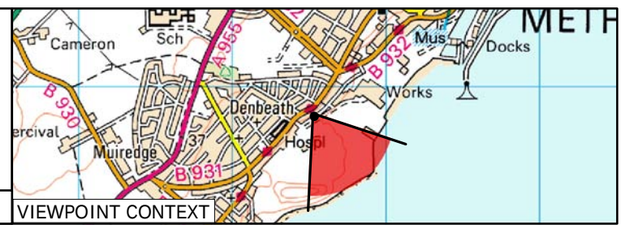
Figure 5.14b

Methil Offshore Demonstration Wind Turbine Environmental Statement

Photomontage showing proposed development from viewpoint

Viewpoint Location:	336537mE 698810mN
View Direction:	145.29 degrees
Camera Elevation:	21m AOD
Distance to Nearest Turbine:	502m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

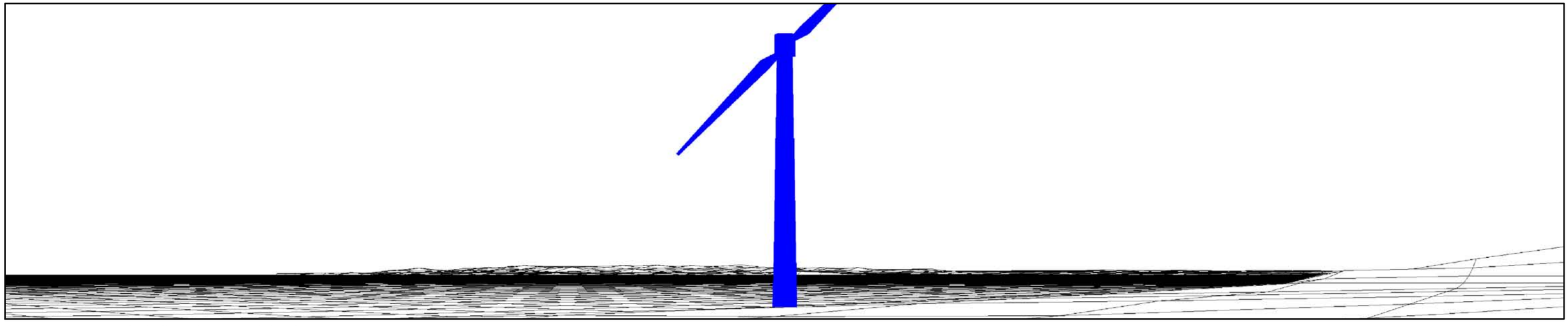
Ref: 323/ES/014 Drawn: GC Reviewed: PM Approved: FM



VP1 B931 Fife Coastal Path, Buckhaven
Figure 5.15a

Methil Offshore Demonstration Wind Turbine Environmental Statement

Existing view from viewpoint



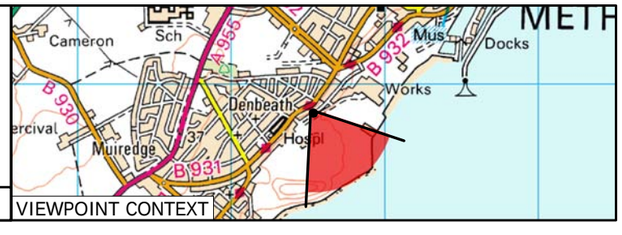
Computer generated wireline of proposed development

VP1 - B931 Fife Coastal Path, Buckhaven
Figure 5.15a

Methil Offshore Demonstration Wind Turbine Environmental Statement

Viewpoint Location:	336537mE 698810mN
View Direction:	145.29 degrees
Camera Elevation:	21m AOD
Distance to Nearest Turbine:	502m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

Ref: 323/ES/014 Drawn: GC Reviewed: PM Approved: FM



VIEWPOINT CONTEXT

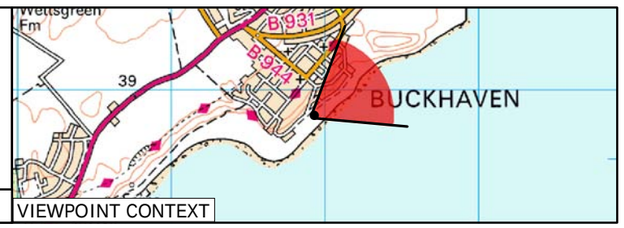
2-B Energy

arcus

Photomontage showing proposed development from viewpoint

Viewpoint Location:	335934mE 697837mN
View Direction:	57.79 degrees
Camera Elevation:	6m AOD
Distance to Nearest Turbine:	1050m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

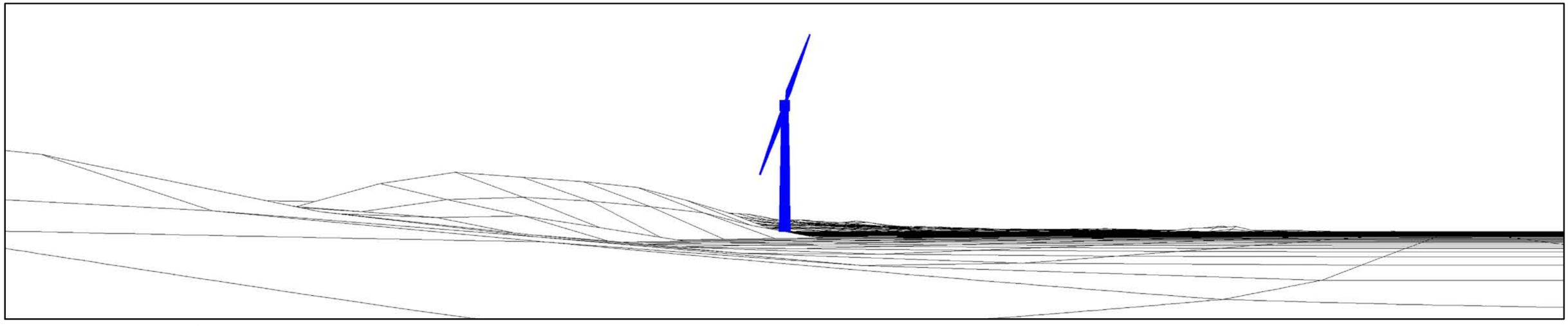
Ref: 323/ES/015 Drawn: GC Reviewed: PM Approved: FM



VP2 - Shore Street, Buckhaven
Figure 5.15b

Methil Offshore Demonstration Wind Turbine Environmental Statement

Existing view from viewpoint



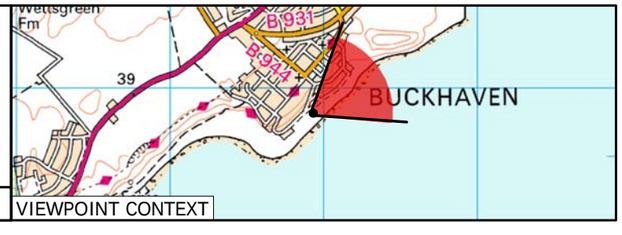
Computer generated wireline of proposed development

VP2 - Shore Street, Buckhaven
Figure 5.15b

Methil Offshore Demonstration Wind Turbine Environmental Statement

Viewpoint Location:	335934mE 697837mN
View Direction:	57.79 degrees
Camera Elevation:	6m AOD
Distance to Nearest Turbine:	1050m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

Ref: 323/ES/015 Drawn: GC Reviewed: PM Approved: FM

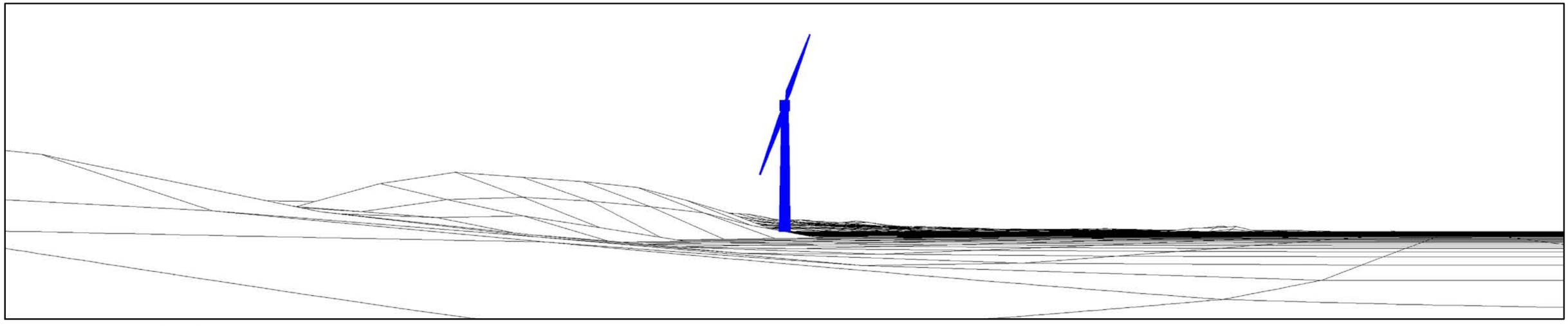


VIEWPOINT CONTEXT

2-B Energy

arcus

Existing view from viewpoint



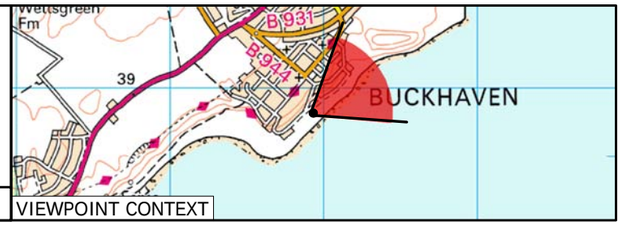
Computer generated wireline of proposed development

VP2 - Shore Street, Buckhaven
Figure 5.15b

Methil Offshore Demonstration Wind Turbine Environmental Statement

Viewpoint Location:	335934mE 697837mN
View Direction:	57.79 degrees
Camera Elevation:	6m AOD
Distance to Nearest Turbine:	1050m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

Ref: 323/ES/015 Drawn: GC Reviewed: PM Approved: FM



VIEWPOINT CONTEXT

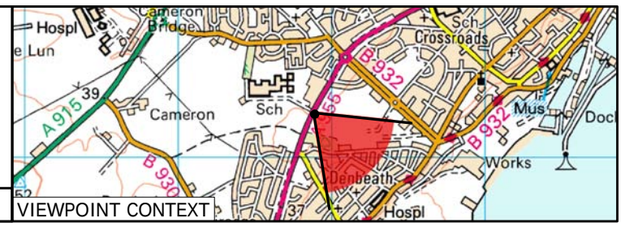
2-B Energy

arcus

Photomontage showing proposed development from viewpoint

Viewpoint Location:	335893mE 699282mN
View Direction:	133.58 degrees
Camera Elevation:	22m AOD
Distance to Nearest Turbine:	1283m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

Ref: 323/ES/016 Drawn: GC Reviewed: PM Approved: FM



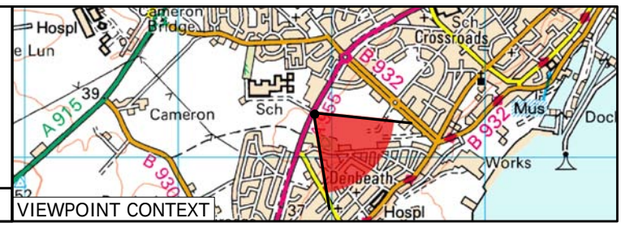
VP3 - A955, Buckhaven
Figure 5.15c

Methil Offshore Demonstration Wind Turbine Environmental Statement

Photomontage showing proposed development from viewpoint

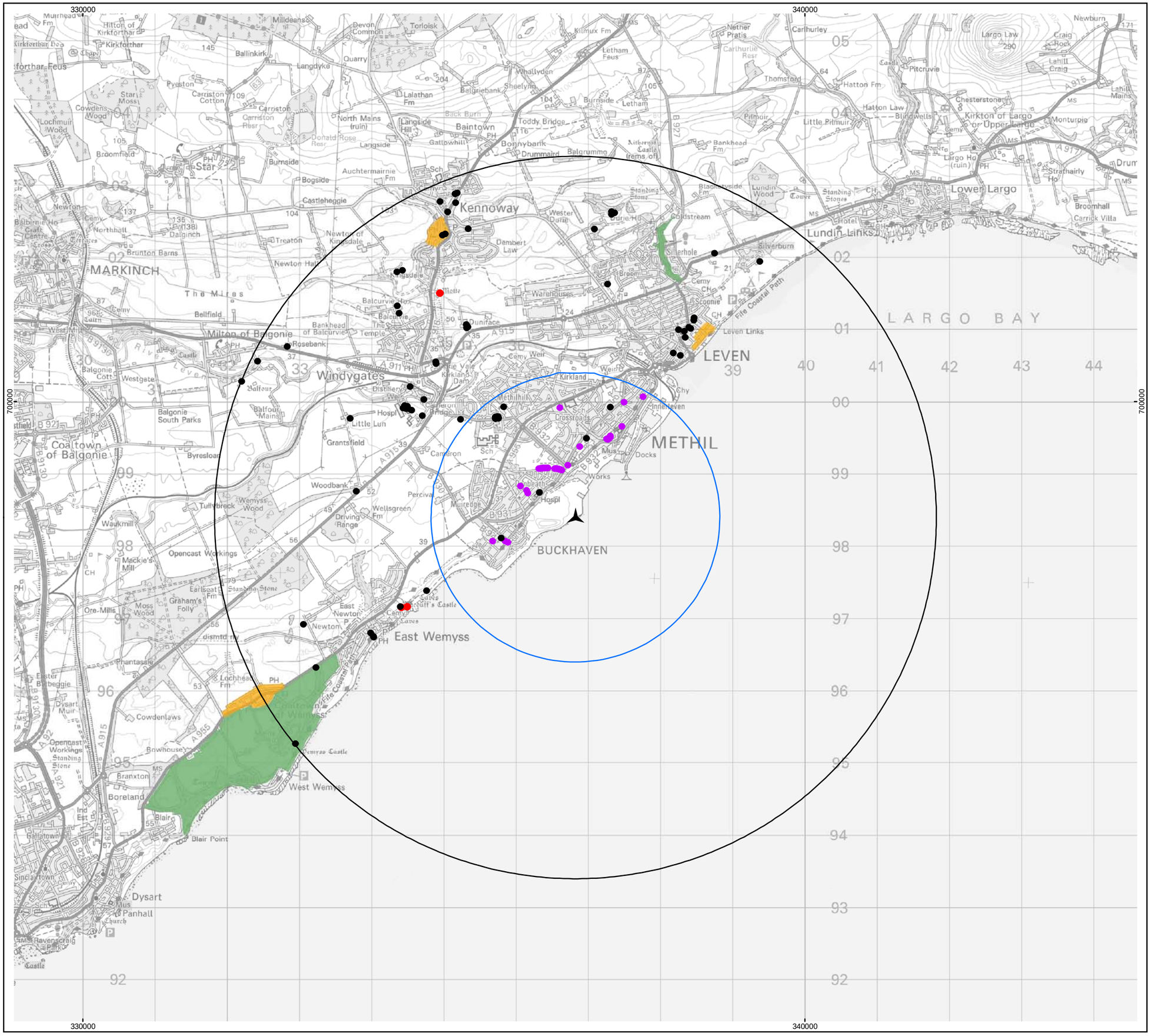
Viewpoint Location:	335893mE 699282mN
View Direction:	133.58 degrees
Camera Elevation:	22m AOD
Distance to Nearest Turbine:	1283m
Horizontal Field of View:	75 degrees
Viewing Distance:	302mm

Ref: 323/ES/016 Drawn: GC Reviewed: PM Approved: FM



VP3 - A955, Buckhaven
Figure 5.15c

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- 2km Buffer of Turbine
- 5km Buffer of Turbine
- Category A and B Listed Building
- Category C(S) Listed Building
- Scheduled Ancient Monument
- Conservation Area
- Garden or Designed Landscape

1:50,000 Scale @ A3

0 1 2 km

N

Produced: PM
Reviewed: SC
Approved: FM

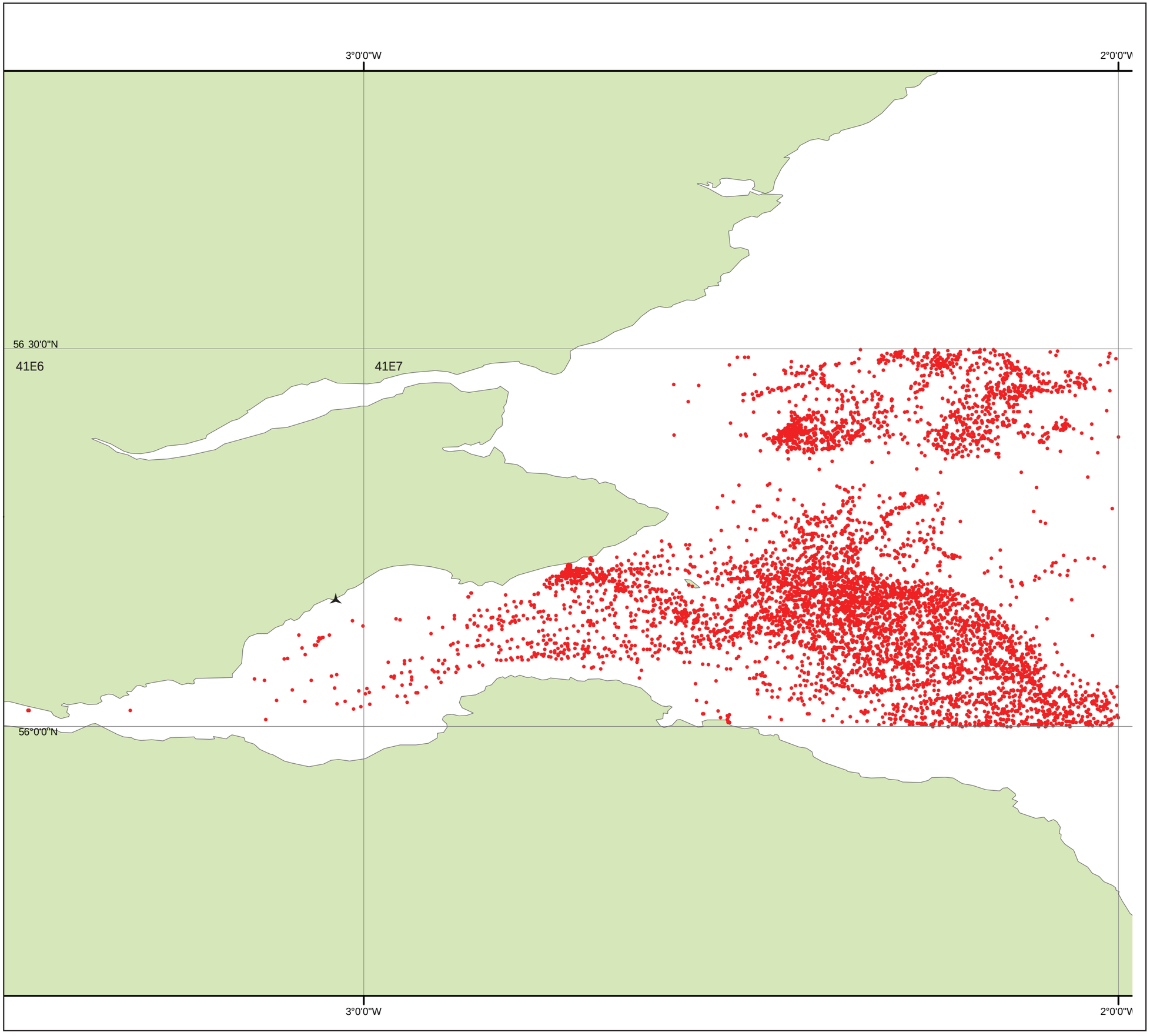
Ref: 323/ENV/012 | Revision: A

Date: 17/02/2010

Cultural Heritage features within 5km

Figure 10.1

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

Proposed Turbine Location

Note: Vessel Monitoring System (VM0S) fishing pings by UK vessels in ICES Rectangle 41E6 and adjoining ICES Rectangle 41E7. Data based on fishing vessel pings from the VMS on board fishing vessels of 15 metres or more in length. Data obtained from the Sea Fisheries Division of the Scottish Government.

N

Not To Scale

Produced: PM
Reviewed: SC
Approved: FM/MK

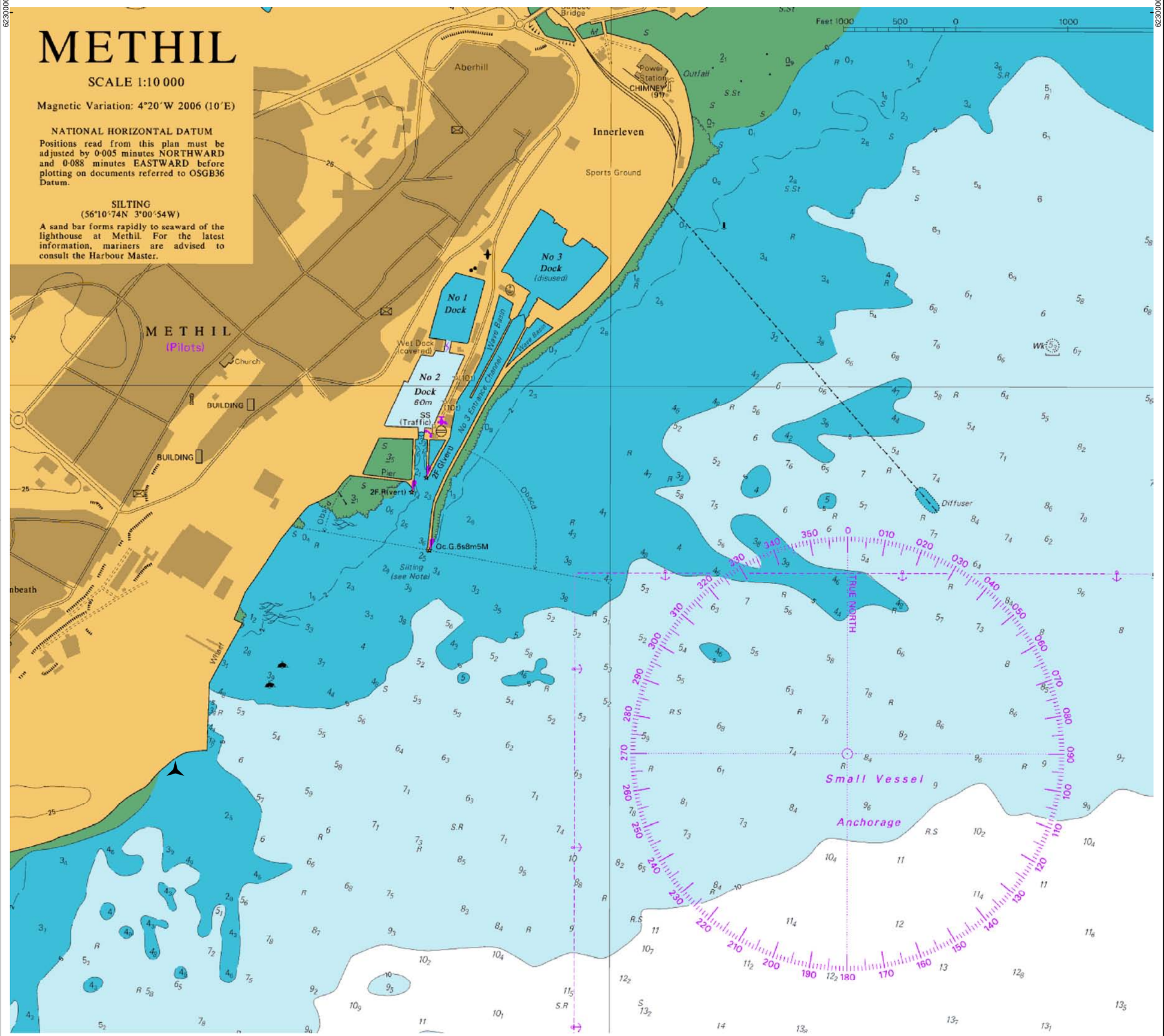
Ref: 323/ES/002 | Revision: A

Date: 11/02/2010

Fishing Activity

Figure 12.1

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

Proposed Turbine Location

1:10,000 Scale @ A3

0 0.2 0.4 km

N

Produced: PM
Reviewed: SC
Approved: FM/MK

Ref: 323/ES/001 | Revision: A

Date: 12/02/2010

Admiralty Chart
Figure 12.2

Methil Offshore Demonstration Wind Turbine Environmental Statement

2-B Energy

arcus

Key

- Proposed Turbine Location
- 500m Radius of Turbine
- Zone of Potential Interference on Transmissions from Blackhill
- Zone of Potential Interference on Transmissions from Craigkelly
- Direction of Transmissions from Blackhill
- Direction of Transmissions from Craigkelly

1:25,000 Scale @ A3

0 0.5 1 km

N

Produced: PM
Reviewed: SC
Approved: FM

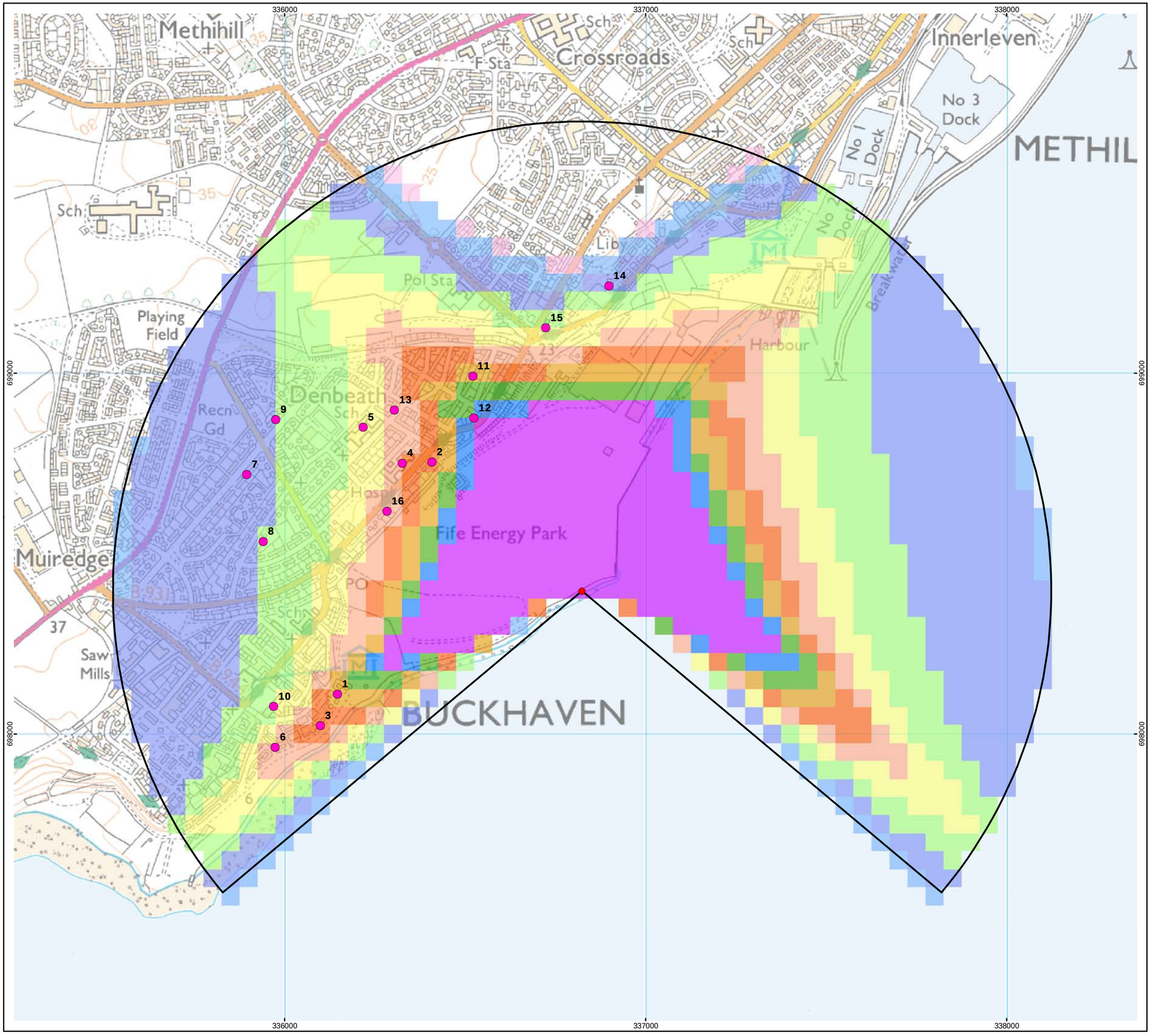
Ref: 323/ENV/013 | Revision: A

Date: 17/02/2010

Potential TV Interference

Figure 13.1

Methil Offshore Demonstration Wind Turbine Environmental Statement



2-B Energy

arcus

Key

- Proposed Turbine Location
- Shadow Flicker Study Area 1300 m

Shadow Flicker Hours Per Annum*

- 0
- 0 - 1
- 2-10
- 11-20
- 21-30
- 31-40
- 41-50
- 51-60
- 61-70
- 71-80
- 81-90
- 91-100

Assessment Locations at

1	Location 1, Lady Wynd
2	Location 2, Wellesley Road
3	Location 3, Bethune Way
4	Randolph Wemyss Memorial Hospital
5	Denbeath Primary School
6	Location 4, Anderson Lane
7	Location 5, Den Walk
8	Location 6, Omar Crescent
9	Location 7, Den Walk
10	Location 8, Braehead Gardens
11	Location 9, Clyde Street
12	Location 10, Wellesley Road
13	Location 11, Ward Street
14	Location 12, Swan Court
15	Location 13, Swan View
16	Location 14, Wellesley Road

* excluding the ratio of bright percentage of sunshine

1:10,000 Scale @ A3

0 250 500 m

N

Produced: PM
Reviewed: SC
Approved: FM

Ref: 323/ES/058 | Revision: A

Date: 10/03/2010

Zone of Potential Shadow Flicker Effect

Figure 13.1

Methil Offshore Demonstration Wind Turbine Environmental Statement

Methil Offshore Demonstration Wind Turbine

Environmental Statement

Volume III - Technical Appendices

March 2010

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APPENDIX A5: REPRESENTATIVE VIEWPOINT ANALYSIS

Introduction

A total of 21 viewpoints have been selected in consultation with Scottish Natural Heritage as being representative of the landscape and visual resources of the 15 km radius study area, from which some visibility of the Demonstration Turbine can be obtained. The viewpoints included in the assessment are listed in Table 5.4 of the Environmental Statement (Volume I) and identified on Figure 5.3 of the Environmental Statement (Volume II). Visualisations by way of photographs, wirelines and, in some cases, photomontages have also been prepared for each viewpoint to illustrate the Demonstration Turbine in conjunction with views that are currently obtained. These visualisations are shown on Figures 5.15a to 5.15u of the Environmental Statement (Volume II). A further set of wirelines have been prepared to show the Demonstration Turbine in conjunction with other wind farm developments and these are shown on Figures 5.16a to 5.16j.

The photographs, wirelines and photomontages shown for each viewpoint cover a 75° arc of view, which reflects the widest field of vision that can be obtained by a static person without moving their head. This is important as it allows the Demonstration Turbine to be seen in context with the surrounding view. When reproduced at A3 size, as is the case with this assessment, the 75° degree photographs, wirelines and photomontages should be viewed at a distance of around 300 mm in order to gain as accurate an impression as possible of the effects of the Demonstration Turbine on the existing views. Additional wirelines prepared to show the Demonstration Turbine in conjunction with other wind farm developments cover a 180° arc of view, which reflects the widest field of vision that can be obtained by a static person by turning their head. These should also be viewed at a distance of around 300 mm.

It should be noted that the actual assessment of the viewpoints has been carried out on site in conjunction with the ZTV and wirelines.

Viewpoint 1: B931/Fife Coastal Path, Buckhaven

Grid reference: E336537 N698810
Approximate distance to demonstration turbine: 500 m
Approximate elevation: 20 m AOD
Receptor type: Residential/ Walkers
Landscape character type: Urban edge with coast
Landscape designation: None
Figure 5.15a

Baseline view: Viewpoint 1 is the closest viewpoint to the Demonstration Turbine, lying on Fife Coastal Path where it follows the B931 through Buckhaven immediately adjacent to Fife Energy Park (FEP) where the Demonstration Turbine is located. The view clearly shows the semi-derelict and industrial character of the FEP site, which includes a large-scale steel fabrication plant, just to the left of the view out of shot, and several tall lighting masts. These combine to convey a degraded character and quality to views obtained both from adjacent housing and from the coastal footpath where views are available. Beyond the FEP site, expansive views are obtained across the Firth of Forth and it is just possible to define the southern shoreline and range of hills behind silhouetted on the skyline, although any detail is indistinguishable.

The viewpoint has been included to illustrate the effect that the Demonstration Turbine will have on available views from residential properties that face on to the FEP site, principally along Wellesley Road, as well as on views from Fife Coastal Path at a point where it passes closest to the Demonstration Turbine.

Sensitivity: Occupiers of residential properties and users of long distance footpaths are normally considered to have a high sensitivity to development. However, the current outlook for occupiers that adjoin the FEP site and users of the coastal path is predominantly one of industrial dereliction,

with views dominated by large-scale industrial buildings and other vertical elements. These combine to lower sensitivity and thus sensitivity of the viewpoint to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be *very large* with the Demonstration Turbine providing the dominating influence in the view despite the presence of other large-scale detracting elements. This is due to the close proximity of the Demonstration Turbine, the width of view affected, the high visibility of the Demonstration Turbine and the contrast that its scale, vertical form and movement will have on the baseline view.

It should be noted, however, that the broad, open and predominantly horizontal nature of the coastal setting in which the Demonstration Turbine will be seen provides an appropriate receiving environment by limiting uncomfortable scale comparisons that can arise when turbines are located in smaller, more intimate and varied landscapes. The presence of large-scale industrial buildings and masts in the view also provides a logical setting for the Demonstration Turbine as well as providing other foreground distractions, which limits the eye catching impact that the Demonstration Turbine would otherwise have. While these factors do reduce the magnitude of change, it will still be classified as very large due to the change in the view that will result from the introduction of the Demonstration Turbine.

The Demonstration Turbine will be the principal visible element of the built scheme and the operations building may also be visible, however, in the context of the existing view this will not be significant. Cranes will also be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be *moderate-substantial* and will be significant. The Demonstration Turbine will have a material effect on the outlook that causes the baseline characteristics of the view to be redefined by its presence. This is due to the combination of factors that results in a very large magnitude of change, irrespective of the sensitivity of the viewpoint.

Viewpoint 2: Shore Street, Buckhaven

Grid reference: E335934 N697837
Approximate distance to demonstration turbine: 1.0 km
Approximate elevation: 5 m AOD
Receptor type: Residential
Landscape character type: Urban edge with coast
Landscape designation: None
Figure: 5.15b

Baseline view: Viewpoint 2 lies on the southern-most tip of Buckhaven, immediately below the FEP site, where views are less influenced by the general industrial character that typifies the coastal edge of the town and neighbouring Methil. Although lighting masts are clearly visible on the FEP site, the outlook is generally one of an open and expansive nature across the Firth of Forth as far as distant hills that define the southern shore, to the right of the view out of shot. The viewpoint has been selected to represent slightly more distant views available from some houses on the coastal edge of the town where industrial influences are also less prevalent.

Sensitivity: Unlike the previous view, this viewpoint has a *high* sensitivity, due to its representation of residential properties and the more scenic coastal qualities represented in the outlook.

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be *very large*, with the Demonstration Turbine being immediately apparent and providing the dominant influence in the view, despite the more oblique angle of visibility. This is due to the close proximity of the Demonstration Turbine, the width of view affected,

the high visibility of the Demonstration Turbine and the contrast that its scale, vertical form and movement will have on the baseline view.

As with viewpoint 1, it should be noted that the broad, open and horizontal nature of the coastal setting in which the Demonstration Turbine will be seen provides an appropriate receiving environment by limiting uncomfortable scale comparisons that can arise when turbines are located in smaller, more intimate and varied landscapes. The magnitude of change will, however, remain very large.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening earthworks screening all other site infrastructure. Cranes will also be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be *substantial* and will be significant. The Demonstration Turbine will have a material effect on the outlook that causes the baseline characteristics of the view to be redefined by its presence. This is primarily due to the combination of factors that results in a very large magnitude of change, although the high sensitivity of the viewpoint reinforces the effect.

Viewpoint 3: A955, Buckhaven

Grid reference: E335893 N699282
Approximate distance to demonstration turbine: 1.3 km
Approximate elevation: 25 m AOD
Receptor type: Residential/ road users
Landscape character type: Urban edge with Coastal Hills
Landscape designation: None
Figure: 5.15c

Baseline view: Viewpoint 3 is at the entrance to Buckhaven High School and has been selected to represent close views available from some houses that lie immediately north of the Demonstration Turbine within Buckhaven and neighbouring Methil, as well as from the school. The general built-up nature of the area north of the Demonstration Turbine has a considerable limiting effect on visibility, however, the slight elevation and more open nature of this viewpoint affords a rare view towards it. Industrial buildings and lighting masts on the FEP site are clearly visible above the roof lines of intervening houses.

Sensitivity: The viewpoint has a *high* sensitivity, due largely to its representation of residential properties.

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be between *large* and *very large*, with the Demonstration Turbine being immediately apparent and providing the predominant influence in the view. This slight reduction in magnitude compared with the previous two viewpoints is due primarily to increased distance, which reduces the perceived scale and vertical influence of the Demonstration Turbine. The presence of built development in the foreground also helps to screen the lower part of the Demonstration Turbine, which in turn reduces the vertical impact that it might otherwise have when seen at full height. Despite these factors, the proximity of the Demonstration Turbine, the relatively high visibility of the Demonstration Turbine and the contrast that its scale, vertical form and movement will have on the baseline view is such that it will remain the predominant influence in the view.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening buildings screening all other site infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be between *moderate-substantial* and *substantial* and will be significant. The Demonstration Turbine will have a material effect on the outlook that causes the baseline characteristics of the view to be redefined by its presence. This is primarily due to the combination of factors that results in a large to very large magnitude of change on a viewpoint of high sensitivity.

Viewpoint 4: Fife Coastal Path, East Wemyss

Grid reference: E334390 N697193
Approximate distance to demonstration turbine: 2.7 km
Approximate elevation: 30 m AOD
Receptor type: Walkers/ Residential/ Local amenity
Landscape character type: Coastal Hills
Landscape designation: None
Figure: 5.15d

Baseline view: Viewpoint 4 is located on Fife Coastal Path where it follows the perimeter of East Wemyss cemetery to Macduff's castle ruin. It has been included to represent close views from the long distance footpath where it follows a more rural route south-west of the Demonstration Turbine, as well as representing views from some houses on the eastern edge of the settlement. The view clearly shows the general character of the *coastal hills* landscape type in the foreground, through which the footpath passes following a tree lined route between two ploughed fields. In the middle distance, the built-up edge of Buckhaven is a noticeable component of the view as are lighting masts on the FEP site. Further to the right, out of shot, expansive views are obtained across the Firth of Forth in the vicinity of the ruined castle.

Sensitivity: This viewpoint has a *high* sensitivity due largely to its location on the long distance and sign posted footpath, as well as its representation of residential properties. People using the route will have an awareness of their surroundings and will be focussed on the landscape through which they are slowly passing. There are also scenic qualities in the coastal landscape seen in the view.

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be *large* with the Demonstration Turbine being immediately apparent and providing the prevailing influence in the view. The reduction in magnitude from very large to large is due primarily to increased distance, which reduces the perceived scale and vertical influence of the Demonstration Turbine in the view. The presence of foreground trees also has some beneficial scale comparison, as the trees lie closer to the viewer so reducing the perceived scale of the Turbine. Intervening built development and landform also ensures that visibility will be restricted to the upper parts of the Demonstration Turbine, which in turn helps to limit the vertical impact. Nevertheless the contrast in scale, vertical form and movement arising from the introduction of the Demonstration Turbine will be immediately apparent and will provide the defining influence in the view.

As with viewpoint 1, it should be noted that the relatively broad, open and horizontal nature of the coastal setting in which the Demonstration Turbine will be seen provides an appropriate receiving environment by limiting uncomfortable scale comparisons that can arise when turbines are located in smaller, more intimate and varied landscapes. The magnitude of change will, however, remain large.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening landform and built development screening all other site infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be *moderate-substantial* and will be significant, with the Demonstration Turbine having a material effect on the outlook that causes the baseline characteristics of the view to be redefined by its presence. This is due primarily to the combination of factors that results in a large magnitude of change, although the high sensitivity of the viewpoint reinforces the significance of the effect.

Viewpoint 5: Fife Coastal Path, Leven

Grid reference: E338522 N700654
Approximate distance to demonstration turbine: 2.8 km
Approximate elevation: 10 m AOD
Receptor type: Walkers/ Residential
Landscape character type: Urban edge with coast
Landscape designation: None
Figure: 5.15e

Baseline view: Viewpoint 5 is located on Fife Coastal Path where it follows the promenade at Leven. It has been included to represent close views from the long distance footpath north-east of the Demonstration Turbine at a point where urban and heavy industrial uses exert a significant influence on views in the direction of the FEP site. In the immediate foreground, Methil power station is clearly visible and dominates the view. To the right of the view, out of shot, residential properties along the sea front are orientated towards the coast and for the most part have no direct visibility towards the FEP site. Further to the left, also out of shot, the view extends across the Firth of Forth and it is just possible to distinguish the southern shoreline and line of hills behind silhouetted on the skyline.

Sensitivity: As with viewpoint 1, this viewpoint has a *medium* sensitivity. This is because although the right of way has a high sensitivity due to people using the route having an awareness of their surroundings, the proximity and position of the power station relative to the Demonstration Turbine lowers the sensitivity.

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be *medium* with the Demonstration Turbine being a readily apparent feature in the view, but with the baseline characteristics continuing to prevail.

There are a number of factors that limit the magnitude of change to medium. The principal factor that reduces the magnitude of change is the presence of Methil power station in the foreground, which partly screens the Demonstration Turbine. The power station also provides a beneficial scale comparison as it lies closer to the viewer so reducing the perceived scale of the Demonstration Turbine and the eye catching impact that it might otherwise have if it were the only or predominant vertical element in the view. Additionally, the broad, open and horizontal coastal setting in which the Demonstration Turbine will be seen provides an appropriate receiving environment by limiting uncomfortable scale comparisons that can arise when turbines are located in smaller, more intimate and varied landscapes.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening buildings screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view but this will not amount to a material change and it will not become the defining influence in the view. This is due to a combination of factors that restricts the magnitude of change and also lowers the sensitivity of the viewpoint.

Viewpoint 6: Kennoway

Grid reference: E335620 N701940
Approximate distance to demonstration turbine: 3.8 km
Approximate elevation: 55 m AOD
Receptor type: Residential

Landscape character type: Urban edge with Lowland Dens
Landscape designation: None
Figure: 5.15f and 5.16a

Baseline view: Refer to Figure 5.15f. The settlement of Kennoway lies directly north of the FEP site on south facing slopes that rise up to a low east-west orientated ridgeline. This landform ensures that many houses do gain long views towards the coast and where they are orientated towards the FEP site they will gain views of the Demonstration Turbine. The viewpoint is located on the southern edge of the settlement and is representative of views gained from the houses there. The view is generally open and expansive and reasonably attractive with arable fields and trees in the immediate foreground extending to the built-up edge of Leven and Methil. Warehousing is a noticeable and large-scale feature of the built-up edge whilst built development generally occupies middle distance views as far as the coast, which is just visible below the skyline. The steel fabrication plant and lighting masts on the FEP site are conspicuous features on the skyline, as is Methil power station to the far left of the view.

Sensitivity: The viewpoint has a *high* sensitivity due largely to its representation of residential properties even though there are a number of detracting features in the view.

Magnitude of change: Refer to Figure 5.15f. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to be between *medium and large* with the Demonstration Turbine being immediately apparent and providing one of the defining influences in the view along with the influence of the baseline characteristics. This is due to a combination of factors.

The principal factor that reduces the magnitude of change is the broad, open and relatively uniform nature of the view which provides an appropriate receiving environment for the Demonstration Turbine by limiting uncomfortable scale comparisons. The single turbine will occupy a small proportion of the view and this is also important as it will leave large parts of the baseline view unaffected. The presence of large-scale and vertical elements further helps to reduce the eye-catching impact that would otherwise be the case if the Demonstration Turbine were seen in isolation. Intervening built development also ensures that the Demonstration Turbine will not be seen at full height. The viewpoint is also just over 3.5 km from the Demonstration Turbine, at which distance the Demonstration Turbine does not constitute the predominant component in the view, although it will be readily apparent.

While these factors limit the magnitude of change, there are other factors that will increase it. The distance of the viewpoint from the Demonstration Turbine ensures that it will be seen in some detail, with movement providing a contrast with the visual setting. Furthermore, the view is a direct outlook from the houses that occupy an elevated position.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening vegetation and built development screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be between *moderate* and *moderate substantial* and will be significant, with the Demonstration Turbine having a material effect on the view that redefines the baseline characteristics. This is due to a combination of factors that results in a medium to large magnitude of change on a viewpoint of high sensitivity.

Cumulative magnitude of change: Refer to Figure 5.16a. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *medium* with the addition of the Demonstration Turbine providing a noticeable role in extending wind farm influence in the view.

Although Little Raith (19 km from the viewpoint) is theoretically visible from hub-height (9 turbines) in successive views to the right, in reality, distance, together with intervening vegetation, is such that this wind farm will either be screened or will have, at best, a very small influence. Thus any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the consented turbine at Methil Docks (3.5 km from the viewpoint).

The principal factor which reduces the cumulative magnitude of change is the small number of turbines visible in the view, in this case two. From this viewpoint, both turbines are seen in the same successive view from right to left and therefore occupy a relatively small proportion of the available outlook. This is important as it means that much of the baseline view will remain unaffected. The general built-up nature of the view, including the presence of other vertical influences, is also important as it reduces the eye catching impact that both turbines might have if they were the only vertical influences in the view. Intervening buildings also ensures that both turbines are not seen at full height.

Whilst these factors limit the magnitude of change, there are other factors that will increase it. The distance separating both turbines (approximately 2 km apart) is such that they will tend to read a separate developments rather than part of a slightly larger group. The viewpoint is also just over 3.5 km from both turbines, at which distance the disparity that exists between them in terms of height and blade configuration is quite evident and reinforces the impression of two quite separate developments. The Demonstration Turbine will also be the more prominent development in the view due to its greater height.

Significance of cumulative effect: The cumulative effect on this view is judged to be *moderate* and will be significant. The addition of the Demonstration Turbine will have a noticeable effect in extending wind farm influence on the view, with the prevailing characteristics of the view being redefined by the addition of the Demonstration Turbine. This is due to a combination of factors that results in a medium cumulative magnitude of change on a receptor of high sensitivity.

Viewpoint 7: Fife Coastal Path, Wemyss Castle

Grid reference: E332950 N695083
Approximate distance to demonstration turbine: 5.0 km
Approximate elevation: 5 m AOD
Receptor type: Walkers/ Local amenity
Landscape character type: Coastal Hills
Landscape designation: Edge of Wemyss candidate SLA/ Inventory site
Figure: 5.15g and 5.16b

Baseline view: Refer to Figure 5.15g. Viewpoint 7 lies on Fife Coastal Path directly below Wemyss Castle. It has been included to represent more distant views from the long distance footpath south-west of the FEP site at a point where the path adjoins the edge of Wemyss candidate Special Landscape Area (SLA) and Wemyss Inventory site. The view shows the particular character of the *Coastal Hills* landscape type where it meets the coast, in particular the wooded nature of the slopes that have a limiting effect on visibility from within the SLA and Inventory site. In the distance the built-up edge of Buckhaven is just visible on the coastal hilltops as are lighting masts on the FEP site, but neither are particularly intrusive features in the wider view. Further to the right, out of shot, expansive views are obtained across the Firth of Forth where the southern shoreline and silhouettes of hills behind are just visible.

Sensitivity: This viewpoint has a *high* sensitivity due to its location on the long distance footpath. There are also scenic qualities in the coastal landscape seen in the view.

Magnitude of change: Refer to Figure 5.15g. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to between *medium* and *large* with the Demonstration Turbine being immediately apparent and providing one of the defining influences in the view along with the influence of the baseline characteristics.

The principal factor that reduces the magnitude of change from large is the open, uniform and expansive nature of the coastal view in which the Demonstration Turbine will be seen, which provides an appropriate receiving environment by limiting uncomfortable scale comparisons. The single turbine will also occupy a small proportion of the view leaving large parts of the baseline view unaffected. The viewpoint is also 5.0 km from the Demonstration Turbine, at which distance the Turbine does not constitute the predominant component in the view, although it will be readily apparent.

While these factors limit the magnitude of change, there are other factors that will increase it. The distance of the viewpoint from the Demonstration Turbine ensures that it will be seen in some detail, with movement providing a contrast with the visual setting. Furthermore, the orientation of the view for users of the footpath heading north-east is directly towards the Demonstration Turbine from an open outlook.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening landform screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be between *moderate* and *moderate-substantial* and will be significant. The Demonstration Turbine will have a material effect on the outlook that causes the baseline characteristics of the view to be redefined by its presence. This is due to the combination of factors that results in a medium to large magnitude of change on a viewpoint of high sensitivity.

Cumulative magnitude of change: Refer to Figure 5.16b. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *small* with the addition of the Demonstration Turbine providing a small role in extending wind farm influence in the view.

This is partly due to the small number of turbines visible in the view, in this case the Demonstration Turbine in conjunction with the single consented turbine at Methil Docks (7 km from the viewpoint). From this viewpoint, both turbines are seen simultaneously in a particularly narrow angle of view where they occupy a very small proportion of the full available outlook. This is important as it ensures that much of the baseline view remains unaffected. The close proximity of the turbines is such that they are almost indistinguishable and this is also important as it ensures that they appear as part of a slightly larger development rather than two distinctly separate schemes. The disparity that exists between both turbines in terms of height and blade configuration will be less apparent from this viewpoint as the Methil Docks turbine is only visible from hub-height directly behind the Demonstration Turbine, which will naturally appear to be taller due to perspective.

Significance of cumulative effect: The cumulative effect on this view is judged to be *slight-moderate* and will be not significant. The addition of the Demonstration Turbine will have a small effect in extending wind farm influence on the view, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a small cumulative magnitude of change.

Viewpoint 8: Local Road West of Kennoway

Grid reference: E333215 N702644
Approximate distance to demonstration turbine: 5.5 km
Approximate elevation: 100 m AOD
Receptor type: Local amenity/ Road users
Landscape character type: Lowland River Basins
Landscape designation: None.
Figure: 5.15h

Baseline view: Viewpoint 8 is located on the local road between Markinch and Kennoway. The view extends across the gently undulating and intensively farmed *Lowland River Basins* landscape type, which occupies the whole of the view. The Firth of Forth is just visible as a narrow strip directly below the horizon. The chimney associated with Methil power station is also visible on the horizon to the left of the view and provides a useful reference point for the location of the FEP site and Demonstration Turbine. Power lines in the foreground are a noticeable and detracting influence on the outlook.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity north of the FEP site from relatively close by. Visibility of the Demonstration Turbine from this road and other local roads further to the north and west is quite limited and this view represents a rare glimpse towards it.

Sensitivity: This viewpoint has some sensitivity due to the rural nature of the view. However, the area is not covered by any landscape-related designations and it is not representative of residential views. The presence of detracting features also lowers sensitivity. As such, sensitivity of the viewpoint to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be *medium* with the Demonstration Turbine forming a readily apparent feature in the view, but with the baseline characteristics continuing to prevail.

There are a number of factors that limits the magnitude of change to medium. Firstly, the open and relatively uniform nature of the outlook provides an appropriate receiving environment by limiting uncomfortable scale comparisons. Secondly, the Demonstration Turbine will only occupy a limited proportion of the full available view leaving the remainder of the outlook unaffected. The slightly elevated nature of the intervening landform also ensures that the Demonstration Turbine will not be seen at full height, which further helps to limit its vertical influence. Thirdly, the presence of pylons in the view provides a beneficial scale comparison with the Demonstration Turbine as they lie closer to the viewer so reducing the perceived scale of the Turbine and ensuring that it appears relatively small in comparison with its visual setting. The pylons also provide vertical elements on the skyline and thus the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view is avoided. Finally, the viewpoint is 5.5 km from the Demonstration Turbine, at which distance the Turbine does not constitute the predominant component in the view, although it will be readily apparent.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening landform screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of Effect: The effect on this view is judged to be *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view but this will not amount to a material change and it will not become the defining influence in the view. This is due to a combination of factors that results in a medium magnitude of change on a viewpoint of medium sensitivity.

Viewpoint 9: Fife Coastal Path, Lower Largo

Grid reference: E340758 N702541
Approximate distance to demonstration turbine: 5.8 km
Approximate elevation: 15 m AOD
Receptor type: Walkers/ Residential
Landscape character type: Lowland Dens
Landscape designation: None, but Lower Largo is a Conservation Area
Figure: 5.15i and 5.16c

Baseline view: Refer to Figure 5.15i. Viewpoint 9 lies on Fife Coastal Path where it adjoins Lundin Golf Course on the western edge of Lower Largo. The slightly elevated nature of the viewpoint is such that it gains an open outlook across the golf course and Firth of Forth, and it is just possible to distinguish a line of distant hills silhouetted against the skyline that define the southern shoreline to the far left of the view, out of shot. In the centre of the view the redundant power station at Methil is a noticeable feature of the outlook, as is the steel fabrication plant and several lighting masts on the FEP site that lies directly behind and slightly to the left of the power station. To the right of the view, out of shot, residential properties along the sea front are mostly orientated towards the coast and for the most part have no direct outlook towards the FEP site.

The viewpoint has been included in the assessment as it makes a suitable representation of more distant views from the coastal path around Largo Bay, north-east of the FEP site, as well as representing views available from the golf course and a small number of residential properties that are orientated towards the FEP site directly behind the viewpoint.

Sensitivity: This viewpoint has a *high* sensitivity due to its location on the long distance and sign posted footpath, as well as its representation of residential properties. There are also some scenic qualities in the coastal landscape seen in the view.

Magnitude of change: Refer to Figure 5.15i. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage is judged to be *medium* with the Demonstration Turbine providing one of the defining influences in the view along with the influence of the baseline characteristics.

As with the previous viewpoint, there are a number of factors that limits the magnitude of change. The open, uniform and expansive nature of the coastal outlook provides an appropriate receiving environment for the Demonstration Turbine by limiting uncomfortable scale comparisons. The single turbine ensures that only a small proportion of the full available view will be occupied, leaving the remainder of the outlook unaffected. The presence of built elements in the view of a vertical nature is important as it limits the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view. The presence of Methil power station also provides a beneficial scale comparison with the Demonstration Turbine as it lies closer to the viewer so reducing the perceived scale of the Turbine and ensuring that it appears relatively small in comparison with its visual setting. The viewpoint is almost 6.0 km from the Demonstration Turbine, at which distance the Turbine does not constitute the predominant component in the view, although it will be readily apparent.

While these factors limit the magnitude of change, there are other factors that will increase it. The distance of the viewpoint from the Demonstration Turbine ensures that it will be seen in some detail, with movement providing a contrast with the visual setting. Furthermore, the view is a direct outlook towards the Demonstration Turbine for users of the footpath and for houses overlooking the golf course.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening built development screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view is judged to be *moderate* and will be significant with the Demonstration Turbine having a material effect on the view. This is due to a combination of factors that results in a medium magnitude of change and the high sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16c. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *small* with the addition of the Demonstration Turbine providing a small role in extending wind farm influence in the view.

Although Little Raith (24 km from the viewpoint) is theoretically visible from hub-height (9 turbines) as a simultaneous view, in reality, distance, together with intervening vegetation and landform, is such that this wind farm will either be screened or will be barely discernible. Thus any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the consented turbine at Methil Docks (4 km from the viewpoint).

The principle factor that limits the cumulative magnitude of change is the small number of turbines visible in the view, in this case just two. From this viewpoint, both turbines are seen simultaneously in a particularly narrow angle of view where they occupy a very small proportion of the full outlook available. This is important as it ensures that much of the baseline view remains unaffected. The close proximity of the turbines is such that they are almost indistinguishable and this is also important as it ensures that they appear as part of a slightly larger development rather than two distinctly separate schemes. Methil power station also has a strong influence on the view and reduces the eye catching impact that both turbines might have if they were the only vertical influences visible. The disparity that exists between both turbines in terms of height and blade configuration will be apparent at this distance, however, this is more a matter of detail and appearance rather than extending wind farm influence in the view.

Significance of cumulative effect: The cumulative effect on this view is judged to be *slight-moderate* and will be not significant. The addition of the Demonstration Turbine will have a small effect in extending wind farm influence on the view, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a small cumulative magnitude of change despite the high sensitivity of the receptor.

Viewpoint 10: Coaltown of Balgonie

Grid reference: E330579 N699699
Approximate distance to demonstration turbine: 6.3 km
Approximate elevation: 70 m AOD
Receptor type: Local amenity/ Road Users
Landscape character type: Lowland River Basins
Landscape designation: None
Figure: 5.15j and 5.16d

Baseline view: Refer to Figure 5.15j. Viewpoint 10 is located on a minor road that runs immediately east of Coaltown, joining with the B9130. This viewpoint gains an outlook towards the Demonstration Turbine across low lying and intensively farmed *Lowland River Basins* landscape type, which extends to the limit of the view. Large, modern agricultural buildings are conspicuous features in the foreground whilst pylons and the built-up edge of Methil are also visible components in the middle distance. The chimney associated with Methil Power Station is just visible on the horizon above a wooded area and provides a useful reference point for the location of the FEP site and Demonstration Turbine further to the right. Largo Law is also visible on the skyline to the far left of the view.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity west of the FEP site. Residential properties in Coaltown gain little or no visibility of the Demonstration Turbine due to the low lying landform on which the settlement lies and general orientation of houses on the edge of the settlement away from the FEP site.

Sensitivity: This viewpoint has some sensitivity due to the rural nature of the view. However, the area is not covered by any landscape-related designations and it is not representative of residential views. The presence of some detracting features also lowers sensitivity. As such, sensitivity to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: Refer to Figure 5.15j. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to be *medium* with the Demonstration

Turbine forming a readily apparent feature in the view, but with the baseline characteristics generally continuing to prevail.

This is due in part to the open outlook and, in this context the Demonstration Turbine will occupy only a limited proportion of the available view with the remainder of the outlook remaining unaffected. The relatively large-scale and horizontal nature of the foreground and middle distance landform also provides a beneficial scale comparison with the Demonstration Turbine ensuring that it appears relatively small in relation to its visual setting. The presence of detracting elements in the outlook of a vertical nature is also important as it limits the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view. The viewpoint is also 6.0 km from the Demonstration Turbine, at which distance the Turbine will not constitute the predominant component in the view, although it will be readily apparent.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening vegetation and landform screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view will be *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that contribute to the medium magnitude of effect and the medium sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16d. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *small* with the addition of the Demonstration Turbine providing a small role in extending wind farm influence in the view.

Although Little Raith (14 km from viewpoint) is theoretically visible from hub-height (9 turbines) in successive views to the right, in reality, distance, together with intervening vegetation, is such that this wind farm will either be screened or will have, at best, a very small influence. Thus any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the consented turbine at Methil Docks (7.5 km from viewpoint).

The principle factor that limits the cumulative magnitude of change is the small number of turbines visible, in this case just the Demonstration Turbine in conjunction with the single consented turbine at Methil Docks. From this viewpoint, both turbines are seen simultaneously where they occupy a relatively small proportion of the full available outlook and thereby leave much of the baseline view unaffected. Additionally, whilst Methil Docks turbine is theoretically visible from near full height, in reality it is likely that intervening vegetation and built development will limit visibility to the hub-height.

Significance of cumulative effect: The cumulative effect on this view is judged to be *slight* and will be not significant. The addition of the Demonstration Turbine may have a small effect in extending wind farm influence in the view, but the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a small cumulative magnitude of change.

Viewpoint 11: A916, north-east of Kennoway

Grid reference: E336996 N704771
Approximate distance to demonstration turbine: 6.5 km
Approximate elevation: 120 m AOD
Receptor type: Local amenity/ Road users
Landscape character type: Lowland Dens
Landscape designation: None

Figure: 5.15k and 5.16e

Baseline view: Refer to Figure 5.15k. Viewpoint 11 is located at the entrance to Letham Feus Caravan Park on the A916 north-east of Kennoway. This viewpoint is on rising ground and gains an outlook across undulating and intensively farmed *Lowland Dens* landscape type, which extends as far as a low tree lined ridge in the middle distance silhouetted against the back drop of the Firth of Forth. The chimney associated with Methil power station is noticeable above the treed ridgeline as is the steel fabrication plant and several lighting masts on the FEP site further to the right. Other incongruous elements in the view include modern agricultural buildings.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity north of the FEP site, as well as representing views from the road.

Sensitivity: This viewpoint has some sensitivity due to the rural nature of the view. However, the area is not covered by any landscape-related designations and it is not representative of residential views. The presence of some detracting features also lowers sensitivity. As such, sensitivity to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: Refer to Figure 5.15k. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to be *medium* with the Demonstration Turbine forming a readily apparent feature in the view, but with the baseline characteristics generally continuing to prevail.

This is due in part to the relatively open outlook and in this context the Demonstration Turbine will occupy only a limited proportion of the available view with the remainder of the outlook remaining unaffected. The relatively large-scale and horizontal nature of the foreground and middle distance view also provides a beneficial scale comparison with the Demonstration Turbine ensuring that it appears relatively small in relation to its visual setting. The presence of detracting elements in the outlook of a vertical nature is also important as it limits the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view. The viewpoint is some 6.5 km from the Demonstration Turbine, at which distance the Turbine will not constitute the predominant component in the view, although it will be readily apparent.

The Demonstration Turbine will be the only visible element of the built scheme, with intervening landform screening all other infrastructure. Cranes will be visible as a short-term effect during the construction and decommissioning periods. There will be no permanent, irreversible effects on the view.

Significance of effect: The effect on this view will be *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that contribute to the medium magnitude of change on the view and the medium sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16e. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *small* with the addition of the Demonstration Turbine providing a small role in extending wind farm influence in the view.

The wireline indicates that Little Raith (22 km from viewpoint) is theoretically visibility, with all 9 turbines seen from blade-tip as a successive view to the right of the Demonstration Turbine. In reality, distance, together with intervening vegetation and landform, is such that this wind farm will almost certainly be screened. Thus any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the consented turbine at Methil Docks (5 km from viewpoint).

The principle factor that limits the cumulative magnitude of change is the small number of turbines visible in the view, in this case just two. From this viewpoint, both turbines are seen simultaneously where they occupy a relatively small proportion of the full available outlook leaving much of the baseline view unaffected. Additionally, whilst Methil Docks turbine is theoretically visible from near full height, it is likely that intervening vegetation and landform will limit visibility to hub-height.

Significance of cumulative effect: The cumulative effect on this view is judged to be *slight* and will be not significant. The addition of the Demonstration Turbine may have a small effect in extending wind farm influence on the view, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a small cumulative magnitude of change.

Viewpoint 12: Largo Law

Grid reference: E342647 N704790
Approximate distance to demonstration turbine: 8.7 km
Approximate elevation: 285 m AOD
Receptor type: Walkers/ Local amenity
Landscape character type: Pronounced Volcanic Hills and Valleys outcrop/ Lowland Dens
Landscape designation: Edge of Largo Law candidate SLA
Figure: 5.15l and Figure 5.16f

Baseline view: Refer to Figure 5.15l. Viewpoint 12 is situated on the summit of Largo Law, a popular walking hill located on the edge of Largo Law candidate Special Landscape Area. Views from the summit in the direction of the FEP site and Demonstration Turbine extend across the lower slopes of the hill and clearly show the general character of the more extensive *Lowland Dens* landscape type that encloses the hill and continues as far as the coast. The coastal town of Lower Largo is a noticeable component of the view as are the slightly more distant towns of Leven, Methil and Buckhaven, which have coalesced. Methil power station with its chimney is also a conspicuous feature of the view as is the steel fabrication plant and several lighting masts on the FEP site. Beyond the coastal edge, expansive views are obtained further to the left across the Firth of Forth and it is just possible to see the southern shoreline and line of distant hills behind silhouetted against the sky.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity, including an area designated for its scenic qualities.

Sensitivity: This viewpoint has a *high* sensitivity due largely to its location within a designated landscape, despite the visible presence of a number of detracting features just beyond the designation boundary.

Magnitude of change: Refer to Figure 5.15l. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to be between *small* and *medium* with the Demonstration Turbine forming an apparent feature in the view, while the baseline characteristics continue to prevail.

This magnitude of change results from a number of considerations. The Demonstration Turbine will be visible, with its scale, vertical form and movement providing a contrast with the existing view. However, the large-scale and generally horizontal nature of the coastal view provides a beneficial scale comparison with the Demonstration Turbine ensuring that it will appear as a relatively small component within the visual setting. The wide, open outlook also ensures that the Demonstration Turbine will occupy a limited part of the full available view, with the remainder of the outlook remaining unaffected. The presence of Methil power station and, to a lesser extent, masts on the FEP site is also important as it introduces strong vertical elements into the outlook, thereby preventing the Demonstration Turbine from providing the eye-catching vertical impact that might otherwise occur if no other such elements are in the view. Finally, the distance of the Demonstration

Turbine from the viewpoint is nearly 9.0 km, which ensures that the Turbine will not be the defining influence in the view although it will be apparent.

Significance of effect: The effect on this view will be between *slight-moderate* and *moderate* but will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that restrict the magnitude of change on the view despite the high sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16f. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *very small* with the addition of the Demonstration Turbine providing a minor role in extending wind farm influence in the view.

The principal factor that limits the cumulative magnitude of change is the small number of turbines that are likely to be visible in the view. The wireline indicates that Little Raith (26 km from the viewpoint), Westfield (22 km from the viewpoint) and Lochelbank (32 km from the viewpoint) are all theoretically visibility in successive views to the right of the Demonstration Turbine. In reality, the distances involved, together with intervening vegetation and landform is such that all three wind farms will either be screened or will be barely discernible. Thus, any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the consented turbine at Methil Docks (7.0 km from viewpoint).

From this viewpoint, both turbines are seen simultaneously in a particularly narrow angle of view where they occupy a very small proportion of the full outlook available. This is important as it ensures that much of the baseline view remains unaffected. The close proximity of the turbines is such that they are almost indistinguishable and this is also important as it ensures that they appear as part of a slightly larger development rather than two distinctly separate schemes. Methil power station also has a strong influence on the view and reduces the eye catching impact that both turbines might have if they were the only vertical influences visible. The disparity that exists between both turbines in terms of height and blade configuration is likely to be apparent at this distance, however, this is a matter of detail and appearance rather than of extending wind farm influence in the view.

Significance of cumulative effect: The cumulative effect on this view is judged to be *slight* and will be not significant. The addition of the Demonstration Turbine may have some limited effect in extending wind farm influence on the view, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a very small cumulative magnitude of change.

Viewpoint 13: Fife Coastal Path, King Craig Point

Grid reference: E346177 N699830
Approximate distance to demonstration turbine: 9.5 km
Approximate elevation: 5 m AOD
Receptor type: Walkers/ Local amenity
Landscape character type: Pronounced Volcanic Hills and Valleys outcrop
Landscape designation: Edge of East Neuk candidate SLA
Figure: 5.15m and 5.16g

Baseline view: Refer to Figure 5.15m. Viewpoint 13 lies on Fife Coastal Path in the vicinity of King Craig Point, on the edge of East Neuk candidate Special Landscape Area. The view extends across Largo Bay to the opposite shoreline and more distant hills that lie beyond. The combined built-up edges of Leven, Methil and Buckhaven are visible spreading along the shore as is the steel fabrication plant and lighting masts on the FEP site. Methil power station is particularly noticeable and introduces a vertical element on the skyline. Further to the left, out of shot, the view extends across the Firth of Forth and it is just possible to detect a line of distant hills that define the southern shore.

The viewpoint has been included in the assessment as it represents the first available views towards the FEP site and Demonstration Turbine from the long distance footpath approaching from the east. It also makes a suitable representation of effects on local visual amenity, including an area designated for its scenic qualities.

Sensitivity: This viewpoint has a *high* sensitivity due largely to its location on the long distance footpath. There are also scenic qualities in the coastal landscape seen in the view.

Magnitude of change: Refer to Figure 5.15m. The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage is judged to be between *small* and *medium* with the Demonstration Turbine forming an apparent feature in the view, while the baseline characteristics continue to prevail.

This is due in part to the large-scale and strongly horizontal nature of the coastal view, which provides a beneficial scale comparison with the Demonstration Turbine ensuring that it will appear as a relatively small component within the visual setting. The wide, open outlook also ensures that the Demonstration Turbine will occupy a limited part of the full available view, with the remainder of the outlook remaining unaffected. The presence of detracting elements in the outlook of a vertical nature is also important as it limits the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view. Finally, the distance of the Demonstration Turbine from the viewpoint is some 9.5 km, which ensures that the Turbine will not be the defining influence in the view although it will be apparent.

Significance of effect: The effect on this view will between *slight-moderate* and *moderate* but will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that restrict the magnitude of change on the view despite the high sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16g. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *very small* with the addition of the Demonstration Turbine providing a minor role in extending wind farm influence in the view.

An important factor in determining the cumulative magnitude of change is the number of turbines that are likely to be visible in the view. The wireline indicates that Little Raith (28 km from the viewpoint) and Westfield (25 km from the viewpoint) are theoretically visible from blade-tip, in successive views to the right of the Demonstration Turbine. In reality, distance, together with intervening vegetation and landform is such that both wind farms will almost certainly be screened. Thus, any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the consented turbine at Methil Docks (8.0 km from the viewpoint).

From this viewpoint, both turbines are seen simultaneously in a relatively narrow angle of view where they occupy a small proportion of the full outlook available. Further, the proximity of the turbines is such that they appear as part of a slightly larger development rather than two distinctly separate schemes. Methil power station also has an influence on the view and reduces the eye catching impact that both turbines might have if they were the only vertical influences visible. The disparity that exists between both turbines in terms of height and blade configuration is likely to be apparent at this distance, however, this has little bearing on extending wind farm influence in the view.

Significance of cumulative effect: The cumulative effect on this view is judged to be *slight* and will be not significant. The addition of the Demonstration Turbine may have some limited effect in extending wind farm influence on the view, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a very small cumulative magnitude of change.

Viewpoint 14: Local Road East of Montrave

Grid reference: E340325 N707255
Approximate distance to demonstration turbine: 9.6 km
Approximate elevation: 150 m AOD
Receptor type: Local amenity/ Road users
Landscape character type: Pronounced Volcanic Hills and Valleys/ Lowland Dens
Landscape designation: On boundary of Tarvit and Ceres candidate SLA
Figure: 5.15n

Baseline view: Viewpoint 14 is located on the local road between Montrave and Woodside. The view extends across two landscape types, the gently undulating *Pronounced Volcanic Hills and Valleys* type in the immediate foreground and the more intensively farmed and wooded *Lowland Dens* type in the middle distance. The chimney associated with Methil power station is just visible on the skyline above an extensive wooded area. Further to the right, the steel fabrication plant and lighting masts on the FEP site are also visible as minor components of the view together with the built-up edge of Leven. The Firth of Forth can also be seen on the distant horizon.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity north of the FEP site, close to the limit of theoretical visibility indicated on the ZTV. Visibility of the FEP site from this road and other local roads in the vicinity is quite limited and this view represents a rare glimpse towards the Demonstration Turbine.

Sensitivity: This viewpoint has some sensitivity due to the rural nature of the view. However, the view is not covered by any landscape-related designations and it is not representative of residential views. As such, sensitivity to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: The magnitude of change on this view, as indicated by the ZTV, wireline and photomontage, is judged to be between *small* and *medium* with the Demonstration Turbine forming an apparent feature in the view, while the baseline characteristics continue to prevail.

This is due in part to the large-scale and horizontal nature of the landform, which provides a beneficial scale comparison with the Demonstration Turbine ensuring that it will appear as a relatively small component within the visual setting. The wide, open outlook also ensures that the Demonstration Turbine will occupy a limited part of the full available view, with the remainder of the outlook remaining unaffected. The wooded nature of the view is important as it helps to screen the lower part of the Demonstration Turbine, which in turn reduces the vertical impact that it might otherwise have when seen at full height. The presence of detracting elements in the outlook of a vertical nature is also important as it limits the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view. Finally, the distance of the Demonstration Turbine from the viewpoint is over 9.5 km, which ensures that the Turbine will not be the defining influence in the view although it will be apparent.

Significance of effect: The effect on this view will be between *slight* and *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that contribute to a small to medium magnitude of change on the view and the medium sensitivity of the viewpoint.

Viewpoint 15: A917

Grid reference: E345599 N702900
Approximate distance to demonstration turbine: 10.0 km
Approximate elevation: 35 m AOD
Receptor type: Local amenity/ Road users
Landscape character type: Coastal Terrace
Landscape designation: On boundary with Largo Law candidate SLA

Figure: 5.15o

Baseline view: Viewpoint 15 lies on the A917 approximately mid-way between Lower Largo and Elie. The general outlook seen from here shows the low lying and intensively farmed character of the *Coastal Terrace* landscape type where it has not been encroached upon by urban development. Apart from the occasional shelter belt and small coniferous plantation, vegetation is almost lacking and this affords expansive views across the Firth of Forth, further to the left of the viewpoint. In the centre of the view, across Largo Bay, Methil power station is just visible on the shoreline together with the steel fabrication plant and several lighting masts on the FEP site.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity east of the FEP site and Demonstration Turbine. Visibility of the Demonstration Turbine from this road and local roads further to the east is quite limited due to the low lying landform and presence of screening vegetation and so this view represents a rare glimpse towards the Turbine.

Sensitivity: This viewpoint has some sensitivity due to the rural nature of the view. However, the view is not covered by any landscape-related designations and it is not representative of residential views. As such, sensitivity to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to be between *small* and *medium* with the Demonstration Turbine forming an apparent feature in the view, while the baseline characteristics continue to prevail.

This is due in part to the large-scale and broadly horizontal nature of the landform, which provides a beneficial scale comparison with the Demonstration Turbine ensuring that it will appear as a relatively small component within the visual setting. The plantations in the foreground have a similar effect as they appear much larger than the Demonstration Turbine. The wide, open outlook also ensures that the Demonstration Turbine will occupy a limited part of the full available view, with the remainder of the outlook remaining unaffected. The presence of detracting elements in the outlook of a vertical nature is also important as it limits the eye-catching impact that the Demonstration Turbine might have if it was the only or predominant vertical element in the view. The viewpoint itself lies 10.0km from the Demonstration Turbine and this ensures that the Turbine will not constitute the predominant component of the view.

Significance of effect: The effect on this view will between *slight* and *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that contribute to a small to medium magnitude of change on the view and the medium sensitivity of the viewpoint.

Viewpoint 16: A921/ Fife Coastal Path, Kirkcaldy

Grid reference: E327948 N690334
Approximate distance to demonstration turbine: 12.0 km
Approximate elevation: 5 m AOD
Receptor type: Residential/ Walkers/ Cyclists/ Road Users
Landscape character type: Coastal Hills (with urban development)
Landscape designation: None
Figure: 5.15p

Baseline view: Viewpoint 16 lies on the promenade at Kirkcaldy from where extensive views are obtained along the coastline in the direction of the FEP site and Demonstration Turbine, as well as further to the right across the Firth of Forth. The general character of the *Coastal Hills* landscape type is evident in more distant views, but the immediate foreground has been extensively modified by built development which has encroached up to the coastal edge. Largo Law is just visible on the

distant skyline in the centre of the view, as is the coastline where it sweeps around to Shell Bay and King Craig Point. Methil power station and lighting masts on the FEP site are barely distinguishable.

The viewpoint has been included in the assessment as it is representative of mid-range views from the long distance footpath south-west of the FEP site and from some houses on the coastal edge of the town with available views. It also represents views from the A921 coastal road and from regional cycle route 63 where it follows the promenade.

Sensitivity: This viewpoint has a *high* sensitivity due largely to its location on the long distance footpath, as well as its representation of residential properties. There are also some scenic qualities in the coastal view despite the built-up nature of the area.

Magnitude of change: The magnitude of change on this viewpoint, as indicated by the ZTV, wireline and photomontage, is judged to be *small* with the Demonstration Turbine providing a small influence on the view.

There are a number of factors that limits the magnitude of change, of which distance is one with the viewpoint lying almost 12.0 km from the Demonstration Turbine. This ensures that the Demonstration Turbine will appear as a small component in the visual setting. The large-scale and broadly horizontal nature of the coastal view in which the Demonstration Turbine will be seen is also important as it provides an appropriate receiving environment by limiting uncomfortable scale comparisons. The wide expanse of the view available from here is important too, as only a small and distant part of it will be affected.

Not-withstanding this, the Demonstration Turbine will have some vertical impact on the horizontal nature of the view. This, together with movement ensures that the Demonstration Turbine will be apparent in the view, although the baseline characteristics will continue to define the view.

Significance of effect: The effect on this view will be *slight-moderate* and will be not significant. The Demonstration Turbine will have some effect on the view, but this will not result in a material change and it will not become the defining influence in the view. This is due to a combination of factors that contribute to a small magnitude of change on the view despite the high sensitivity of the viewpoint.

Viewpoint 17: Local Road North of Kinglassie

Grid reference: E323564 N699741
Approximate distance to demonstration turbine: 13.3 km
Approximate elevation: 150 m AOD
Receptor type: Walkers/ Road users/ Local amenity
Landscape character type: Pronounced Volcanic Hills and Valleys
Landscape designation: None
Figure: 5.15q and 5.16h

Baseline view: Refer to Figure 5.15q. Viewpoint 17 is located on a public footpath where it meets a minor road to the north of Kinglassie. The viewpoint gains an outlook towards the FEP site and Demonstration Turbine from across rising ground within the *Pronounced Volcanic Hills and Valleys* landscape type, which extends to the middle distance. The built-up edge of Glenrothes is just visible on the wooded ridgeline to the left of the view where gaps in the vegetation occur.

The viewpoint has been included in the assessment as it makes a suitable representation of effects on local visual amenity west of the FEP site from some distance. It also represents views from the right of way.

Sensitivity: This viewpoint has some sensitivity due to the largely rural nature of the view. However, the area is not covered by any landscape-related designations and it is not representative of residential views. As such, sensitivity to the Demonstration Turbine is judged to be *medium.*

Magnitude of change: Refer to Figure 5.15q. The magnitude of change on this viewpoint, as indicated by the ZTV and wireline is judged to be *small* with the Demonstration Turbine providing a small influence on the view that may be missed by the casual observer.

This is largely due to distance, the viewpoint lies over 13.0 km from the Demonstration Turbine from where it will appear as a small component in the view. The view is generally open and expansive and this provides an appropriate receiving environment for the Demonstration Turbine, limiting uncomfortable scale comparisons. The wide expanse of the view available is also important as only a small and distant part of the full outlook will be affected. The Demonstration Turbine will have some vertical impact in this predominantly horizontal view and it is this, together with movement, that will make it a visible component in the outlook.

Significance of effect: The effect on this view is judged to be *slight* and will be not significant. The Demonstration Turbine will have some limited effect on the outlook, but this will not result in a material change, and the prevailing characteristics of the view will continue to be defined by the baseline components. This is due to the combination of factors that contribute to a small magnitude of change and the medium sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16h. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be negligible with the addition of the Demonstration Turbine providing a barely discernible role in extending wind farm influence in the view.

The wireline indicates that Little Raith (9 km from the viewpoint) and Methil Docks turbine (14.5 km from the viewpoint) are theoretically visible in successive views, together with the Demonstration Turbine in close proximity to Methil Docks. In reality, distance together with intervening vegetation, landform and buildings is such that Methil Docks turbine will almost certainly be screened or be barely discernible. Thus, any potential for cumulative effects on the view lies chiefly between the Demonstration Turbine added to the nine consented turbines at Little Raith.

An important factor limiting cumulative magnitude is the number of turbines visible, in this case the Demonstration Turbine is adding one additional turbine to the consented situation. Distance is also important, and, as noted above, the Demonstration Turbine will appear as a small component of the view. Although both developments are widely spaced apart and will therefore read as two distinctly separate schemes, they will be seen in the context of an open and expansive view with the Demonstration Turbine in particular occupying a very small and distant part of it.

Significance of cumulative effect: The cumulative effect on this view is judged to be *neutral* and will be not significant. The addition of the Demonstration Turbine is unlikely to have any effect in extending wind farm influence on the view, and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to a combination of factors that results in a negligible cumulative magnitude of change.

Viewpoint 18: Fife Coastal Path, Kinghorn

Grid reference: E327614 N687574
Approximate distance to demonstration turbine: 14.2 km
Approximate elevation: 10 m AOD
Receptor type: Walkers
Landscape character type: Pronounced Volcanic Hills and Valleys/ Coastal Hills
Landscape designation: Edge of Cullaloe Hills and Coast candidate SLA
Figure: 5.15r

Baseline view: Viewpoint 18 lies on Fife Coastal Path north of Kinghorn, on the edge of Cullaloe Hills and Coast candidate Special Landscape Area. The outlook obtained from here is similar to that

seen in other views from the coastal path south-west of the FEP site, albeit the view is more distant and takes in a section of *Pronounced Volcanic Hills and Valleys* landscape type in the foreground.

The viewpoint has been included in the assessment as it represents the first available views towards the FEP site and Demonstration Turbine from the long distance footpath approaching from the south-west. It also makes a suitable representation of effects on local visual amenity, including an area designated for its scenic qualities.

Sensitivity: This viewpoint has a *high* sensitivity due to its location on the long distance footpath. There are also scenic qualities in the coastal landscape seen in the view.

Magnitude of change: The magnitude of change on this viewpoint, as indicated by the ZTV and wireline, is judged to be *small* with the Demonstration Turbine providing a small influence in the view that may be missed by the casual observer.

This is largely due to distance, the viewpoint is over 14.0 km from the FEP site from where the Demonstration Turbine will appear as a small component in the view. The view is open and expansive and this provides an appropriate receiving environment for the Demonstration Turbine, limiting uncomfortable scale comparisons. The wide expanse of the view available is also important as only a small and distant part of the full outlook will be affected. The Demonstration Turbine will have some vertical impact in this predominantly horizontal view and it is this that will make it a visible component in the outlook, together with movement. The orientation of the view for users of the footpath heading north-east is also directly towards the Turbine.

Significance of effect: The effect on this view is judged to be *slight-moderate* and will be not significant. The Demonstration Turbine will have some limited effect on the outlook, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline components. This is due to the combination of factors that contribute to the small magnitude of change in the view despite the high sensitivity of the viewpoint.

Viewpoint 19: East Lomond Hill

Grid reference: E324442 N706174
Approximate distance to demonstration turbine: 14.5 km
Approximate elevation: 450 m AOD
Receptor type: Walkers/ Local amenity
Landscape character type: Uplands/ Lowland River Basins/ Lowland Dens
Landscape designation: Lomond Hills candidate SLA
Figure: 5.15s and 5.16i

Baseline view: Refer to Figure 5.15s. Viewpoint 19 is situated on the summit of East Lomond Hill, a popular walking hill located within Lomond Hills Regional Country Park and candidate Special Landscape Area. Whilst coniferous woodland is present on the lower slopes of the hills, the more elevated parts are open and this allows panoramic views to be obtained over long distances. Views in the direction of the FEP site and Demonstration Turbine extend across the open *Uplands* landscape type in the immediate foreground and encompass the more extensive and settled *Lowland River Basins* and *Lowland Dens* landscape types that extend as far as the coast. Urban development associated with Glenrothes is a noticeable component of the view as are pylons generally. Methil power station is just visible on the coastline as a minor component of the wider outlook that includes Largo Law to the left of the view and the Firth of Forth further to the right.

The viewpoint has been included in the assessment as it lies in a particularly open and elevated part of the landscape north-west of the FEP site from where long views are available towards the Demonstration Turbine close to the limit of theoretical visibility indicated on the ZTV. The viewpoint also represents views from the Regional Country Park and candidate Special Landscape Area.

Sensitivity: This viewpoint has a *high* sensitivity due to its representation of the Regional Country Park and candidate Special Landscape Area designation. Visitors to this important recreational resource will have an interest in and focus upon views of the landscape.

Magnitude of change: Refer to Figure 5.15s. The magnitude of change on this viewpoint, as indicated by the ZTV and wireline is judged to be *small* with the Demonstration Turbine providing a small influence in the view that may be missed by the casual observer.

This is due largely to distance, the viewpoint lies over 14 km from the Demonstration Turbine, from where the Turbine will appear as a small component in the view. The view is open and expansive and this provides an appropriate receiving environment for the Demonstration Turbine, limiting uncomfortable scale comparisons. The wide expanse of the view available from here is also important, as only a small and distant part of the full outlook will be affected. Urban influences in the view will also reduce the eye-catching impact that the Demonstration Turbine might otherwise have. The Demonstration Turbine will have some vertical impact in this predominantly horizontal landscape and this, together with movement, will make it visible in clear conditions.

Significance of effect: The effect on this view is judged to be *slight-moderate* and will be not significant. The Demonstration Turbine will have some limited effect on the outlook, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to the combination of factors that contribute to a small magnitude of change on the view despite the high sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16i. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be negligible with the addition of the Demonstration Turbine providing a barely discernible role in extending wind farm influence in the view.

The (360°) wireline indicates that Lochelbank (14 km from the viewpoint), Little Raith (15 km from the viewpoint), Westfield (8 km from the viewpoint) and Methil Docks (15 km from the viewpoint) are theoretically visible in successive views, together with the Demonstration Turbine. In reality, distance together with intervening vegetation, landform and buildings is such that Lochelbank, Little Raith and Methil Docks will either be screened or will, at best, have a very small influence. Similarly, although Westfield lies much closer to the viewpoint, the wireline indicates visibility is limited to four blade-tips and it is likely that intervening landform and vegetation will mostly screen these.

Significance of cumulative effect: The cumulative effect on this view is judged to be *neutral* and will be not significant. The addition of the Demonstration Turbine is unlikely to have any effect in extending wind farm influence on the view, and the prevailing characteristics of the view will continue to be defined by the existing baseline characteristics. This is due to a combination of factors that results in a negligible magnitude of change.

Viewpoint 20: Local Road North-West of Kinghorn

Grid reference: E326110 N687866
Approximate distance to demonstration turbine: 15.0 km
Approximate elevation: 105 m AOD
Receptor type: Local amenity/ Road users
Landscape character type: Pronounced Volcanic Hills and Valleys
Landscape designation: Cullaloe Hills and Coast candidate SLA
Figure: 5.15t and 5.16j

Baseline view: Refer to Figure 5.15t. Viewpoint 20 is located on a minor road north-west of Kinghorn. The view from here extends across open, gently undulating and intensively farmed lower slopes of the *Pronounced Volcanic Hills and Valleys* landscape type, which occupies the foreground and middle distance view. The coastal town of Kirkcaldy is clearly evident below the horizon as are wooded coastal hills that continue further along the coast line towards the FEP site and Methil power

station, which is just distinguishable in the view. To the right, expansive views are obtained across the Firth of Forth.

The viewpoint has been included in the assessment as it lies in a relatively open and elevated part of the landscape south-west of the FEP site from where long views are available towards the Demonstration Turbine. The viewpoint also represents views from Cullaloe Hills and Coast candidate Special Landscape Area. Visibility of the Demonstration Turbine from this road and other local roads is, however, quite limited and this view represents a rare glimpse towards the Turbine.

Sensitivity: This viewpoint has a *high* sensitivity due largely to its representation of the candidate Special Landscape Area designation.

Magnitude of change: Refer to Figure 5.15t. The magnitude of change on this viewpoint, as indicated by the ZTV and wireline, is judged to be *small* with the Demonstration Turbine providing a small influence on the view that may be missed by the casual observer.

This is due largely to distance, the viewpoint lies 15 km from the Demonstration Turbine, from where the Turbine will appear as a small component in the view. The view is open and expansive and this provides an appropriate receiving environment for the Demonstration Turbine, limiting uncomfortable scale comparisons. The wide expanse of the view available from here is also important, as only a small and distant part of the full outlook will be affected. The Demonstration Turbine will have some vertical impact in this predominantly horizontal landscape and it is this that will make it visible in clear conditions, along with movement.

Significance of effect: The effect on this view is judged to be *slight-moderate* and will be not significant. The Demonstration Turbine will have some limited effect on the outlook, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to the combination of factors that contribute to a small magnitude of change on the view despite the high sensitivity of the viewpoint.

Cumulative magnitude of change: Refer to Figure 5.16j. The cumulative magnitude of change on this viewpoint, as indicated by the cumulative ZTV and wireline, is judged to be *negligible* with the addition of the Demonstration Turbine providing a barely discernible role in extending wind farm influence in the view.

This is partly due to the small number of turbines visible in the view, in this case the Demonstration Turbine in conjunction with the single consented turbine at Methil Docks (17 km from the viewpoint). Distance and the wide expanse of view available is also important, as this ensures that the turbines will appear as small components in the view. Both turbines are also seen in the same narrow angle of view and will therefore only occupy a very small and distant part of the full outlook available. The close proximity of the turbines is such that they are almost indistinguishable and ensures that they will appear as part of a slightly larger development. Furthermore, the disparity between both turbines in terms of height is less noticeable due to distance, but also because the Demonstration Turbine is seen in front of the Methil Docks turbine from this direction and naturally appears to be taller due to the effects of perspective.

Significance of cumulative effect: The cumulative effect on this view is judged to be *neutral* and will be not significant. The addition of the Demonstration Turbine is unlikely to have any effect in extending wind farm influence on the view, and the prevailing characteristics of the view will continue to be defined by the existing baseline characteristics. This is due to a combination of factors that results in a negligible cumulative magnitude of change.

Viewpoint 21: Gullane

Grid reference: E347899 N683064
Approximate distance to demonstration turbine: 19.0 km
Approximate elevation: 25 m AOD

Receptor type: Residential/ Local amenity
Landscape character type: Coastal Margins (East Lothian)
Landscape designation: Area of Great Landscape Value (East Lothian)
Figure: 5.15u

Baseline view: Viewpoint 21 is located at Gullane on the southern shore of the Firth of Forth. From here, expansive views are obtained across the coastal estuary in the direction of the FEP site and Methil power station. A line of distant hills that define the northern shoreline are just visible on the horizon, including Largo Law, but generally lack any detail. Methil power station forms a minor component of the outlook in clear conditions, but is barely distinguishable most of the time.

The viewpoint has been included in the assessment at the request of Scottish Natural Heritage. It represents the closest available views of the FEP site and Demonstration Turbine from along the southern shores of the Firth of Forth as well as representing views available from some houses on the coastal edge of the settlement.

Sensitivity: This viewpoint has a *high* sensitivity due largely to its representation of residential properties. There are also scenic qualities in the coastal landscape seen in the view.

Magnitude of change: The magnitude of change on this viewpoint, as indicated by the ZTV and wireline is judged to be *very small* with the Demonstration Turbine providing a minor influence on the view that is likely to be missed by the casual observer.

This is due largely to distance, the viewpoint lies 19 km from the Demonstration Turbine, from where the Turbine will appear as a minor component in views even in clear conditions. The large-scale and strongly horizontal nature of the coastal view is important as it provides an appropriate receiving environment for the Demonstration Turbine, limiting uncomfortable scale comparisons. The wide expanse of the view available from here is important too, as only a very small and distant part of the full outlook will be affected. The Demonstration Turbine will have some vertical impact in this horizontal landscape and it is this that will make it visible in clear conditions, with some movement likely to be discernible.

Significance of effect: The effect on this view is judged to be *slight* and will be not significant. The Demonstration Turbine may have a very limited effect on the outlook, but this will not result in a material change and the prevailing characteristics of the view will continue to be defined by the baseline characteristics. This is due to the combination of factors that contribute to a very small magnitude of effect on the view.

Technical Appendix A6

Noise

Technical Appendix A6.1

Turbine Noise Emission Data

2B DWAS Turbine - investigation of low frequency noise and broadband noise

Helge Aagaard Madsen

Risø-I-2757(EN)

Risø National Laboratory
Technical University of Denmark
Roskilde, Denmark
August 2008

Author: Helge Aagaard Madsen
Title: 2B DWAS Turbine - investigation of low frequency noise and broadband noise
Department: Department of Wind Energy

Risø-I-2757(EN)
August 2008

Abstract (max. 2000 char.):
The noise characteristics of a turbine design with a two-bladed downwind rotor with active stall control (the DWAS concept) have been simulated. This comprises both low frequency noise (LFN) as well as broadband noise (BN).

LFN has been simulated with the model of Viterna[3] and the aerodynamic input to this model, which are time traces of thrust and torque, have been simulated with the aeroelastic code HAWC2. Three different rotor positions relative to the four legged tower have been investigated. At low frequencies (below 10 Hz) the case with the rotor parallel to one side of the tower gives the highest LFN but this is opposite at higher frequencies where the case with the turbine rotor turned 22 deg. relative to the tower gives the highest LFN. The directivity of the noise has also been investigated showing the lowest LFN in a plane coinciding with the rotor plane. These two findings indicate, that the rotor orientation can be chosen so as to minimize the LFN at neighboring locations to the turbine. The influence of the drag on the tower legs has been investigated and there seems to be a rather weak relation with about 1 dB for an increase in CD for the tower legs of 0.1. Influence of wind speed is also rather low but can be more pronounced if the rotor speed is a function of wind speed. Finally, it should be noted that the velocity deficits from the tower legs have been modeled with a steady model which cannot take into account any possible vortex shedding from the tower legs. Previous studies have shown that vortex shedding can increase LFN considerably and should be avoided.
Broadband noise has been simulated with the model of Brooks, Pope and Marcolini[5] which models the self noise from the blade such as trailing edge noise as well as turbulent inflow noise. A total A-weighted sound power level of around 106 dB was computed. As for the LFN the rotor speed is an important parameter for the level of BN.

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Information Service Department
Risø National Laboratory
Technical University of Denmark
P.O.Box 49
DK-4000 Roskilde
Denmark
Telephone +45 46774004
bibl@risoe.dk
Fax +45 46774013
www.risoe.dtu.dk

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Preface

This work has been carried out on contract for 2-B Energy Holding B.V. and is confidential.

1 Summary

The noise characteristics of turbine design with a two-bladed downwind rotor with active stall control (the DWAS concept) have been simulated. This comprises both low frequency noise (LFN) as well as broadband noise (BN).

LFN has been simulated with the model of Viterna[3] and the aerodynamic input to this model, which are time traces of thrust and torque, have been simulated with the aeroelastic code HAWC2. Three different rotor positions relative to the four legged tower have been investigated. At low frequencies (below 10 Hz) the case with the rotor parallel to one of the tower sides gives the highest LFN but this is opposite at higher frequencies where the case with the turbine rotor yawed 22 deg. relative to the tower gives the highest LFN. The directivity of the noise has also been investigated showing the lowest LFN in a plane coinciding with the rotor plane. These two findings indicate, that the rotor orientation can be chosen so as to minimize the LFN at neighboring locations to the turbine. The influence of the drag on the tower legs has been investigated and there seems to be a rather weak relation with about 1 dB increase of LFN for an increase in CD for the tower legs of 0.1. Influence of wind speed is also rather low but can be more pronounced if the rotor speed is a function of wind speed. Finally, it should be noted that the velocity deficits from the tower legs have been modeled with a steady model which cannot take into account any possible vortex shedding from the tower legs. Previous studies have shown that vortex shedding can increase LFN considerably and should be avoided.

Broadband noise has been simulated with the model of Brooks, Pope and Marcolini[5] which models the self noise from the blade such as trailing edge noise as well as turbulent inflow noise. A total A-weighted sound power level of around 106 dB was computed. As for the LFN the rotor speed is an important parameter for the level of BN.

2 Introduction

The overall objective of the present work is to investigate and compute the aeroacoustic characteristics of the 2B DWAS turbine design. The broadband noise (BN) emission is a common characteristic for wind turbines but in the present case focus will also be on the low frequency noise (LFN) as a down wind rotor concept is considered. For a downwind rotor the blades pass through the velocity deficit behind the tower and this causes a considerable variation in lift on the blades which is the source of low frequency noise, Figure 1. On the upwind side of the tower the disturbances of the flow are much less Figure 1, and so also the dynamics in lift are low. Therefore LFN is generally not considered to be a problem for turbines with upwind rotors.

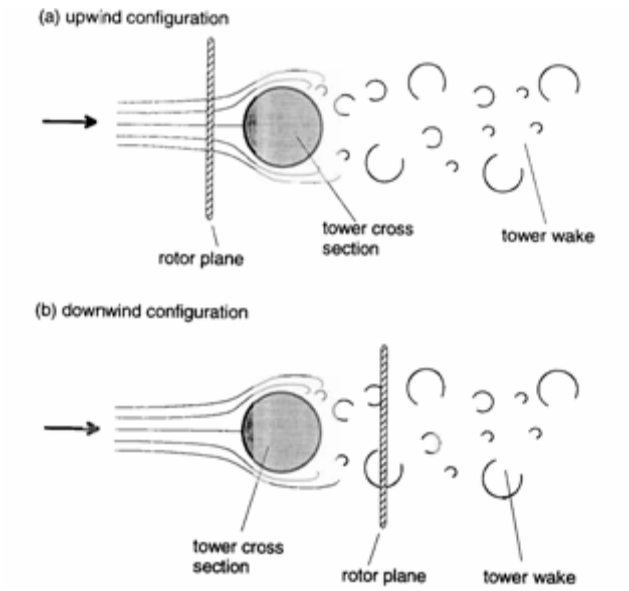


Figure 1 *The disturbed flow behind the tower results in highly unsteady aerodynamic blade forces which in the final end is the main cause of low frequency noise (illustration from Wagner[1]..*

2.1 Low frequency noise – background

In the period from around 1975 to 1990 a number of MW two-bladed turbines with down-wind rotors were build in USA and Sweden. A lot of experience on low frequency noise has been learned from these prototype machines. One general characteristic of the noise was that it could vary considerably in time and the causes for this were not clear at that time. However, in a recent study[2] it has been shown that the vortex shedding from a cylindrical tower can increase the LFN from 5-20 dB or even more if the Strouhal

1 Wagner, S., Bareiss, R., Guidatti, G. "Wind Turbine Noise". Springer –Verlag Berlin Heidelberg 1996. European Commission (DGXII), EUR 16823.

2 Madsen, H.A., Johansen, J., Sørensen, N.N., Larsen, G.C. and Hansen, M.H. "Simulation of Low frequency Noise from a Downwind Wind Turbine Rotor. Paper AIAA 2007-623 presented at 45th AIAA Aerospace Sciences Meeting and Exhibit, 8-11 January 2007, Reno, Nevada, US.

number for the vortex shedding from the tower coincides with the blade passing frequency. The vortex shedding should therefore be avoided.

The research activities on LFN in this period led to the development of a prediction code for LFN which will be briefly described below.

3 The modeling of low frequency noise

3.1 The acoustic model

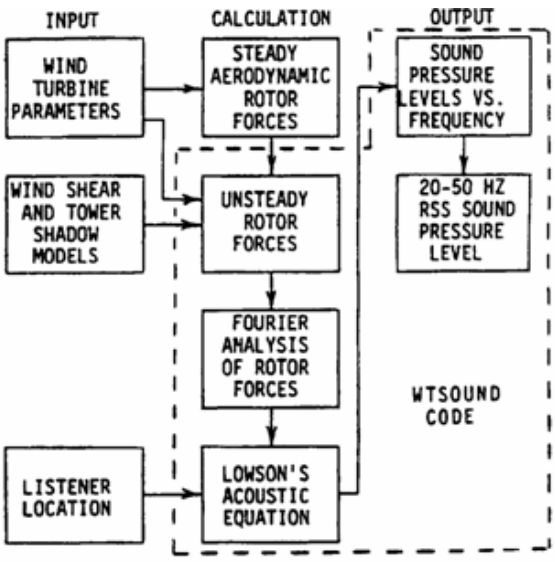


Figure 2 The original flow chart of Viterna showing the main components and steps in computation of low frequency noise. (from Viterna[3]).

The model is based on established theories and methods for computation of propeller and compressor noise. In a compressor there are stationary blade rows and behind them follows rotating blades which are passing through the velocity deficits and disturbances of the stationary blades. Lowson[4] has developed a general theory for such cases relating the sound pressure level (SPL) to the Fourier coefficients for the unsteady aerodynamic forces on the blades.

A number of assumption and simplifications have been made in the theory of Lowson in order to end up with a relatively compact model. One of the assumptions is to concentrate the unsteady aerodynamic forces on the blades at one radial station. However, for observation points not too close to the turbine this seems to be reasonable.

3 Viterna, L.A. ”Method for Predicting Impulsive Noise Generated by Wind Turbine Rotors”. Presented at Second DOE/NASA Wind Turbine Dyn. Workshop, Cleveland, 1981.

4 Lowson, M.V. ”Theoretical Analysis of Compressor Noise Evaluation”. J. Acoust. Soc. Am. , 47, 1 (part 2), pp 371-385, 1970.

To compute the unsteady aerodynamic forces the general aeroelastic code HAWC2 developed at Riso DTU is used. The HAWC2 code has different sub-models to handle the computation of the unsteady blade aerodynamics such as the Beddoes Leishman model for unsteady blade aerodynamics.

A verification example from the original paper of Viterna is show in Figure 3.

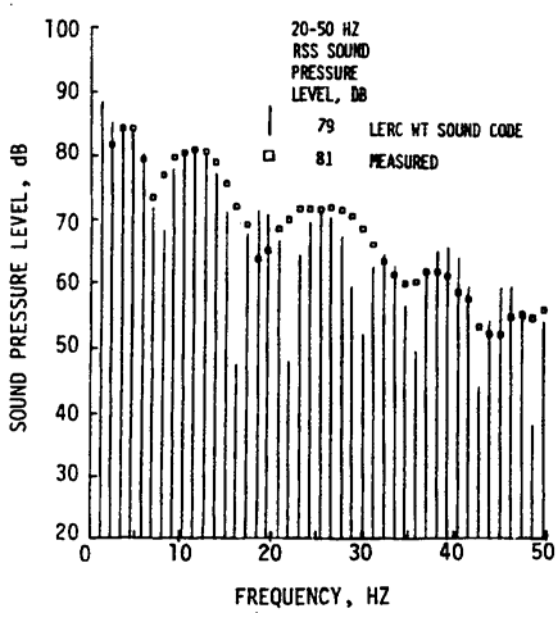


Figure 3 *A verification example of the LFN code from Viterna[3] showing sound pressure level SPL in a distance of a about 80 m from the MOD1 turbine*

3.2 Modelling of the velocity deficit behind the tower

The modeling in the aeroelastic code HAWC2 of the velocity deficit behind a cylindrical tower is based on a so-called source model of the initial deficit behind the tower Figure 4 and another model for development of this deficit further downstream the tower. This latter model is a called the JET model as it is based on the boundary layer equations for a jet flowing into a fluid at rest. An example of the deficits at different distances behind the tower is shown in Figure 5. As input to the wake deficit model the drag coefficient of

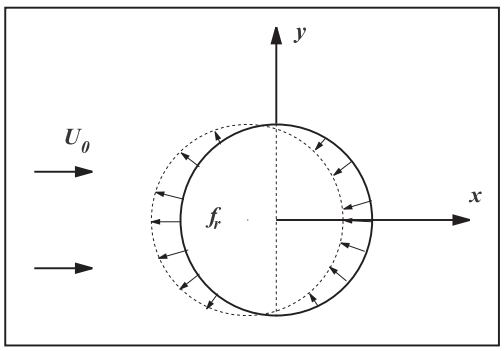


Figure 4 *The source model for computation of the wake deficit behind the tower is comprised of radial directed volume forces distributed along a circle, a so-called actuator cylinder.*

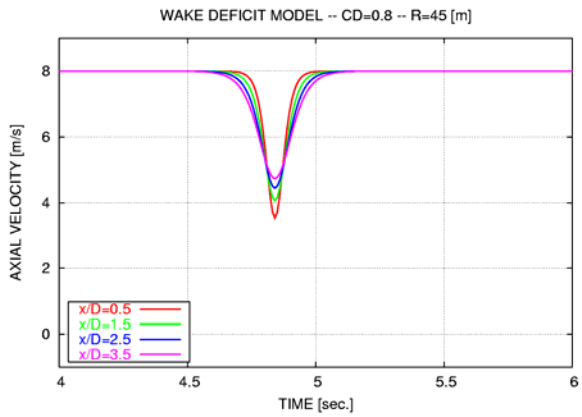


Figure 5 *An example of the velocity deficits behind the tower seen from a point on the blade in radius 45 m and at different distances from the tower (non-dimensional with tower diameter)*

the tower must be chosen and this will typically be in the range from 0.6 to 0.8. Further details of the tower velocity deficit modeling can be found in Madsen[2].

3.3 Multiple cylindrical tower legs

In the present tower design a four leg tower is considered. Such a design can without any simplifications structurally be modeled in HAWC2 as it is a multibody code. However, the modeling of the velocity deficit behind the individual tower legs is simplified as the deficits are computed individually and finally the deficits are combined. An example of how the deficits are combined are shown in Figure 10, Figure 11and Figure 12 where the influence from the two legs closest to the rotor is shown in Figure 10 and for the pair of legs further downstream in Figure 11. For the latter wakes it can be seen that they have spread further out compared with the deficit in Figure 10. Noise has been investigated for the rotor in three different positions relative to the tower as illustrated in Figure 7, Figure 8 and Figure 9. The corresponding deficits are shown in Figure 12, Figure 13, and Figure 14

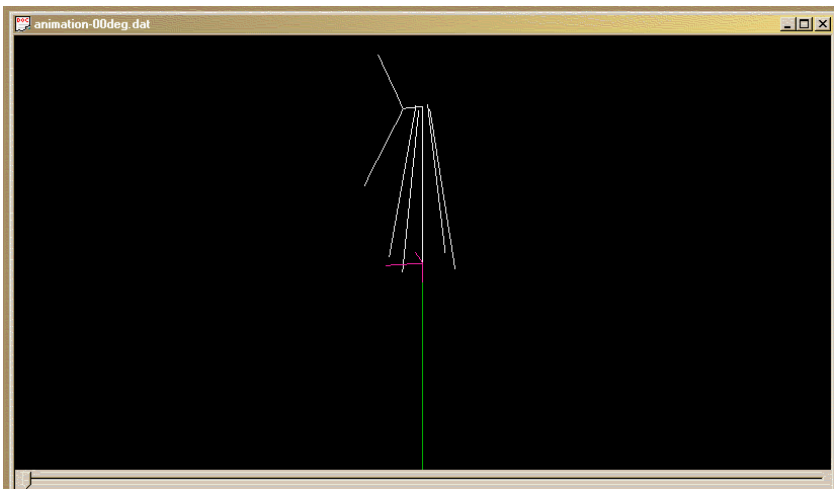


Figure 6 *Model of the2B DWAS turbine in HAWC2.*

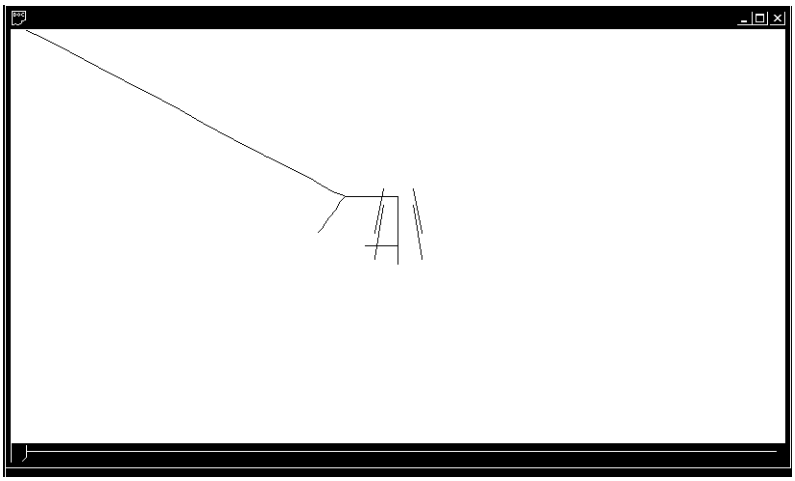


Figure 7 *The turbine rotor in pos. 1 relative to the tower. This means that the rotor shaft axis is perpendicular to one side in the tower.*

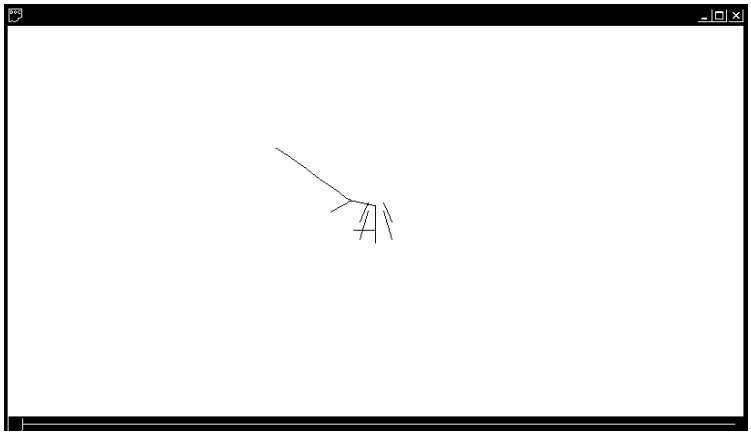


Figure 8 *The turbine rotor in pos. 2 relative to the tower. This means that the rotor shaft axis is turned 22. deg. relative to pos 1.*

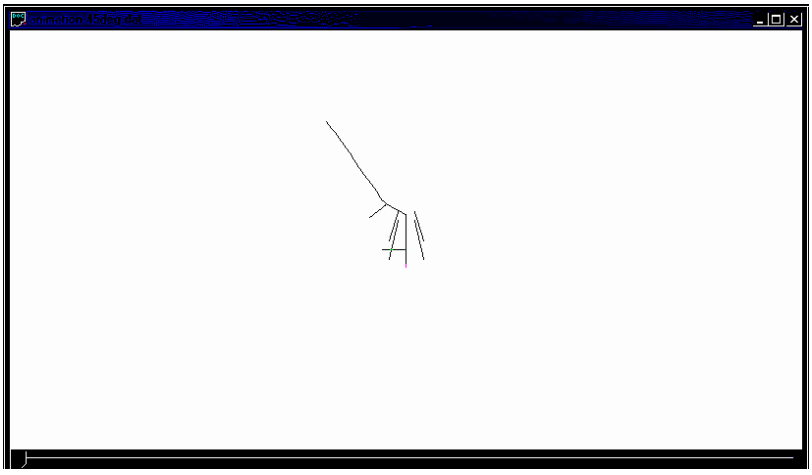


Figure 9 *The turbine rotor i pos 3 relative to the tower. This means that the rotor shaft axis is turned 45 deg. relative to pos 1 and is again aligned with two tower legs.*

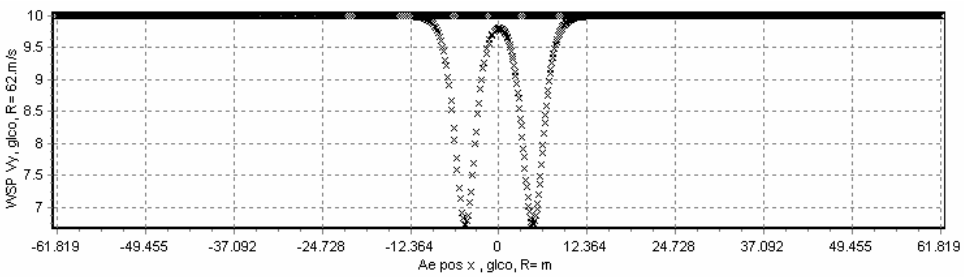


Figure 10 *Axial velocity with influence of only the two legs closest to the tower as function of lateral position for the tip of the blade (see the turbine model in Figure 7).*

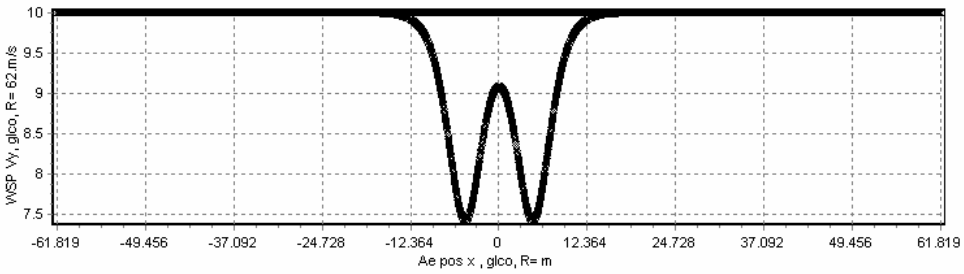


Figure 11 *Axial velocity with influence of only the two legs most far downstream the tower as function of lateral position for the tip of the blade (see the turbine model in Figure 7).*

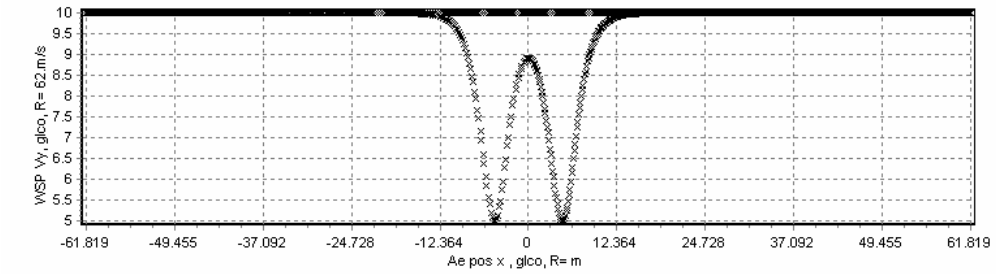


Figure 12 *Axial velocity with influence of all four legs as function of lateral position for the tip of the blade (see the turbine model in Figure 7).*

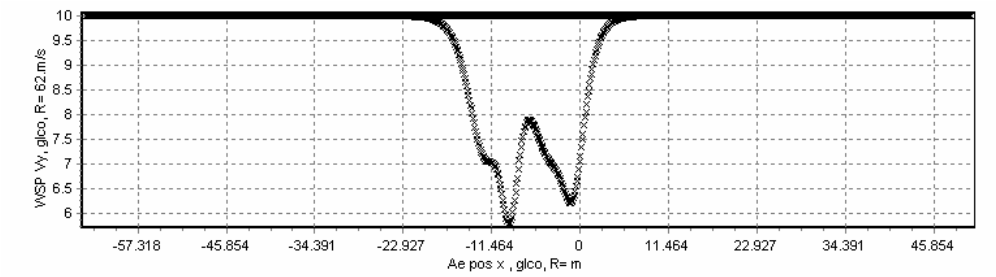


Figure 13 *Axial velocity with influence of all four legs as function of lateral position for the tip of the blade – rotor in position 2 (see the turbine model in Figure 8).*

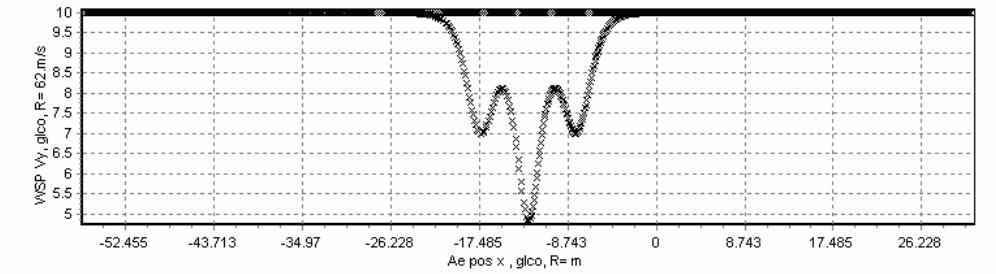


Figure 14 *Axial velocity with influence of all four legs as function of lateral position for the tip of the blade – rotor in position 3 (see the turbine model in Figure 9).*

4 Computations on tower configuration OWEC-1

4.1 Assumptions/parameters in computations

In the computations the influence of the diagonals were not modeled.

The drag coefficient of the tower legs was set to 0.8.

Side length between tower legs: 3.92 m at tower top and 14.14m at tower bottom

Diameter of tower legs: 1.2 m

Turbine structure was assumed stiff.

However, the blade tip deflection was modeled by adjusting the cone on the rotor so that the blade tip position should be the same as for the flexible blade. The following coning was used:

Table 1 The tip deflection modelled by change in coning.

V m/s	tip deflection [m]	eq. coning [deg.]	total coning [deg.]
8	**3.45**	**3.11**	**9.11**
10	**4.41**	**3.98**	**9.98**
12	**5.27**	**4.76**	**10.76**
14	**6.25**	**5.65**	**11.65**
16	**6.75**	**6.10**	**12.10**

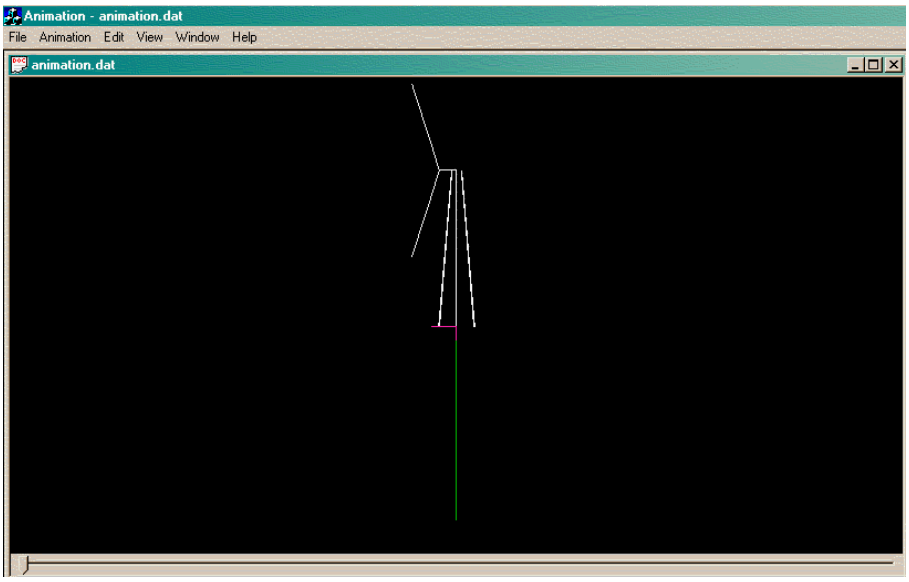


Figure 15 The turbine according to tower configuration OWEC-1 – tower legs 1.2 m in diameter.

4.2 Input to the noise computation

As mentioned in the description of the LFN model the input to this model are the Fourier coefficients of thrust and torque, respectively. An example of the time traces is shown in Figure 16 and Figure 17 for thrust and torque, respectively. The variations in thrust and torque originate from the variation in lift on the blades. An example of the variation of the lift at the tip of a blade as function of lateral position is shown in Figure 18.

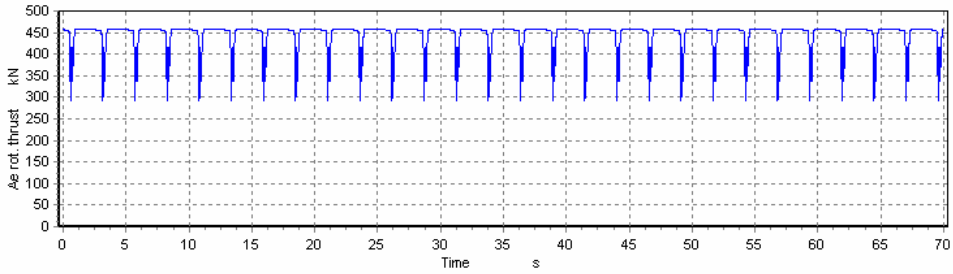


Figure 16 *Computed thrust as function of time at 10 m/s and the rotor i pos. 1 relative to the tower.*

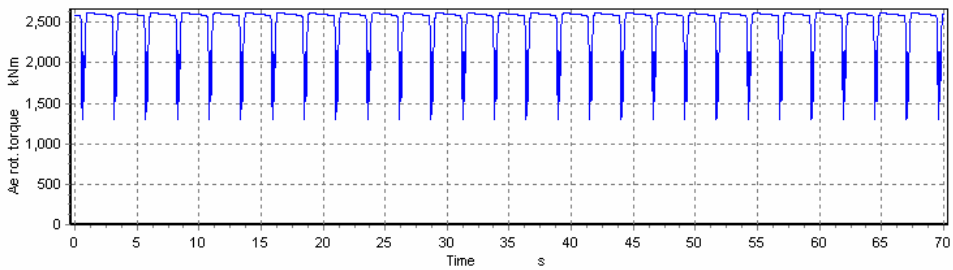


Figure 17 *Computed thrust as function of time at 10 m/s and the rotor i pos. 1 relative to the tower.*

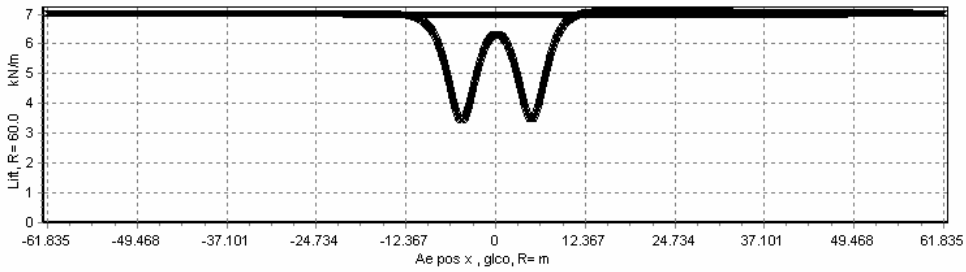


Figure 18 *Lift et the tip of the blade as function of lateral position.*

4.3 Computed sound pressure levels (SPL) for 8 m/s, 10 m/s, 12 m/s, 14 m/s and 16 m/s

The sound pressure level at a distance of 400 m downstream the turbine is shown for wind speeds of 8 m/s, 10 m/s, 12 m/s, 14 m/s and 16 m/s in Figure 19 to Figure 23 and for the rotor in position 1 (0 deg.), position 2 (22 deg.) and position 3 (45 deg.) relative to the tower (see Figure 7, Figure 8 and Figure 9 for definition of these positions.

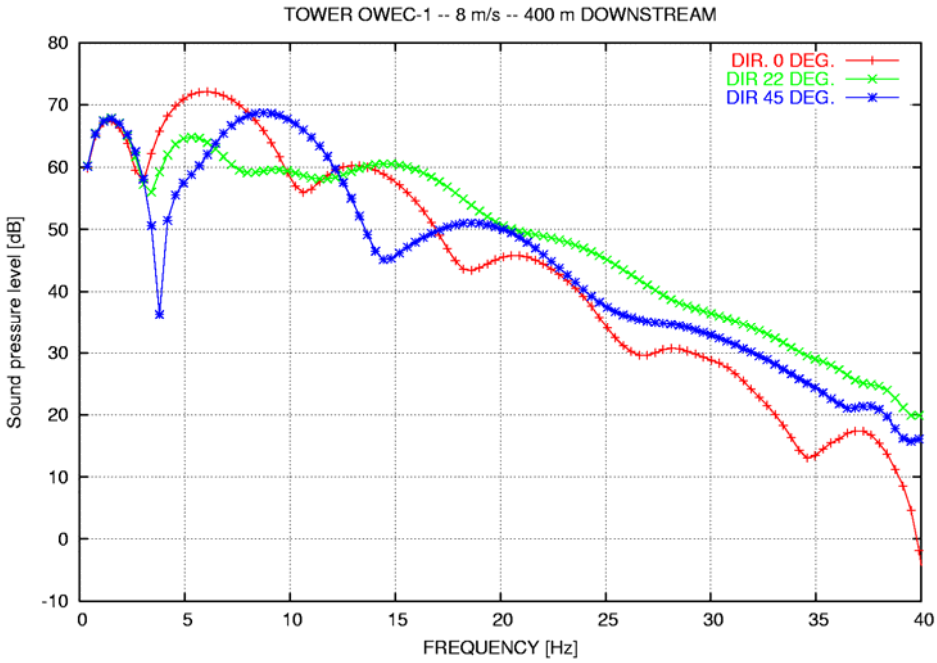


Figure 19 *Computed SPL for tower configuration OWEC-1 and at 10 m/s for different inflow angles to the rotor (0 deg. is perpendicular to one tower side).*

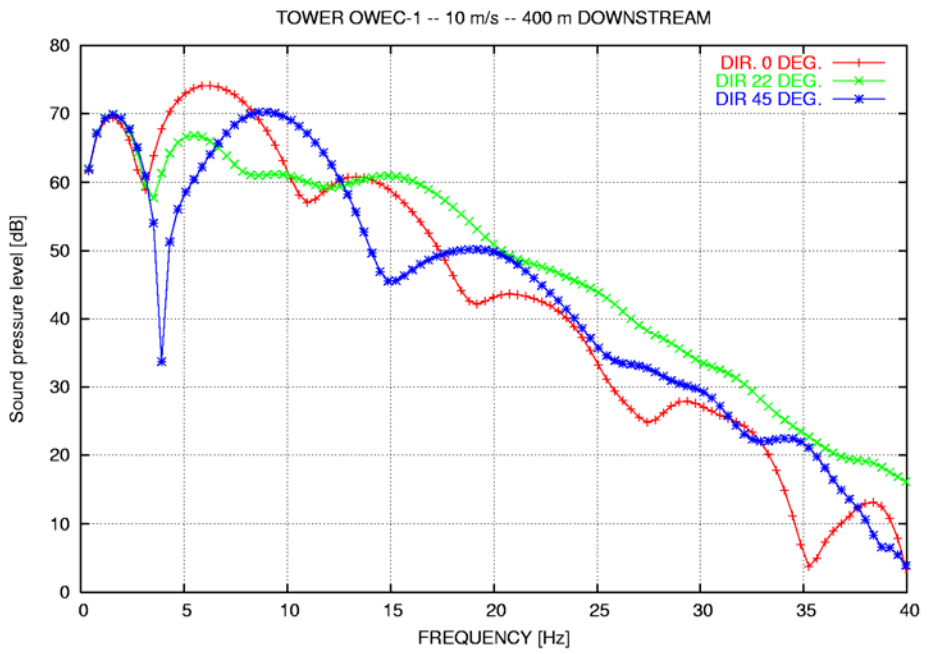


Figure 20 *Computed SPL for tower configuration OWEC-1 and at 10 m/s for different inflow angles to the rotor (0 deg. is perpendicular to one tower side).*

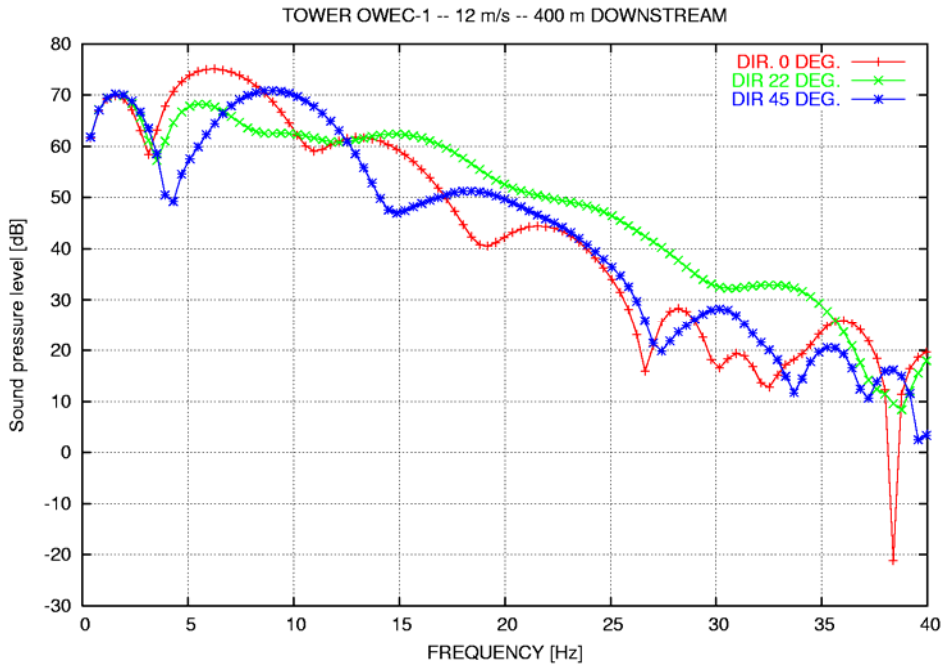


Figure 21 *Computed SPL for tower configuration OWEC-1 and at 12 m/s for different inflow angles to the rotor (0 deg. is perpendicular to one tower side).*

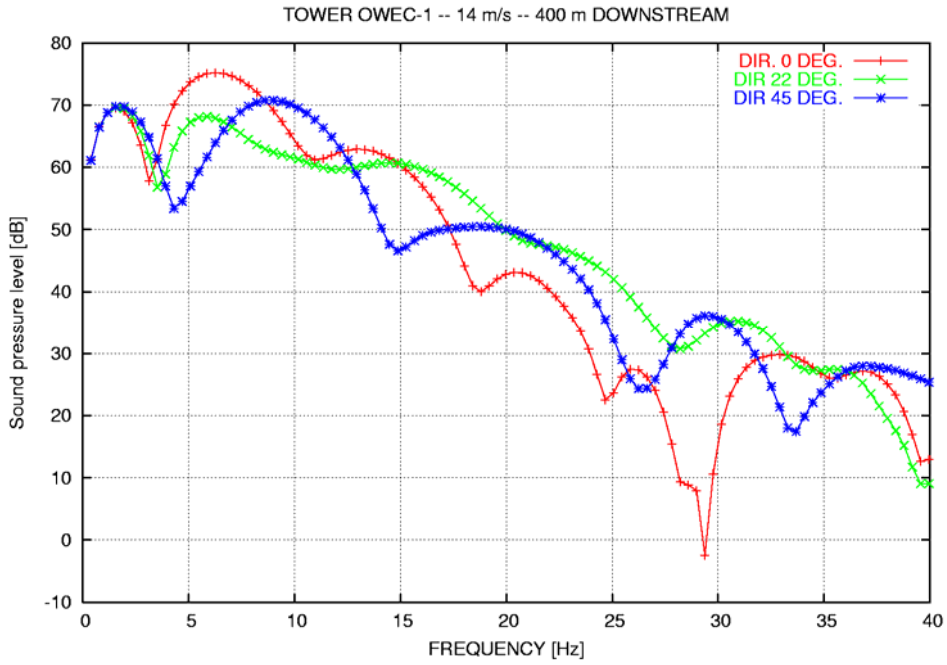


Figure 22 *Computed SPL for tower configuration OWEC-1 and at 14 m/s for different inflow angles to the rotor (0 deg. is perpendicular to one tower side).*

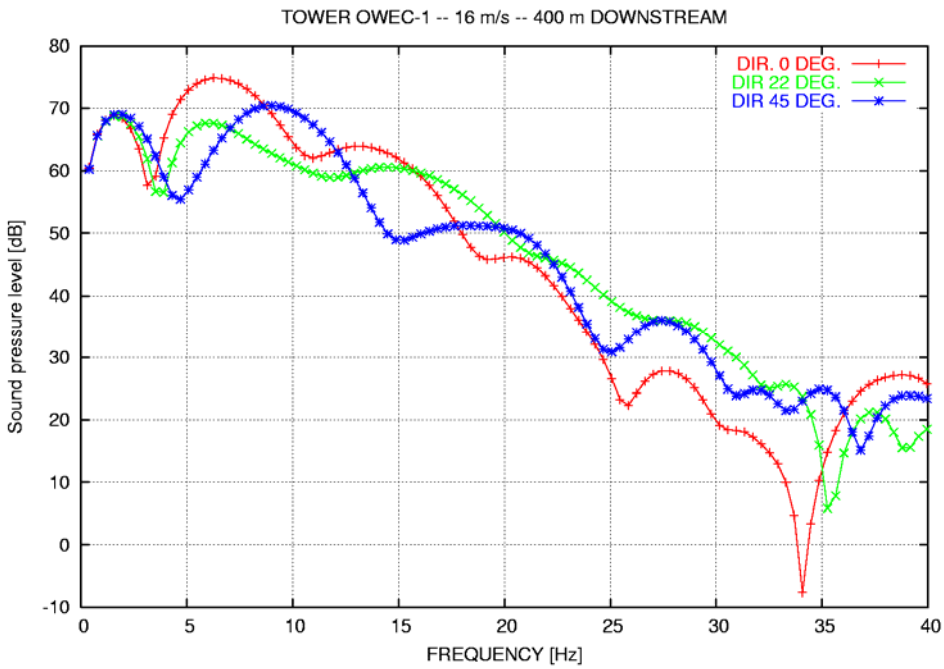


Figure 23 *Computed SPL for tower configuration OWEC-1 and at 16 m/s for different inflow angles to the rotor (0 deg. is perpendicular to one tower side).*

4.4 SPL as function of wind speed for rotor/tower relative direction 0 deg.

The SPL as function of wind speed is compared in Figure 24. It is seen that SPL is a relative weak function of wind speed with the biggest difference from 8 to 10 m/s. This can be explained by the slightly lower rotor speed at 8 m/s compared with the rotor speed at the other wind speeds.

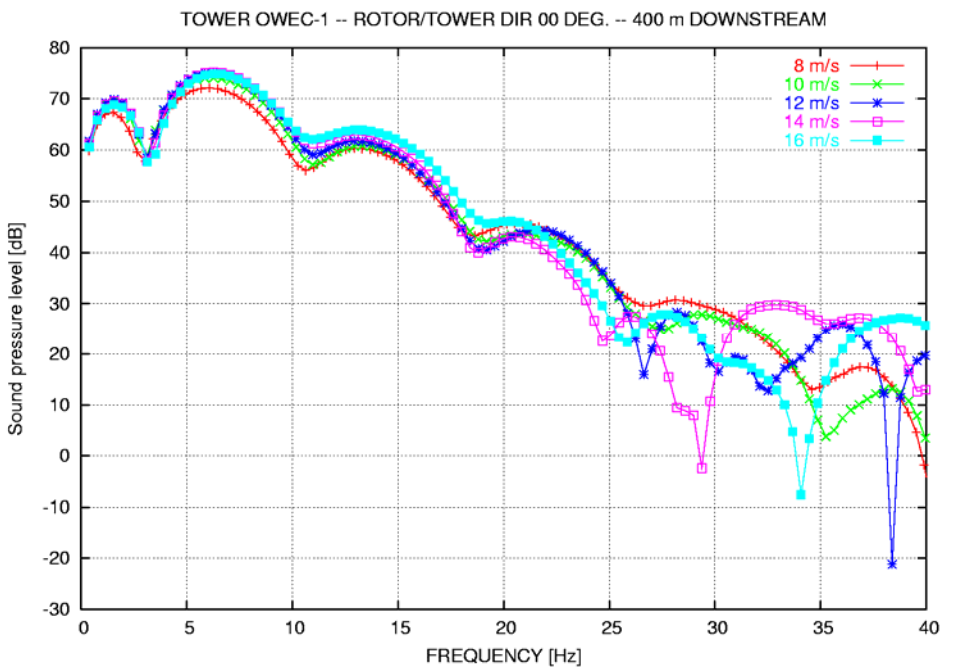


Figure 24 *SPL as function of wind speed for the rotor/tower relative direction 0 deg. (pos.1).*

4.5 Directivity at 8 M/S

The directivity has been computed at 8 m/s for all three rotor/tower positions. The comparison is based on the integral of the spectrum for 5-15 Hz and is shown in Figure 25. It appears, that the directivity is almost the same for the different rotor/tower configurations with a considerable lower noise for the listener in the plane of the rotor (lateral position away from the rotor). The SPL spectra for the different listener directions are shown in Figure 26, Figure 27 and Figure 28.

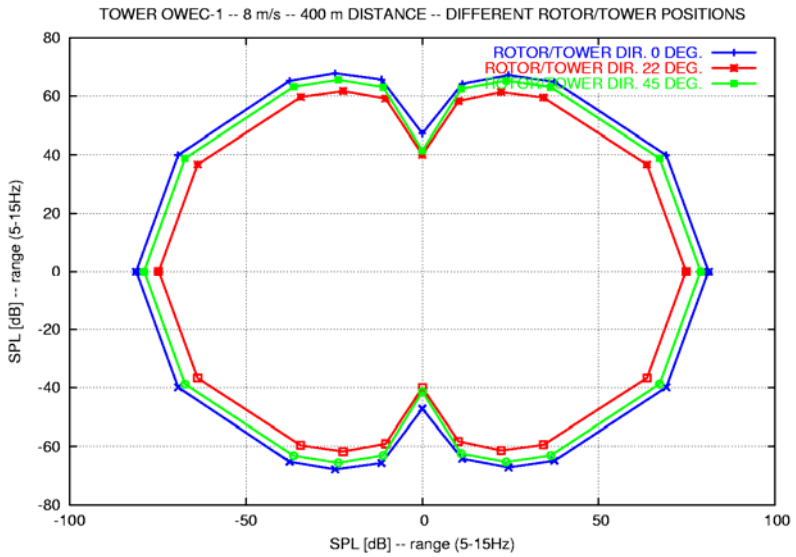


Figure 25 *Influence of position of the listener on the sound pressure level.*

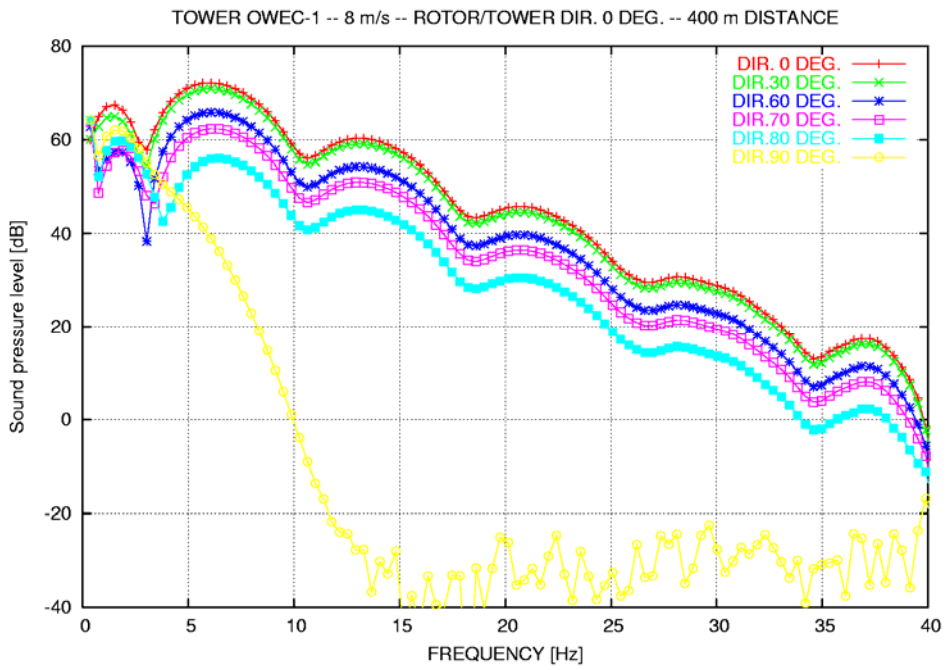


Figure 26 *The SPL at 8 m/s for different positions of the listener.*

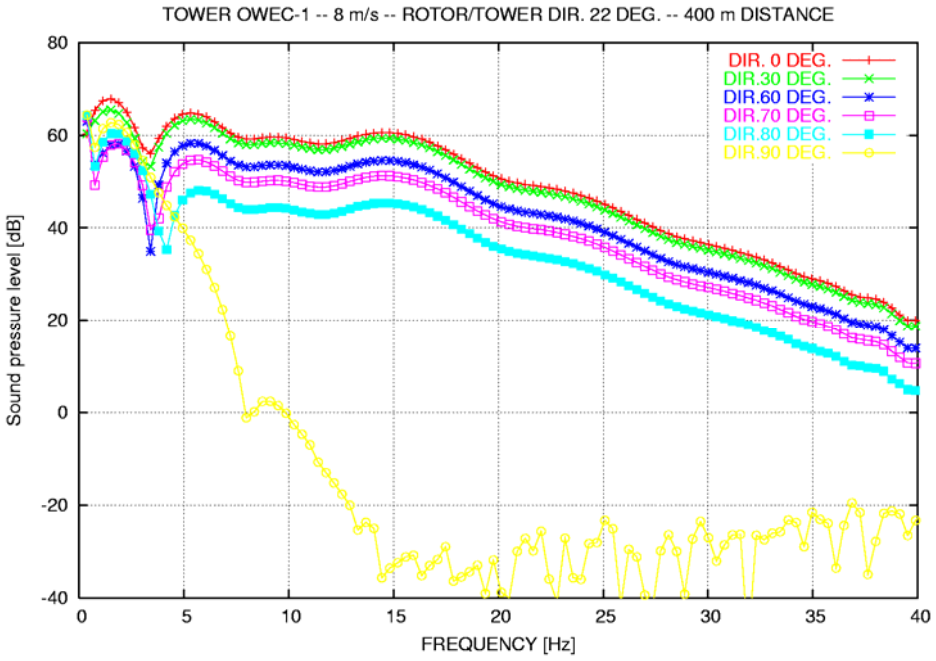


Figure 27 *The SPL at 8 m/s for different positions of the listener.*

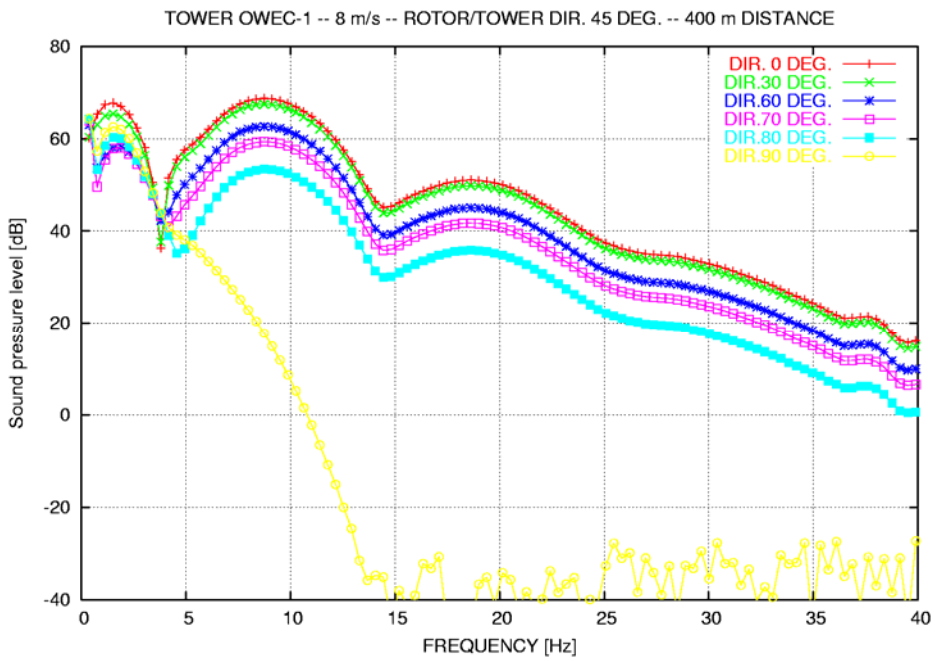


Figure 28 *The SPL at 8 m/s for different positions of the listener.*

4.6 Influence of drag coefficient of the tower legs

The drag coefficient of the tower legs is one of the parameters that has to be chosen as input for the noise computations. In all of the above results the drag coefficient has been set to 0.8. As there is some uncertainty about this value a number of computations for different values of CD has been run in order to see the sensitivity of the SPL as function of this parameter.

The computations have been run for the 8 m/s case and for the rotor in direction 0 deg. relative to the tower. In the CD range from 0.6 to 1.0 the relation is about an increase of 1 dB for an increase in CD of 0.1 which is a rather weak influence.

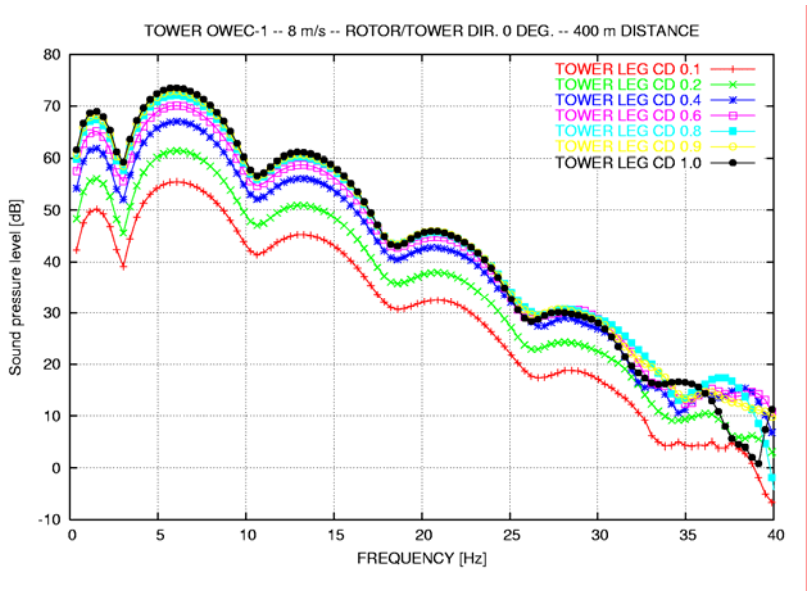


Figure 29 *The influence of the tower leg drag coefficient on the SPL level at 8 m/s and for a rotor direction of 0 deg. relative to the tower.*

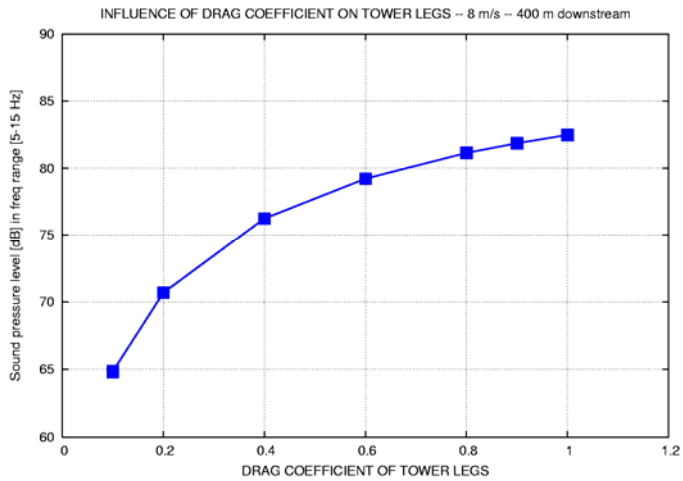


Figure 30 *The influence of the tower leg drag coefficient on the SPL level (range 10-15 Hz) at 8 m/s and for a rotor direction of 0 deg. relative to the tower.*

5 Computations of broadband noise

The broadband noise from the turbine has been computed with the model of Brooks, Pope and Marcolini[5] (BPM model). Implementation and verification of this model at Risoe is documented in[6]. The BPM model is based on comprehensive acoustic measurements on airfoils in wind tunnels.

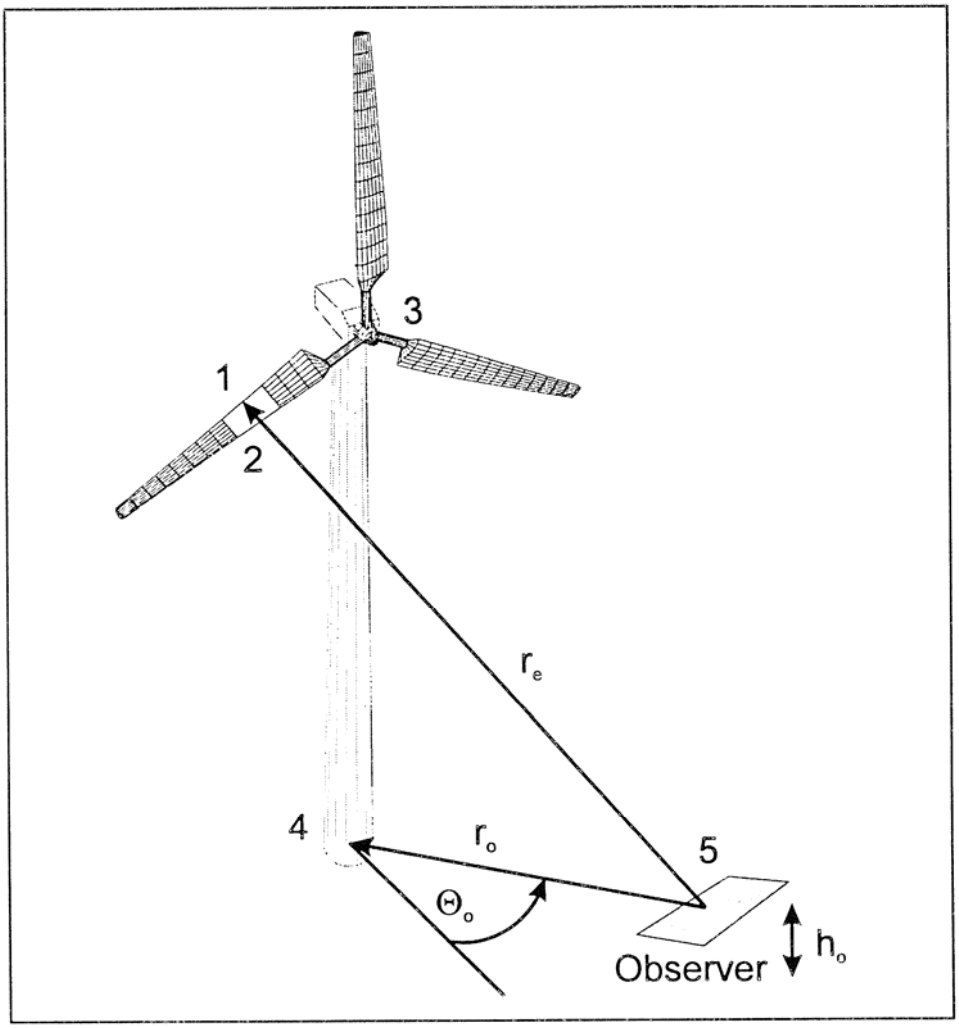


Figure 31 The definition of observer position.

The model can compute the sound pressure level (SPL) at a specified position around the turbine as well as the sound power level Lw , which is a direct measure of the strength of the noise source.

5 Brooks, T.F., Pope, D.S. and Marcolini, M.A., 1989, ”Airfoil Self-Noise and Prediction”, NASA Reference Publication 1218, National Aeronautics and Space Administration, USA.

6 Fuglsang, P. and Madsen, H.A., ”Implementation and Verification of an Aeroacoustic Noise Prediction Model for Wind Turbines”. Report Risø-R-867(EN), Risø National Laboratory, Denmark, March 1996.

5.1 Results – influence of wind speed

First, the influence of wind speed is investigated. The sound power level Lw and the A-weighted sound power level LwA is shown in Figure 32 for a rotor speed of 12 rpm and a pitch of 0 deg. There is a considerable increase in the Lw as function of wind speed but when the A weighting is applied the increase is much less pronounced.

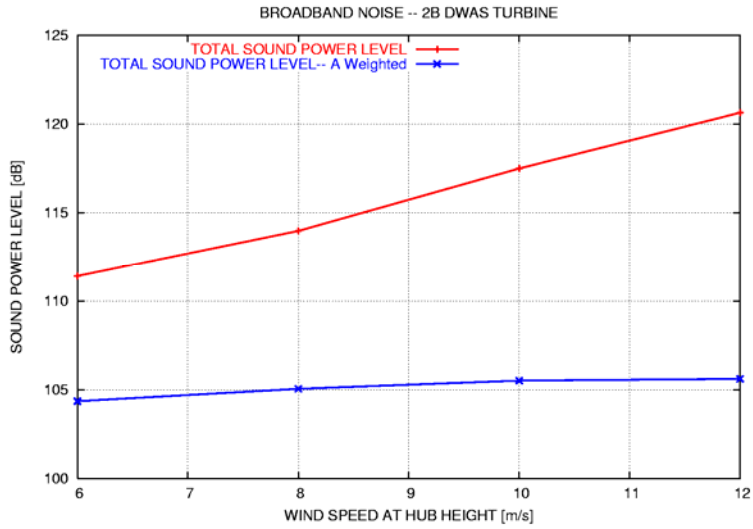


Figure 32 *The sound power level as function of wind speed at a rotor speed of 12 rpm and a pitch of 0 deg.*

5.2 Results – influence of rotor speed

Next, the influence of rotor speed has been investigated, Figure 33. It is seen that this is an important parameter for controlling the noise level.

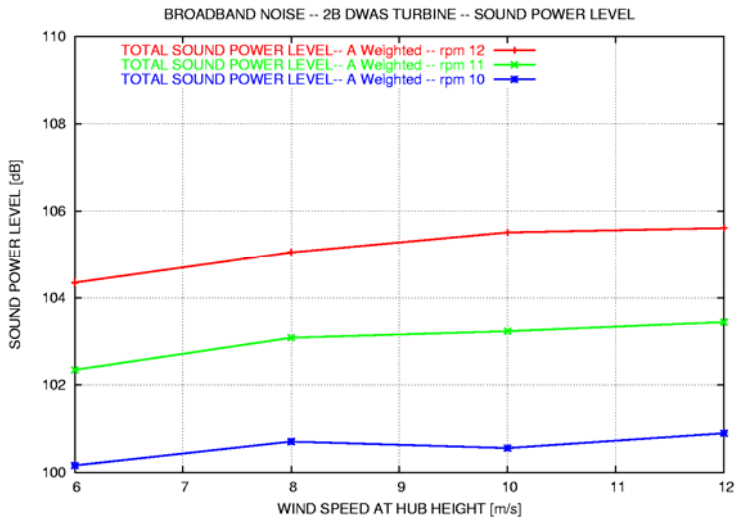


Figure 33 *The sound power level as function of wind speed at a pitch of 0 deg. and at different rotor speeds.*

5.3 Results – influence of pitch angle

Another important operational parameter is the pitch angle, For lower wind speeds the general influence is that the noise level is reduced by increasing the pitch angle and the mechanism behind this is that the trailing edge noise is dependent on the effective angle of attack on the airfoil and this can be changed by changing the pitch of the blade, Figure 34.

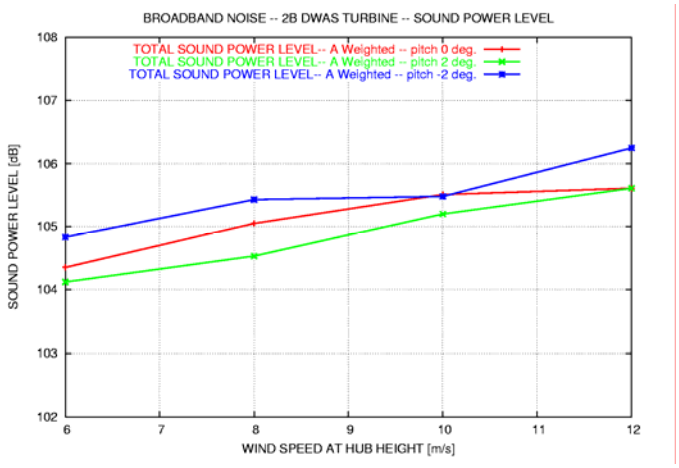


Figure 34 *The sound power level for different pitch settings of the blade as function of wind speed and at a rotor speed of 12 rpm.*

5.4 Results – directivity

Finally, the directivity has been computed for the case of 12 rpm, 8 m/s and pitch 0 deg. The sound pressure level has been computed at a distance of 126 m (one rotor diameter) at a direction varying from 0 deg. (upstream of the rotor) to 180 deg.(downstream), Figure 35. It is seen, that there is a slight variation of the noise level as function of direction with the lowest noise in the rotor plane.

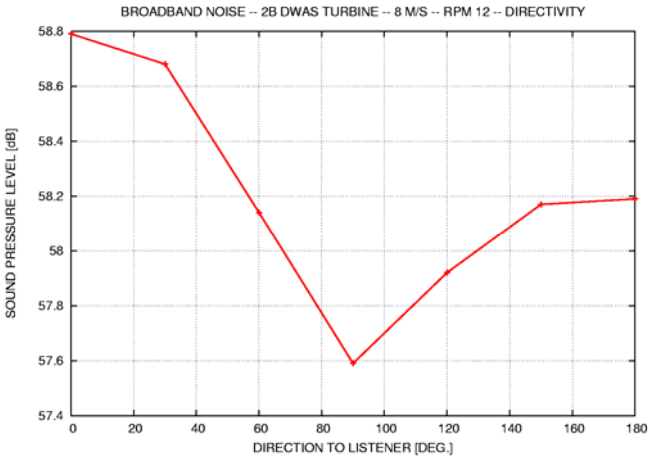


Figure 35 *The sound pressure level as function of direction to the listener in a distance of 126 m on the ground. Operational conditions are 12 rpm , 8 m/s and a pitch of 0 deg. The convention of the directivity is that 0 deg. is upstream and 180 deg. downstream.*

Risø's research is aimed at solving concrete problems in the society.

Research targets are set through continuous dialogue with business, the political system and researchers.

The effects of our research are sustainable energy supply and new technology for the health sector.

Data Provided by RISO by email 20100317

Sound Power Levels from original Report:

#case	vhub	omega	pitch	SPL-TOT
0	6.00	12.00	0.00	104.33
1	8.00	12.00	0.00	105.03
2	10.00	12.00	0.00	105.47
3	12.00	12.00	0.00	105.55

Sound Power Levels, Control 0:

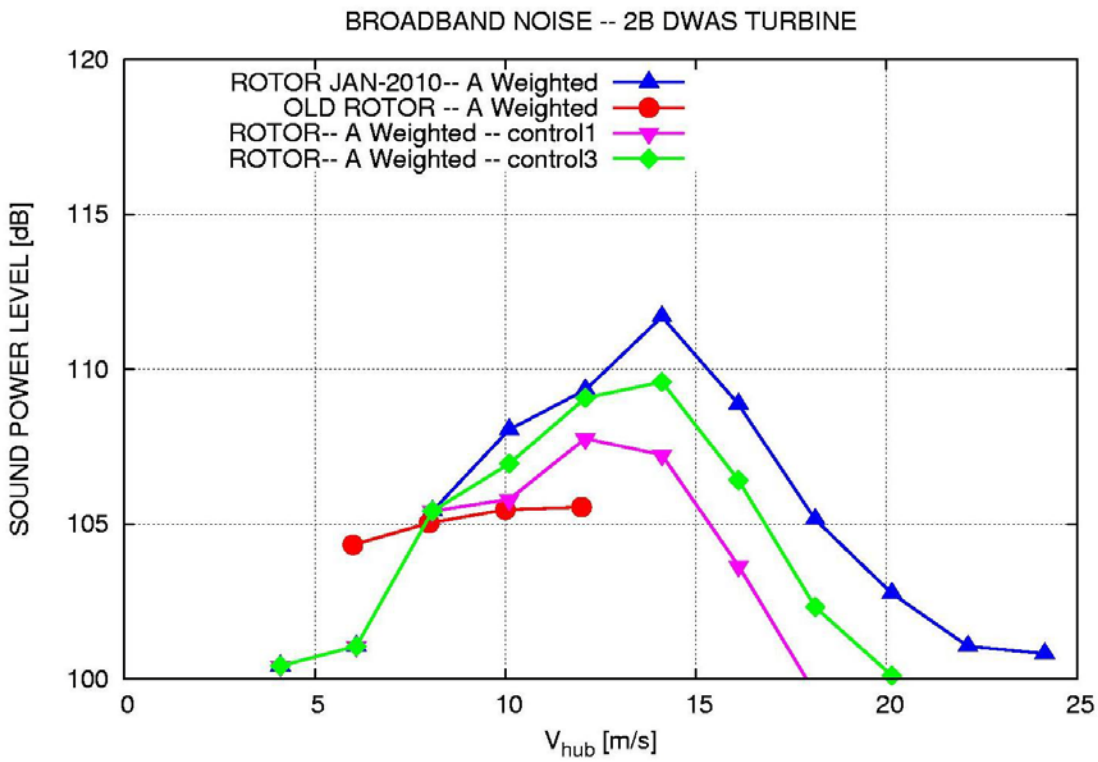
#case	vhub	omega	pitch	SPL-TOT
0	4.10	9.90	0.38	100.42
1	6.09	9.98	0.20	101.06
2	8.09	11.78	0.40	105.42
3	10.10	12.98	0.55	108.05
4	12.10	13.08	0.06	109.33
5	14.11	13.07	-1.94	111.69
6	16.12	13.21	-3.62	108.87
7	18.13	13.25	-4.55	105.15
8	20.14	13.25	-4.60	102.76
9	22.14	13.26	-4.63	101.06
10	24.15	13.26	-4.33	100.82

Sound Power Levels, Control 1:

#case	vhub	omega	pitch	SPL-TOT
0	4.1	9.9	0.38	100.4
1	6.1	9.98	0.2	101.1
2	8.1	11.78	0.4	105.4
3	10.1	11.98	0.55	105.8
4	12.1	12.08	0.06	107.8
5	14.1	12.07	-1.94	107.2
6	16.1	12.21	-3.62	103.7
7	18.1	12.25	-4.55	99.5
8	20.1	12.25	-4.6	98.0
9	22.1	12.26	-4.63	97.4
10	24.2	12.26	-4.33	97.7

Sound Power Levels, Control 3:

#case	vhub	omega	pitch	SPL-TOT
0	4.1	9.9	0.38	100.4
1	6.09	9.98	0.2	101.1
2	8.09	11.78	0.4	105.4
3	10.1	12.48	0.55	107.0
4	12.1	12.58	0.06	109.1
5	14.11	12.57	-1.94	109.6
6	16.12	12.71	-3.62	106.4
7	18.13	12.75	-4.55	102.3
8	20.14	12.75	-4.6	100.1
9	22.14	12.75	-4.63	99.2
10	24.15	12.75	-4.33	99.1



Technical Appendix A6.2

Baseline Noise Survey Records

Wind Farm Noise Survey Record Sheet

Project No:	323	**Project Name:**	Methil
Client:	2-B Energy	**Survey By:**	MR / ND

Location No (x/y):	1/3	**Location Name:**	Park East
Monitoring Location (GPS Grid Reference):			NT 36442,98712
Monitoring Location Description:	East end of fenced-off area on northern boundary of energy park, adjacent to rear boundary of nearest noise-sensitive receptors.		
Distance From Façade:		>>10m	
Noise Sources Present:	Factory, traffic, wind, birds		
Notes:	Meter date set one day ahead 9/3/10 – meter failed to restart correctly after battery change. Replaced with 01062690		
Noise files	AU2_0101, 0102,0103		
Photograph numbers	P2290032.JPG		
Start Date & Time	19/02/2010 1700	**End date & Time**	17/03/2010 11.50

Equipment			
Item	**Make**	**Model**	**Serial No.**
Sound Level Meter	Rion	NL-31	01062691/01062690
Calibrator	Rion	NC-74	34327238
Source of Equipment:		Arcus	
Noise Meter clock set to GMT			

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	19/02/2010 16:55	93.9	N/A
Mid-Survey Check 1	01/03/2010 13.55	93.9	93.9
Mid-Survey Check 2	09/03/2010 11.50	93.9	93.9
Meter replaced			
Mid-Survey Check 3	09/03/2010 15:45	93.9	N/A
Final Check	17/03/2010 11.51	93.9	93.8

Photo(s) of Monitoring Location 1:

Wind Farm Noise Survey Record Sheet

Project No:	323	**Project Name:**	Methil
Client:	2-B Energy	**Survey By:**	MR / ND

Location No (x/y):	2/3	**Location Name:**	Park West
Monitoring Location (GPS Grid Reference):			
Monitoring Location Description:	West end of fenced-off area on northern boundary of energy park, adjacent to rear boundary of nearest noise-sensitive receptors.		
Distance From Façade:		>>10m	
Noise Sources Present:	Traffic, birds, wind, screened from Bifab		
Notes:	Meter date set incorrectly at start of survey		
Noise files	AU2_0201/0202/0203		
Photograph numbers	P2290033.JPG		
Start Date & Time	19/02/10 1710	**End date & Time**	17/3/2010 11.58

Equipment			
Item	**Make**	**Model**	**Serial No.**
Sound Level Meter	Rion	NL-31	01062699
Calibrator	Rion	NC-74	34327238
Source of Equipment:		Arcus	
Noise Meter clock set to GMT			

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	19/02/2010 17:10	93.9	N/A
Mid-Survey Check 1	01/03/2010 14:08	93.9	93.9
Mid-Survey Check 2	09/03/2010 12:10	93.9	93.8
Final Check	17/03/2010 11.59	93.9	93.9

Photo(s) of Monitoring Location 2:

Wind Farm Noise Survey Record Sheet

Project No:	323	**Project Name:**	Methil
Client:	2-B Energy	**Survey By:**	MR / ND

Location No (x/y):	3/3	**Location Name:**	Buckhaven
Monitoring Location (GPS Grid Reference):			NT 36114,98187
Monitoring Location Description:	12 Erskine St, Buckhaven, Rear Garden		
Distance From Façade:		Approx 4m from shed	
Noise Sources Present:	Factory, traffic, wind, birds		
Notes:	Meter moved on 09/03/2010 further from hedge to check that measurements were not affected by proximity to foliage.		
Noise files	AU2_0301/0302/0303		
Photograph numbers	01032010001.jpg 01032010002.jpg 09032010003.jpg 09032010004.jpg		
Start Date & Time	20/02/2010 17:50	**End date & Time**	17/03/2010 10.55

Equipment			
Item	**Make**	**Model**	**Serial No.**
Sound Level Meter	Rion	NL-31	01062689
Calibrator	Rion	NC-74	34327238
Source of Equipment:		Arcus	
Noise Meter clock set to GMT			

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	20/02/2010 17:45	93.9	N/A
Mid-Survey Check 1	01/03/2010 14:35	93.9	93.9
Mid-Survey Check 2	09/03/2010 12:50	93.9	93.8
Final Check	17/03/2010 10.55	93.9	93.9

Photos of Monitoring Location 3:
Position 1:

Position2:

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GREAT DUNMOW, Essex, CM6 1HD
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Certificate of Calibration

CALIBRATION 0789

Certificate No.: U4955

Test object :	Sound Calibrator
Manufacturer:	Rion
Type :	NC-74
Serial no:	34372738
Customer:	ARCUS 2F Swinegate Court East, 3 Swinegate, York. YO1 8AJ Neil Dodds.
Order No:	

Measurement Results:	Level	Level Stability	Frequency	Frequency Stability	Distortion
1:	94.20 dB	0.11 dB	1001.48 Hz	0.00 %	1.75 %
2:	94.20 dB	0.11 dB	1001.47 Hz	0.00 %	1.71 %
3:	94.20 dB	0.11 dB	1001.46 Hz	0.01 %	1.69 %
Result (Average):	**94.20 dB**	**0.11 dB**	**1001.47 Hz**	**0.00 %**	**1.72 %**
Expanded Uncertainty:	0.10 dB	0.02 dB	1.00 Hz	0.01 %	0.11 %
Degree of Freedom:	>100	>100	>100	>100	>100
Coverage Factor:	2.00	2.00	2.00	2.00	2.00

The stated level is relative to 20µPa.
The stated level is valid at measurement conditions.
The reported expanded uncertainty of measurements is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%. Where the degrees of freedom are insufficient to maintain this confidence level then the coverage factor is increased to maintain this confidence level. The uncertainty has been calculated in accordance with UKAS requirements.

Records : K:\C A\Calibration\Nor-1504\Nor-1018 CalCal\2009\RIONNC74_34372738_M1.nmf

	Pressure :	Temperature :	Relative humidity :
Environmental conditions:			
Reference conditions:	101,325 kPa	23,0 °C	50 %RH
Measurement conditions :	99.471 ± 0.004 kPa	22.4 ± 1.2 °C	39.6 ± 7.8 %RH

Date received :	20/03/2009
Date of calibration:	26/03/2009
Date of issue:	26/03/2009

Engineer

Michael Tickner

Supervisor

Ian Campbell MSc MIOA

Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, CM6 1HD
www.campbell-associates.co.uk
Phone 01371 871030 Facsimile 01371879106

Certificate of Calibration

Certificate number: **U4963** **CALIBRATION** **0789**

Test object : **Sound Level Meter**
Manufacturer: **Rion**
Type : **NL31**
Serial no: **01062689**

Customer: **Arcus Renewable Energy Consulting Ltd**
2F Swinegate Court East
3 Swinegate
York, Yorkshire, YO1 8AJ
Mr Neil Dodds - Senior Acoustic Consultant

Order no.: **Letter**

Method of Calibration
Calibration has been performed as set out in the CA Technical procedures TP01 & 2 as appropriate.

The following items have been tested according to BS 7580, Part 1, 1997

	Producer:	Type:	Serial No:
Microphone	Rion	UNC53A	310534
Calibrator*	Rion	NC-74	34372738
Preamplifier	Rion	NH-21	20327

Additional items that also have been submitted for verification

Wind shield	None
Attenuator	None

Environmental conditions:	Pressure :	Temperature :	Relative humidity :
Reference conditions:	101,325 kPa	23,0 °C	50 %RH
Measurement conditions :	99.621 kPa	23.6 °C	45.7 %RH

Date received :	20/03/2009
Date of calibration:	26/03/2009
Date of issue:	26/03/2009

Engineer

Darren Batten Tech IOA

Supervisor

Ian Campbell MSc MIOA

* The calibrator was complete with any required coupler for the microphone specified

Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, CM6 1HD
www.campbell-associates.co.uk
Phone 01371 871030 Facsimile 01371879106

Certificate of Calibration

Certificate number: **U4957** **CALIBRATION** **0789**

Test object : **Sound Level Meter**
Manufacturer: **Rion**
Type : **NL31**
Serial no: **01062690**

Customer: **Arcus Renewable Energy Consulting Ltd**
Acoustics
2F Swinegate Court East, 3 Swinegate
York, Yorkshire, YO1 8AJ
Neil Dodds - Senior Acoustic Consultant

Order no.: **Letter**

Method of Calibration
Calibration has been performed as set out in the CA Technical procedures TP01 & 2 as appropriate.

The following items have been tested according to BS 7580, Part 1, 1997

	Producer:	Type:	Serial No:
Microphone	Rion	UNC53A	311678
Calibrator*	Rion	NC-74	34372738
Preamplifier	Rion	NH-21	20328

Additional items that also have been submitted for verification

Wind shield	None
Attenuator	None

Environmental conditions:	Pressure :	Temperature :	Relative humidity :
Reference conditions:	101,325 kPa	23,0 °C	50 %RH
Measurement conditions :	99.607 kPa	23.6 °C	45.1 %RH

Date received :	20/03/2009
Date of calibration:	26/03/2009
Date of issue:	26/03/2009

Engineer

Darren Batten Tech IOA

Supervisor

Ian Campbell MSc MIOA

* The calibrator was complete with any required coupler for the microphone specified

Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, CM6 1HD
www.campbell-associates.co.uk
Phone 01371 871030 Facsimile 01371879106

Certificate of Calibration

Certificate number: **U4941** **CALIBRATION** **0789**

Test object : **Sound Level Meter**
Manufacturer: **Rion**
Type : **NL31**
Serial no: **01062691**

Customer: **Arcus Renewable Energy Consulting Ltd**
Acoustics
2F Swinegate Court East, 3 Swinegate
York, Yorkshire, YO1 8AJ
Neil Dodds - Senior Acoustic Consultant

Order no.: **Letter**

Method of Calibration
Calibration has been performed as set out in the CA Technical procedures TP01 & 2 as appropriate.

The following items have been tested according to BS 7580, Part 1, 1997

	Producer:	Type:	Serial No:
Microphone	Rion	UNC53A	309605
Calibrator*	Rion	NC-74	34372738
Preamplifier	Rion	NH-21	20239

Additional items that also have been submitted for verification

Wind shield	None
Attenuator	None

Environmental conditions:	Pressure :	Temperature :	Relative humidity :
Reference conditions:	101,325 kPa	23,0 °C	50 %RH
Measurement conditions :	99.455 kPa	24.4 °C	34.7 %RH

Date received :	20/03/2009
Date of calibration:	25/03/2009
Date of issue:	26/03/2009

Engineer

David Egan

Supervisor

Ian Campbell MSC MIOA

* The calibrator was complete with any required coupler for the microphone specified

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 14 October 2009 Certificate N° 04844

UKAS CALIBRATION 0653

AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
Tel: +44 (0)1462 638600
Fax: +44 (0)1462 638601
Email: lab@avcalib.co.uk
www.avcalibration.co.uk

Approved Signatory
G.Parry

CLIENT	Arcus Renewable Energy Consulting Ltd 2F Swinegate Court East 3 Swinegate York YO1 8AJ
F.A.O.	Neil Dodds
REF.	- Job N° UKAS09/10256/01
DATE OF RECEIPT	12 October 2009
PROCEDURE	AV Calibration Engineer's Handbook, Section 3: verification of sound level meters to BS 7580:Part 1:1997
IDENTIFICATION	Sound level meter Rion type NL-31 [serial no. 01062688] connected via a preamplifier type NH-21 [serial no. 20326] to a half-inch microphone type UC-53A [serial no. 310533] fitted with a foam windshield type WS-10. Associated calibrator Rion type NC-74 [serial no. 34372738] with one-inch housing and adapter type NC-74-002 for half-inch microphone.
CALIBRATED ON	13 October 2009
PREVIOUS CALIBRATION	None known

The sound level meter was set to frequency weighting A and adjusted to read 94.0 dB (corresponding to 94.0 dB at standard atmospheric pressure) in response to the sound calibrator supplied. This reading was derived from the Calibration Certificate no. U4955 supplied by UKAS laboratory 0789 and manufacturers' information on the free-field response of the sound level meter when fitted with the windshield.

The sound level meter was then tested, and its overall sensitivity adjusted, in accordance with clause 5 of BS 7580:Part 1:1997†.

The acoustic calibration at 1 kHz specified in subclause 5.6.1 of the standard was performed by application of a standard sound calibrator, whilst the tests at 125 Hz and 8 kHz (subclause 5.6.2) were performed by the electrostatic actuator method.

At the end of the test, the sound calibrator was reapplied to the sound level meter and the meter reading was recorded.

RESULTS

The sound level meter was found to conform to BS 7580:Part 1:1997† for a Type 1 meter.

The self-generated noise recorded in the test specified in subclause 5.5.2 was:

6.8 dB (A) ; 11.4 dB (C) ; 19.1 dB (Lin)

The sound level meter reading obtained at the end of the test in response to the sound calibrator was 94.0 dB (corresponding to 94.0 dB at standard atmospheric pressure). This reading, corrected for ambient pressure, should be used henceforth to set up the sound level meter for field use.

The expanded level uncertainty of the Laboratory's 1 kHz sound calibrator used during this verification is ± 0.22 dB; that of the calibrator supplied with the sound level meter is ± 0.22 dB.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor *k*=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

All measurement data are held at AV Calibration for a period of at least six years.

Typical case reflection factors specified by the manufacturer have been used for this verification.

The reference range, linearity range and primary indicator range specified by the manufacturers have been used.[see note 4]

The Rion NL-31 sound level meter design has successfully undergone pattern evaluation at Physikalisch-Technische Bundesanstalt (PTB). It was found to meet the requirements of BS EN 60651* and BS EN 60804* and was granted pattern approval as a Type 1 sound level meter.

No component of uncertainty for manufacturer-specified corrections has been included in the uncertainty budget and, in accordance with Amendment No. 1 to BS 7580:Part 1:1997†, the measured values obtained during the verification have not been extended by any measurement uncertainty when assessing conformance to the standard.

NOTES

*1 BS EN 60651:1994 and BS EN 60804:1994 were formerly numbered BS 5969:1981 and BS 6698:1986 respectively.

†2 BS 7580:Part 1:1997 was formerly numbered BS 7580:1992 .

3 The NL-31 does not have a "max hold" function available when operating with time weighting I. The results given for the tests of time weighting I are therefore the highest instantaneous reading shown on the display. Whilst these results meet the requirements of the standard, those for response to a single tone burst in particular may give a misleading impression of the accuracy of time weighting I on this instrument.

4 After consultation with the manufacturers and their European agents, it has been established that the specifications given in the standard English-language handbook for the NL-31 are both incomplete and incorrect. An addendum to the handbook based on the PTB tests has been provided by Rion, and this revised specification has been used for the purposes of the present verification. For information, extracts from the addendum have been appended as page 8 of this certificate.

5. The instrument was tested with integral software as received.

6 No suitable microphone frequency response information was supplied with the instrument. It was therefore measured by this laboratory using the electrostatic actuator method. This response in isolation is not covered by our accreditation.

7 The instrument was submitted for calibration following repair by ANV Measurement Systems, Beaufort Court, 17 Roebuck Way, Milton Keynes MK5 8HL .

CERTIFICATE OF CALIBRATION

UKAS ACCREDITED CALIBRATION LABORATORY No 0653

Measurement data - linearity at 4 kHz

Reference range (30 - 120)		
Instrument reading, dB	Leq error, dB	SPL error, dB
28.0	0.1	0.1
29.0	0.0	0.0
30.0	0.1	0.1
31.0	0.1	0.1
32.0	0.1	0.1
33.0	0.1	0.1
34.0	0.1	0.1
39.0	0.2	0.2
44.0	0.1	0.1
49.0	0.0	0.0
54.0	0.0	0.0
59.0	0.0	0.0
64.0	0.0	0.0
69.0	0.0	0.0
74.0	0.0	0.0
79.0	0.0	0.0
84.0	0.0	0.0
89.0	0.0	0.0
94.0	0.0	0.0
99.0	0.0	0.0
104.0	0.0	0.0
109.0	0.0	0.0
114.0	0.0	0.0
119.0	0.0	0.0

Reference range (30 - 120)		
Instrument reading, dB	Leq error, dB	SPL error, dB
122.0	0.0	0.0
123.0	0.0	0.0
124.0	0.0	0.0
125.0	0.0	0.0
126.0	0.0	0.0
127.0	0.0	0.0

Other measurement ranges		
Instrument reading, dB	Range	Leq error, dB
94.0	20 - 90	0.0
94.0	20 - 100	0.0
94.0	20 - 110	0.0
94.0	40 - 130	0.1
85.0	20 - 80	0.1
95.0	20 - 90	0.1
105.0	20 - 100	0.1
115.0	20 - 110	0.1
135.0	40 - 130	0.0
34.0	20 - 80	0.2
34.0	20 - 90	0.2
34.0	20 - 100	0.2
34.0	20 - 110	0.2
40.0	40 - 130	0.2

continued.....

The estimated expanded measurement uncertainty for linearity measurements is ± 0.20 dB

.....continued

Largest overall errors, dB		
Positive	Negative	Tolerance
0.3	0.0	± 0.7*
0.2	0.0	± 1.0**

*= within primary indicator range

**= outside primary indicator range

The estimated expanded measurement uncertainty for linearity measurements is ± 0.20 dB

Measurement data - frequency response. The following data include all corrections for microphone response, case reflections and windshield, and linearity errors.

Frequency, Hz	Largest error in A-weighting, dB		Largest error in C-weighting, dB		Largest error in Lin-weighting, dB		Tolerance, dB
	most +ve	most -ve	most +ve	most -ve	most +ve	most -ve	
31.5	0.1	-0.2	0.0	-0.2	0.0	-0.2	± 1.5
63	0.1	-0.1	0.2	0.0	0.1	-0.1	± 1.5
125	0.0	-0.2	0.1	-0.1	0.1	-0.1	± 1.0
250	-0.1	-0.3	0.0	-0.2	0.0	-0.2	± 1.0
500	-0.1	-0.3	0.1	-0.1	0.1	-0.1	± 1.0
1000	0.0	-0.1	0.0	-0.1	0.0	-0.1	± 1.0
2000	0.1	-0.1	-0.1	-0.3	0.0	-0.2	± 1.0
4000	0.0	-0.2	-0.1	-0.3	-0.1	-0.3	± 1.0
8000	-0.3	-0.5	-0.5	-0.7	-0.6	-0.8	+ 1.5, – 3.0
12500	0.3	0.1	0.3	0.1	-0.1	-0.3	+ 3.0, – 6.0

The estimated expanded measurement uncertainty for frequency response measurements is ± 0.23 dB except for those shaded above, where ± 0.26 dB applies.

Measurement data - Time weightings F, S and I

Time weighting	Signal type	Reading 1, dB	Reading 2, dB	Reading 3, dB	Requirement, dB
F	Single toneburst	106.0	106.0	106.0	106.0 ± 1.0
S		102.9	102.9	102.9	102.9 ± 1.0
I		100.7	102.0	100.9	102.2 ± 2.0
	Pulse chain	108.2	N/A	N/A	108.3 ± 1.0

The estimated expanded measurement uncertainty for measurements of Time Weighting F, S and I is ± 0.20 dB

Measurement data - Peak response

Signal type	Reading 1, dB	Reading 2, dB	Reading 3, dB	Requirement, dB
+ve 10 ms pulse	110.1	109.9	109.7	≥ 108.0
-ve 10 ms pulse	109.6	110.0	110.0	

The estimated expanded measurement uncertainty for measurements of Peak response is ± 0.29 dB

Measurement data - RMS accuracy for signal of crest factor 3

Instrument reading, dB	Requirement, dB
109.0	109.0 ± 0.5

The estimated expanded measurement uncertainty for measurements of RMS accuracy is ± 0.23 dB

Measurement data - Time averaging

Burst duty factor	Instrument reading, dB	Requirement, dB
1/1000	97.0	97.0 ± 1.0
1/10000	86.9	87.0 ± 1.0

The estimated expanded measurement uncertainty for measurements of time averaging is ± 0.23 dB

Measurement data - Pulse range

Background sig., dB	Reading 1, dB	Reading 2, dB	Reading 3, dB	Requirement, dB
28.0	56.1	56.1	56.1	56.0 ± 1.7
67.0	95.0	95.0	95.0	95.0 ± 1.7

The estimated expanded measurement uncertainty for measurements of pulse range is ± 0.23 dB

Measurement data - Sound exposure level

Background sig., dB	Reading 1, dB	Reading 2, dB	Reading 3, dB	Requirement, dB
28.0	66.1	66.1	66.1	66.0 ± 1.7
67.0	105.0	105.0	105.0	105.0 ± 1.7

The estimated expanded measurement uncertainty for measurements of SEL is ± 0.23 dB

Measurement data - Overload indicator (non-integrating)

Instrument reading, dB	Target, dB	Tolerance, dB
117.3	117.3	± 0.4

The estimated expanded measurement uncertainty for measurements of overload indicator response in non-integrating mode is ± 0.23 dB

Measurement data - Overload indicator (integrating)

Reading 1, dB	Reading 2, dB	Reading 3, dB	Target, dB	Tolerance, dB
86.2	86.2	86.2	86.3	± 2.2

The estimated expanded measurement uncertainty for measurements of overload indicator response in integrating mode is ± 0.23 dB

Measurement data - Electrostatic actuator tests at 125 Hz and 8 kHz. The following data include all corrections for microphone response, case reflections and windshield, and linearity errors.

Frequency, Hz	Averaged reading, dB	Target, dB	Tolerance, dB
125	78.2	78.2	± 1.0
8000	77.4		+1.5, -3.0

The estimated expanded measurement uncertainty for electrostatic actuator measurements is ± 0.22 dB

The following data supplied by Rion are included for completeness:

Addendum to the NL-31 Instruction Manual

Errata (page 133):

- Total range: 23 to 137 dB(A).
- Linearity range (on 30 - 120 dB reference range): 99 dB (28 to 127).

Additional information

- Primary indicator range (on 30 - 120 dB reference range): 32 - 111 dB, allowing a crest factor of 10 for Impulse time weighting.
- Pulse range: > 63 dB
- Measurement range for various LEVEL settings: See table below.

Measurement ranges				
Measurement range for various "LEVEL" range settings (dB) * Frequency weighting A-, C- and Lin.				
"LEVEL" setting (dB)	Time weighting			Leq
	Fast/Slow	Impulse	Peak	
20 - 80	23 – 80 **	23 – 70 **	50 – 90	23 – 87 **
20 - 90	23 – 90 **	23 – 80 **	50 – 100	23 – 97 **
20 - 100	23 – 100**	23 – 90 **	50 – 110	23 – 107 **
20 - 110	23 – 110**	23 – 100 **	50 – 120	23 – 117 **
30 - 120	28 – 120**	28 – 110 **	50 – 130	28 – 127 **
40 - 130	38 – 130	38 – 120	50 – 140	38 – 137

*For time weighting Fast and Slow a crest factor 3, and for time weighting Impulse a crest factor 10, is taken into account.
**The lower limit of the measurement range is 30 dB(C) for C- weighting and 35 dB(Lin) for Lin- weighting.

Technical Appendix A8

Ornithology

2B Energy

Wind turbine

Ornithological Assessment

FINAL- UPDATED

2B Energy

Wind turbine

Ornithological Assessment

February 2010

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Ove Arup & Partners Ltd
4 Pierhead Street, Capital Waterside, Cardiff CF10 4QP
Tel +44 (0)29 2047 3727 Fax +44 (0)29 2047 2277
www.arup.com

Job number

ARUP

Document Verification

Job title	Wind turbine		Job number
Document title	Ornithological Assessment		File reference
Document ref			

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Draft 1	15/10/09	Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Pippa Wood / Debbie Brown	Pete Wells / Neil Harwood	Fraser Maxwell
		Signature			
Final	13/01/10	Filename	0003Ornithological Assessment Report - Final.doc		
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			Prepared by	Checked by	Approved by
		Name	Pippa Wood / Debbie Brown	Pete Wells / Neil Harwood	Fraser Maxwell
		Signature			
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		Name	Pippa Wood	Pete Wells	Fraser Maxwell
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

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Figure 1

Site Location and Designated Sites

Figure 2

Turbine Design

Figure 3

BTO Core Counts Locations

Figure 4

VP Survey Area

Figure 5

Activity Survey Area

Figure 6

Flight Lines

Appendices

Appendix A

Firth of Forth Designations

Appendix B

Sensitivity Map

Appendix C

VP Survey Recording Form

Appendix D

Survey Dates and Weather Conditions

Appendix E

Stage 1 and 2 Worked Example for Oystercatcher

Appendix F

Stage 1 and 2 Worked Example for Peregrine

Appendix G

Monthly Species Flight Totals

Appendix H

Activity Summaries

Appendix I

Photos

1 Introduction

1.1 Overview of Proposals

The turbine demonstration project will be located at the Fife Energy Park (FEP) in Methil, Fife, at grid reference NT 368 984, as shown on Figure 1. The site is currently owned by Scottish Enterprise, and is largely derelict and disused. To the east of the FEP site there is an active steelworks, operated by Burntisland Fabrications (BiFab). BiFab operates the yard, producing major fabrications for the offshore oil and gas industry, and has been identified as the potential suppliers of the steel tower structure if the project is commissioned.

The FEP site is currently undergoing a significant redevelopment with around £10m of investment in infrastructure in buildings, roads, coastal defence, utilities and the creation of development platforms. Bi-Fab's base adjacent to the FEP, and in combination with the sites physical attributes and the opportunity for further demonstration and development opportunities, makes the FEP the preferred location for this project.

Scottish Enterprise has already identified the opportunity for the potential installation of wind turbines on site. As part of this process, initial assessments in relation to potential site locations and 12 months of bird survey work have already been completed. In addition there will also be significant investment in the electrical infrastructure on site, where new mains transformers will be installed and a new site distribution network established.

Scottish Enterprise also own the area of seabed adjacent to the quayside, where it is proposed that the near-shore turbine will be located, with the associated infrastructure located on land within the Energy Park.

2B Energy is developing wind turbine technology for application to the global offshore wind market. The proposal is innovative in its simplicity, with large two-blade turbines on steel lattice towers, producing power fed to a high-voltage direct current (HVDC) grid and transmitted to shore with HVDC cabling (see Figure 1.1 inset).

The development of 2B Energy's prototype system includes the manufacture, assembly and installation of a full scale 6MW turbine and the HVDC electrical grid system.

The turbine is a large two-blade machine, approximately 114m to the hub with a rotor diameter of 130m (see Figure 2 for scaled drawing of the turbine with the dimensions). The turbine is fixed to a steel tubular lattice structure which provides the foundation and tower in a single piece. The HVDC system has already been secured and will comprise two buildings 17x22m and up to 3km of DC cables.

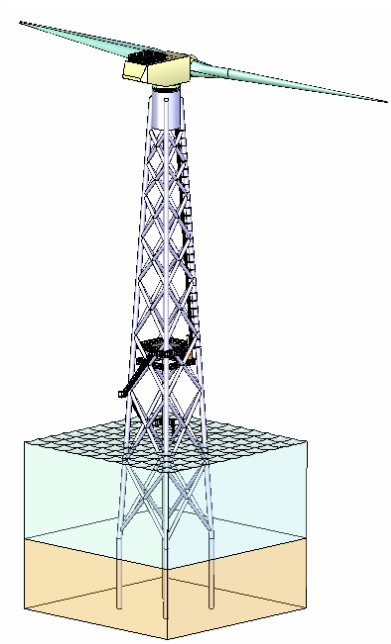


Figure 1.1. 2B Energy two-blade offshore turbine

1.2 Site Description and Land Use

The site lies on the northern shore of the Firth of Forth and directly adjacent to the Firth of Forth Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar site. Figure 1 shows the location of the site in relation to the Firth of Forth designations. These designations have primarily been declared for the protection of various bird populations which occur within the Firth of Forth at different times of the year. Appendix A

includes the full SSSI, SPA and Ramsar site citations. Many of the species afforded protection through these designations occur in very large numbers and comprise significant proportions of the total UK or international populations.

1.3 Report Scope

The scheme has the potential to affect birds that are present on the site throughout the year, as well as those passing over the site, particularly qualifying species from the nearby SPA/SSSIs.

Twelve months of bird surveys were undertaken at the site, having commenced in September 2006 and running through to September 2007. The survey methodology was original agreed for this period based on smaller turbines, as explained in Section 4.1.1.1.

This report presents the data collected, providing information on bird usage at the site as well as collision risk and the potential for disturbance.

1.4 Consultation

Consultation with Scottish Natural Heritage (SNH) on 1st June 2009 concluded that the collision risk assessment for the 2B Energy demonstrator turbine at the Fife Energy Park (FEP) site would:

- Use the data collected in 2006 and 2007 at the FEP site, with acknowledgement that bird flight paths would follow the line of any realignment of the coastal edge (which have occurred since the data collection period);
- Use ‘Stage 1: Regular flights through a windfarm’ from the Band et al.(2005) model for the collision risk models for species recorded flying along the coast;
- Not need to include heights underneath the swept area,
- Apply a 100m buffer area around the turbine for the ‘risk window’ area to be incorporated into the model;
- Use the default 95% avoidance rate for all species, other rates can be quoted alongside if considered relevant;
- Give particular emphasis to SPA qualifying species;
- Include figures indicating the flight lines at rotor height; and
- Include tabulated raw data and include examples of calculations in the report.

Consultation with SNH prior to the data collection at the FEP site in 2006 involved the presentation of the proposed methodologies for this project. A reply from Darren Hemsley (Area Officer) and Rhys Bullman (Ornithologist) was received recommending changes to the original proposed level of survey effort. These changes were incorporated into the methodology described in Section 4 below.

The RSPB was also consulted regarding the suitability of the methodologies, and a reply was received from Jared Wilson. They made a number of comments, which were discussed further and agreement was reached on all aspects raised. The following actions were agreed to discharge their concerns:

- The abundance of lesser black-backed gulls would be monitored informally, and if significant numbers were being encountered their potential inclusion as a target species would be reviewed.
- Kittiwakes would be included as a target species.

- The method for monitoring terns would be reviewed in April/May to potentially collect timed observations of their movements through the study area, since they tend to reside for longer periods of time within the swept area.
- The proposed level of VP survey effort will be reviewed in April/May 2007 for a potential increase to 8hrs per month for the summer period June – August.

Rhys Bullman (SNH) requested the FEP study included recent work undertaken on the continent in relation to wind farms and coastal sites. As a result of this request, Joris Everaert of the Research Institute for Nature and Forests at the Scientific Institute of the Flemish Government was contacted directly and provided unpublished results regarding the impacts certain Belgium wind farms have had on birds.

Wetland Bird Survey (WeBS) data was obtained from the British Trust for Ornithology (BTO) for relevant sections of the Firth of Forth. These data are described in Section 4.

The installation of wind turbines in the general area of the proposed 2B Energy turbine is considered to have the potential to cause significant impacts on the bird populations within the Firth of Forth, and also birds passing through the area on migration. This view was reinforced during consultation with SNH, who stated that they would require an assessment of the potential impacts on birds as part of the development proposal. SNH have issued guidance on how impacts on birds from wind turbines should be assessed (described in Section 3.3).

2 Legislation and Guidance

2.1 Legislation and Statutory Framework

Due to the proximity of the site to the Firth of Forth SPA/Ramsar/SSSI it is considered that development could influence the integrity of these sites. Local authorities are duty bound to consult conservation agencies about planning applications which could affect statutory designated areas, and the onus is on the developer to demonstrate that a significant adverse impact would not occur.

2.1.1 The Wild Birds Directive (79/409/EEC, SPA sites)

The Wild Birds Directive 79/409/EEC (the 'Birds Directive') aims to provide protection, management and control of all naturally occurring bird species in European Member States. It requires the countries to preserve significant habitats for all species of wild bird (including migratory species) listed in Annex 1 of the directive, in order to maintain populations at ecologically and scientifically sound levels. Areas of land considered appropriate for protection are designated Special Protected Areas (SPA), which are part of the Natura 2000 network of sites. In the U.K., the Birds Directive is implemented by the Conservation (Natural Habitats &c.) Regulations 1994 (as amended).

Sites designated as SPA have restrictions placed on them, only allowing development that is not connected to the conservation of the sites if:

- there is no alternative solution; or
- there are imperative reasons of over-riding public interest, including those of a social or economic nature; or
- where there are no impacts on the integrity of the site or any impacts can be mitigated.

It is important to recognise that the Directive does not impose a general prohibition on development in or adjacent to SPA sites. Proposals for new development need to be assessed for their impact on the site's conservation objectives.

2.1.2 Convention on Wetlands 1971 (Ramsar sites)

Ramsar sites are wetlands which are considered to be of international importance due to the habitats and species they support. Ramsar sites are those wetlands which regularly support over 20,000 waterbirds and/or have over 1% of a global population of a species or subspecies of waterbird.

The international convention was devised in Ramsar, Iran in 1971 as an answer to the need for worldwide wetland conservation. Signatories agreed to identify and protect their most significant wetlands for wildlife, especially waterfowl.

Ramsar sites are protected from development to the same extent as sites within the Natura 2000 network (i.e. SPAs) through the planning process, restricting development unless over-riding circumstances are present.

2.1.3 Sites of Special Scientific Interest (SSSI)

Under the Wildlife and Countryside Act 1981 (as amended) the government is duty bound to notify any land which has a special interest for its flora, fauna, geological or physiological feature and designate such sites as SSSI.

The SSSI designation carries certain protection against damaging operations, requiring permission from the country's statutory nature conservation authority (i.e. Scottish Natural Heritage).

2.2 Scottish Natural Heritage Wind Turbine Guidance

SNH produced the wind turbine guidance (SNH 2005) in response to a need from developers and consultants for a standardised methodology to assess impacts from potential wind farms. Although not a prescriptive methodology, it gives advice on a recommended approach for scoping, survey methods and project assessment, which can be tailored to suit the need of specific projects.

For reference, Table 2.1 contains text reproduced from the SNH guidance (SNH 2005) relating specifically to wind turbines within or in close proximity to designated sites.

Table 2.1: SNH Guidance Relating to Wind Turbines and Designated Sites

14. Where a site is designated for its bird interest, either as an SSSI or as a Special Protection Area as required by the European Birds Directive, the requirement that a wind farm proposal should not adversely affect those interests becomes more explicit in legislation or planning guidance. The protection requirements following from European Directives for Natura sites (i.e. SPA), embodied within the UK Conservation (Natural Habitats &c) Regulations 1994, place a stringent requirement that, normally, before a development proposal is approved, it should be ascertained that proposals will not adversely affect the integrity of a Natura site; exceptions may only be made where there are imperative reasons of overriding public interest. Scottish Executive national planning guidance (NPPG 6 revised) states that wind farms should not adversely affect the interest for which an SSSI is designated.
15. While neither the legislation nor planning guidance preclude wind farm development in or near an SPA or SSSI designated for bird interests, it follows that a greater effort in detailed study is required to demonstrate whether a proposal is acceptable or not, so development costs are greater. There is also a higher chance that a planning application will be refused, so development costs are less likely to be recouped. Hence, it is clearly beneficial to all stakeholders that an early identification of whether a site is important for birds or not should be part of the site selection process. This may be considered as the very earliest stage of assessment, and ideally occurs before the formal Environmental Impact Assessment process is entered.
16. Natura sites are accorded the highest sensitivity to wind farm development in SNH's strategic locational guidance for onshore wind farms, and all areas with several bird species of conservation importance likely to be sensitive to wind farm development are classed as of medium sensitivity.
17. The European Wind Energy Association recommends that wind farms should not be located in areas important for birds, such as Special Protection Areas (SPAs) or Ramsar sites (European Wind Energy Association 1999). The Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats 2003) has also echoed the need to avoid areas which are important for birds (page 6):

    'There is a strong consensus that location is critically important to avoid deleterious impacts of wind farms on birds. There should be precautionary avoidance of locating wind farms in statutorily designated or qualifying international (e.g. Natura sites – SPAs and SACs) or national sites for nature conservation, or other areas with large concentrations of birds, such as migration crossing points, or species identified as being of conservation concern. The favourable conservation status of habitats and species in these areas is a central tenet to their designation, requiring demonstration of compatibility with this aim by any proposed development. The weight of evidence to date indicates that locations with high bird use, especially by protected species, are not suitable for wind farm development.'
18. Note that the protection arrangements for designated sites take account of the fact that developments outwith the site boundary may affect the interest within. Therefore, for

proposed wind farm sites which lie outwith but close to the boundary of a site designated for its bird interest, then the bird interest for the designated site should be also included as explicit targets for analysis of bird impacts. The distance over which such effects may be important will be related to the foraging ranges of the species concerned.

3 Review of Existing Data

3.1 Designated sites

The Firth of Forth is a complex of estuarine and coastal habitats in south-east Scotland stretching east from Alloa to the coasts of Fife and East Lothian. The site includes extensive invertebrate-rich intertidal flats and rocky shores, areas of saltmarsh, lagoons and sand dune. The area is underpinned by the Firth of Forth SSSI due to its internationally and nationally important numbers of wintering and moulting wildfowl and waders. It is also designated as a SPA and Ramsar site as a result of the populations of birds using it, as described below (taken from the citation documents which are presented in full in Appendix A):

Firth of Forth SPA

- "The Firth of Forth SPA qualifies under Article 4.1 by regularly supporting wintering populations (1993/94-97/98 winter peak means) of European importance of Annex 1 species: red-throated diver *Gavia stellata* (90 individuals 2% of GB), Slavonian grebe *Podiceps auritus* (84; 2% of NW Europe, 21% of GB), golden plover *Pluvalis apricaria* (2,949;1% of GB) and bar tailed godwit *Limosa lapponica* (1,974; 2% of Western Europe, 4% of GB)."
- "The site further qualifies under Article 4.1 by regularly supporting post-breeding (passage) population of European importance of the Annex 1 species sandwich tern *Sterna sandvicensis* (1,617, 6% of GB, 1% of East Atlantic)."
- "The Firth of Forth SPA qualifies under Article 4.2 by regularly supporting wintering populations (1993/94-97/98 winter peak means) of both European and international importance of the migratory species pink-footed goose *Anser brachyrhynchus* (10,852; 6% of Icelandic/Greenlandic), shelduck *Tadorna tadorna* (moulting flock of 4,509; 2% of NW European), knot *Calidris canutus* (9,258; 3% of western European/Canadian), redshank *Tringa totanus* (4,341; 3% of European/West African) and turnstone *Arenaria interpres* (860 individuals; 1% of European)."
- "The Firth of Forth SPA further qualifies under Article 4.2 by regularly supporting a wintering waterfowl assemblage of European importance: a 1992/93-96/97 winter peak mean of 95,000 waterfowl, comprising 45,000 wildfowl and 50,000 waders. This assemblage includes nationally important numbers of 15 migratory species: great crested grebe *Podiceps cristatus* (720; 7% of GB), cormorant *Phalacrocorax carbo* (682; 5% of GB), scaup *Aythya marila* (437; 4% of GB), eider *Somateria mollissima* (9,400; 13% of GB), long-tailed duck *Clangula hyemalis* (1,045; 4% of GB), goldeneye *Bucephala clangula* (3,004; 18% of GB), red-brested merganser *Mergus serrator* (670; 7% of GB), oystercatcher *Haematopus ostralegus* (7,846; 2% of GB), ringed plover *Charadrius hiaticula* (328; 1% of gB), grey plover *Pluvialis squatarola* (724; 2% of GB), dunlin *Calidris alpine* (9,514; 2% of GB), and curlew *Numenius arquata* (1,928; 2% of GB). The assemblage also includes large numbers of the following species: wigeon *Anas penelope* (2,139 [1991/2-95/96]), mallard *Anas platyrhynchos* (2,564 [1991/2-95/96]) and lapwing *Vanellus vanellus* (4,148 [1991/2-95/96])."

Firth of Forth Ramsar site

- "The Firth of Forth qualifies as a Ramsar site under Criterion 3a by regularly supporting in winter over 20,000 waterfowl. The site supported a 1993/94-97/98 winter peak mean of 95,000 waterfowl, comprising 45,000 wildfowl and 50,000 waders."
- "The Firth of Forth Ramsar site qualifies under Criterion 3c by regularly supporting internationally important wintering populations (1993/94-97/98 winter peak means) of Slavonian grebe *Podiceps auritus* (84; 2% of NW Europe, 21% of GB), pink-footed

goose *Aser brachyrhynchus* (10,852; 6% of Icelandic/Greenlandic and GB population), shelduck *Tadorna tadorna* (moulting flock of 4,509; 2% of NW Euoprean, 6% of GB), goldeneye *Bucephala clangula* (3,004; 1% of NW European, 18% of GB population), knot *Calidis canutus* (9, 258; 3% of western European/Canadian and GB), redshank *Tringa tetanus* (4,341; 3% of European/West African, 4% of GB), bar-tailed godwit *Limosa lapponica* (1,974; 2% of Western Europe, 4% of GB) and turnstone *Arenaria interpres* (860 individuals; 1% European and GB). It also qualifies by supporting an internationally important post-breeding concentration of sandwich tern *Sterna sandvicensis* (1,617, 1% of East Atlantic, 6% of GB.)"

Firth of Forth SSSI

The Firth of Forth SSSI is designated for it's coastal habitats and species, as well as it's geological interest. The Firth of Forth SSSI comprises an extensive mosaic of intertidal and coastal habitats. Extensive mudflats make up much of the intertidal area with areas of sand, shingle, rock and boulders. Associated coastal habitats include saltmarsh, grassland and sand dunes.

The mudflats are invertebrate rich and form important feeding grounds for the abundant waders and wildfowl in the Forth. Mussel beds occur on the lower shores in some areas and marine algae such as *Fucus*, *Ascophyllum* and *Enteromorpha* species, and eelgrass *Zostera* species are supported on these mudflats.

The site is considered to be of special interest for the following habitats and species:

- Saltmarsh/sand dune
- Fen and lagoon
- Grassland (coastal, neutral, dune and maritime grassland)
- Vascular plants - Nationally scarce species include eelgrasses – narrow-leaved eelgrass *Zostera angustifolia*, eelgrass *Z. marina*, dwarf eelgrass *Z. noltii*, which are supported on the extensive mudflats.
- Invertebrates - Several nationally scarce species of invertebrates occur, including the Sand Dart moth *Agrotis ripae*, and the northern brown argus butterfly *Aricia artaxerxes*, scarce and declining in Britain, which has two Fife colonies, between Burntisland and Kirkcaldy, and East Wemyss and Anstruther.
- Wildfowl and waders - Internationally and nationally important numbers of wintering and moulting wildfowl and waders occur in the inner Forth, at Kinneil Kerse, Skinflats, Torry Bay and Alloa Inches. Nationally important numbers of wintering divers, grebes and sea ducks frequent the offshore areas of the outer Forth.
- Breeding birds – Nationally important breeing eider occur at Aberlady Bay and important breeding colonies of shelduck occur at Aberlady Bay, Alloa Inch and Skinflats. Nationally important breeding ringed plover occur at Gllane to Broadsands, Skinflats and Tyninghame. There are also important breeding colonies of three species of tern, common, Arctic and little, supported at Aberlady and Tyninghame. The cliffs at Tantallon on the North Berwick coast support one of largest colonies of Fulmar in the Forth and the only large colony on the mainland. There is also a colony of cliff nesting house martins of regional importance.

3.2 Literature Review: Wind Farms and Birds

A significant amount of research has been undertaken internationally into the impact of wind farms on birds. However, much of the research is very recent and few studies provide results over long periods of time. Studies have produced mixed results dependent on a

variety of factors, including the topography of the area surrounding the wind farm, number and type of species, population sizes and the development's specification. Wind farms can affect bird populations in four main ways:

1. Displacement from the area of the wind farm.
2. Death through collision or interaction with the turbine blades.
3. Direct habitat loss through construction of the turbine and associated infrastructure.
4. Barrier effects causing birds to avoid the area where the wind turbine is sited.

Due to the scale and location of the wind turbine, it is considered the most likely sources of impact could occur through items 1, 2 and 4 above.

3.2.1 Displacement due to Disturbance

The presence of turbines on a site can directly cause displacement of birds through visual and acoustic disturbance. Furthermore, personnel and vehicles on the site during construction and operation can create disturbance to bird populations. The scale and degree of disturbance and displacement of birds is considered site and species specific, necessitating assessment of a projects' disturbance on a site by site basis (Drewitt and Langston 2006)[1]. The current literature does not offer any conclusions or guidelines on the issue of disturbance as there are few studies addressing the problem. Those that have been carried out often lack before/after data, wind farm area/reference area comparisons or are carried out over too short a time scale.

Pedersen and Poulsen (1991)[2] found that wintering waterfowl (particularly species of geese) became less abundant at a distance of less than 800m from the wind farm, however 600m is widely accepted as the maximum reliably recorded distance for disturbance (Drewitt and Langston 2006)[1]. Petersen *et al.* (2004)[3] found that northern gannets (*Morus bassanus*), common scoters (*Melanitta nigra*) and common guillemots (*Uria aalge*) were present in lower numbers in the wind farm area post-construction, however gull and tern numbers increased within the area. General observations of resting and foraging waterbirds at three wind farms in Flanders, Belgium noted that they tend to keep a distance of between 150 and 300m from the wind turbines (Everaert 2003)[4].

Hötket *et al*. (2006)[5] evaluated 127 separate wind farm studies and found that the impact of wind farms on non-breeding birds was stronger than on breeding birds. Wind farms had a significantly negative effect on local populations of geese, wigeon, golden plover and lapwing. Geese and waders, particularly, were shown to avoid approaching the wind farm in the non-breeding season, with distances up to 500m form the turbines.

The variability in study results infers that disturbance is highly variable, depending on many factors including: seasonal and diurnal patterns of use by birds, the species of bird, the number of birds, the stage of lifecycle each individual is in, the turbine location with respect to important habitats, availability of alternative habitats, and turbine and wind farm specifications (Drewitt and Langston 2006)[1].

[1] Drewitt A.L. & Langston R.H.W. (2006) Assessing the impacts of wind farms on birds. Ibis 148:29–42
[2] Pedersen, M.B. & Poulsen, E. (1991) Impact of a 90 m/2MW wind turbine on birds. Avian responses to the implementation of the Tjaereborg wind turbine at the Danish Wadden Sea. Danske Vildtunderogelser Haefte 47. Rønde, Denmark: Danmarks Miljøundersøgelser
[3] Petersen, I.K., Clausager, I. & Christensen, T.J. (2004) Bird Numbers and Distribution on the Horns Rev. Offshore Wind Farm Area. Annual Status Report 2003. Report commissioned by Elsam Engineering A/S 2003. Rønde, Denmark: National Environmental. Research Institute
[4] Everaert J. (2003) Wind Turbines and Birds in Flanders: Preliminary study results and recommendations. Natuur.Oriolus 69(4):145-155
[5] Hötker H., Thomsen, K-M. & Jeromin H. (2006. Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats. Micheal-Otto-Institut im NABU, Bergenhusen,

The incidence of bird habituation to wind farms has been reported by Langston and Pullan (2003)[6], though there is little supporting evidence. Some studies' results are known to contradict their findings, with bird abundance continuing to decrease the longer the wind farm is operational (e.g. Stewart et al. 2004)[7]. The lack of research carried out in addressing this subject, the difficulty in isolating the cause of the change in bird abundance and the variability between wind farm projects and their effects prevents definitive conclusions being made regarding habituation by birds.

A recent study by Pearce-Higgins *et al.* (2009)[8] concluded that species occupying remote semi-natural habitats are more sensitive to wind farm development than species occupying intensive production landscapes.

3.2.2 Collision Risk

A review of available literature on collision rates and wind farm assessments by Drewitt and Langston (2006)[1] found collision rates per turbine varied between 0.01 and 23 birds annually. The maximum value is from a coastal site in Belgium where mainly gulls, ducks and terns were affected (Everaert *et al.* 2001)[9]. However a study by Everaert (2003)[4] of a wind farm on a canal in Belgium had a collision rate as high as 125 birds per wind turbine per year (mainly locally common species of gulls and ducks) on one of the surveyed turbines, with average rates for three wind farms of 24, 35 and 18 birds per turbine per year. This study also suggests that all collision statistics should be considered as a minimum.

Studies of sites in the Netherlands recorded average collision rates of 0.01 to 1.2 birds per turbine per year (wintering waterfowl, gulls and passerines) (Winkelman 1992)[10] and 6 birds per turbine per year (eider and gulls) at Blyth in Northumberland (Painter *et al.* 1999)[11]. However neither of these examples was associated with significant population declines.

Wind farms in Altamont Pass, California and certain sites in Spain (e.g. Navarre), have had significant levels of mortality associated with wind farms. However, the size of the wind farm (in the case of Altamont Pass) and the location of the wind farm (in the case of Navarre) are considered major factors for the impacts on certain raptor populations, since even small collision rates per turbine can have significant impacts when turbines number in the thousands.

Some studies on collisions of birds with wind turbines suggest a relatively low level of mortality (e.g. Painter et al. 1999)[11]. However, this could be a result of the locating of many farms away from large bird concentrations. Also, the difficulty in accurately recording the number of collision kills could lead to erroneous results (Langston and Pullan 2003)[6].

Terminal injury or direct mortality can be caused by both collisions with rotors and other associated structures on the site. Winkelman (1992)[10] provides evidence of birds being forced to the ground and killed through vortex forces created by the moving rotors.

Collision risk is dependent on many factors, principally including the following:

[6] Langston, R.H.W. & Pullan, J.D. (2003) Wind farms and birds: an analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues. Report written by Birdlife International on behalf of the Bern Convention. Council Europe Report T-PVS/ Inf.
[7] Stewart, G.B., Coles, C.F. & Pullin, A.S. (2004) Effects of Wind Turbines on Bird Abundance. Sytematic Review no. 4. Birmingham, UK: Centre for Evidence-based Conservation
[8] Pearce-Higgins, J. W., Stephen, L., Langston, R. H. W., Bainbridge, I. P. and Bullman, R. (2009) The distribution of breeding birds around upland windfarms. Journal of Applied Ecology 46, 1323-1331.
[9] Everaert, J., Devos, K. & Kuijken, E. (2001) Windtrubines en vogels in Vlaaneren: Voorlopige Onderzoeksresultaten En Buitenlandse Bevindingen [Wind Turbines and Birds in Flanders (Belgium): Preliminary Study Results in a European Context]. Instituut Voor Natuurbehoud. Report R.2002.03. Brussels B.76pp. Brussels, Belgium: Institut voor Natuurbehoud
[10] Winkelman, J.E. (1992). The impact of the Sep wind park near Oosterbierum, the Netherlands on birds 2: nocturnal collision risks. RIN rapport 92/3 Arnhem: Rijksintituut voor Natuurbeheer
[11] Painter, A., Little, B. & Lawrence, S. (1999). Continuation of Bird Studies at Blyth Harbour Wind Farm and the Implications for Offshore Wind Farms. Report by Border Wind Limited DTI, ETSU W/13/00485/00/00

Bird species: Large birds with poor manoeuvrability are less able to take avoiding action and have a larger wingspan, creating a greater area for the turbine blades to strike (Larsen and Clausen 2002)[12].

Population size: The incidence of collision will be directly related to the number of birds in the area surrounding the turbines, as passes through the turbine airspace will be more frequent (Drewitt and Langston 2006)[1].

Behaviour: The activity of birds can influence the amount of time they spend within the airspace of the wind farm. This mostly concerns soaring raptors, but commuting species (e.g. geese) can also be affected, needing to fly through wind farms on a daily basis to travel between feeding and roosting sites. Crepuscular and nocturnal species are also more susceptible, being less able to detect the turbines by sight (Larsen and Clausen 2002)[12].

Site topography: Some land features will be used by different species (e.g. soaring birds use hills for lift), meaning siting of a wind farm in these areas could increase collision rate. Wind farms on migratory flyways and local flight paths is also suggested as having the potential for significant adverse affects on birds (Drewitt and Langston 2006)[1]. In coastal sites the collision risk will also vary according to the spatial movement of birds according to currents and the state of the tide.

Wind farm dimensions and turbine position: The number of turbines, their size, alignment and rotor speed are all likely to influence the risk of collision (Thelander et al. 2003)[13]. There is also evidence that warning lights on the structures can increase collision rate, especially when there is poor visibility (Ericksson *et al.* 2001)[14], either by disorientating birds or attracting them.

Weather: Evidence from some studies suggests that more birds will collide with turbines when visibility is affected due to bad weather (Erickson *et al.* 2001)[14].

The level of terminal collision needs to be put into perspective on a site by site basis, as the loss of individuals can be insignificant to the integrity of a population if there are large numbers of birds of a high fecundity species. Issues are more apparent when the development impacts long-lived species with low fecundity and slow maturation rates, or species with low population levels (Drewitt and Langston 2006)[1].

3.2.3 Habitat Change and Loss

The actual footprint of a wind farm is relatively small with only 2-5% of land being lost to the development (Fox *et al.* 2006)[15]. However, the integrity of the site could be altered if siting of turbines and construction significantly affect conditions on the site (Drewitt and Langston 2006)[1]. It is considered that the impact on bird populations would be more extensive if the presence of the turbines on the site prevents bird species using the site for feeding or other activities.

3.2.4 Barrier Effects

Wildfowl have been recorded avoiding wind farms by between 100 and 3000m (Kahlert *et al.* 2004)[16]. This has a potential for population disturbance by increasing energy expenditure

[12] Larsen, J.K. & Clausen, P. (2002) Potential wind park impacts on whooper swans in winter: the risk of collision. Waterbirds 25: 327–330
[13] Thelander, C.G., Smallwood, K.S. & Rugge, L. (2003) Bird Risk Behaviours and Fatalities at the Altamont Pass Wind Resource Area. Report to the National Renewable Energy Laboratory, Colorado
[14] Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, D.P., Jr Sernja, K.J. & Good, R.E. (2001). Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States. Western EcoSystems Technology Inc. National Wind Coordinating Committee Resource Document. http:// www.nationalwind.org/publications/avian.html
[15] Fox, A.D., Desholm, M., Kahlert, J., Christensen, T.K. & Krag Petersen, I.B. (2006). Information needs to support environmental impact assessments of the effects of European marine offshore wind farms on birds. In Wind, Fire and Water: Renewable Energy and Birds. Ibis 148 (Suppl. 1): 129–144
[16] Kahlert, J., Petersen, I.K., Desholm, M. & Clausager, I. (2004). Investigations of migratory birds during operation of Nysted offshore wind farm at Rødsand: Preliminary Analysis of Data from Spring 2004. NERI Note commissioned by Energi E2. Rønde, Denmark: National Environmental. Research Institute

of individuals and affecting regularly used flight paths between important sites for feeding, roosting, etc. On a small scale the impact of barrier effects on bird populations has been found to be not significant. However the cumulative effect of numerous wind farms, or extensive sites could have a negative effect on populations (Drewitt and Langston 2006)[1].

3.2.5 Conclusions from Literature Review

The inconclusive nature of studies carried out on birds and wind farms necessitates careful location of wind turbines using a precautionary principle. This is crucial to minimise or avoid deleterious effects on bird populations (Langston & Pullan, 2003). Due to the dispersed nature of many species listed on Annex 1 of the Birds Directive (rare/vulnerable in Europe), it is not sufficient to rely on the protected sites network alone to indicate areas where bird/wind farm conflicts are likely to arise. RSPB have created a sensitivity map of Scotland to aid location of onshore wind farms, based on the distribution of a range of species of conservation concern (Appendix B). The proposed site falls within a tetrad classified as "high sensitivity", which was taken into account when devising the methodology for this study.

3.3 Historical Data and Records: British Trust for Ornithology

A record search for Wetland Bird Survey (WeBS) data was commissioned with the British Trust for Ornithology. This provided recent data for bird counts over five years for the Core Count area of East Wemyss to Leven power station (Area 85433, Figure 3). These data have been used to ensure the collected sample data is representative of the overall populations of bird species in the area, as well as describing general species and trends within this locality.

The summary WeBS data was used to produce Table 3.1, which shows the abundance of birds for which the Firth of Forth SPA was designated. It also shows the bird population counts of the East Wemyss to Leven power station area, which includes the site for development, and the proportion of the SPA populations it represents.

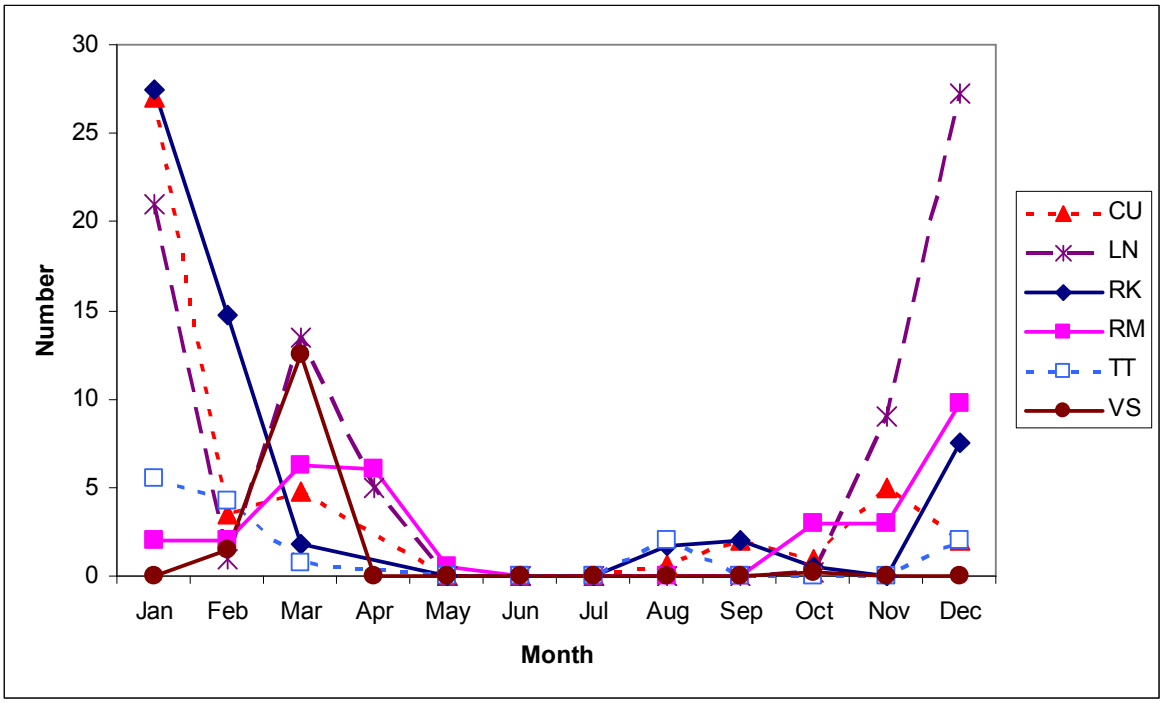
Table 3.1: The abundance of species of qualifying interest for the Firth of Forth SPA and within the East Wemyss to Leven power station core count area (85433).

The Firth of Forth SPA qualifying species	Firth of Forth SPA bird assemblage-winter peak means 1993-98 / sandwich tern post-breeding peak mean 1993-98 (percentage of GB population)	East Wemyss to Leven power station bird assemblage-winter peak means 2000-05 / sandwich tern post-breeding peak mean 2000-05 (percentage of SPA population)
Article 4.1 birds: wintering populations of species of European importance (Annex 1).		
Red throated diver	90 (2%)	2 (2.2%)
Slavonian grebe	84 (21%)	1 (0.250%)
Golden plover	2949 (1%)	not recorded during the winters
Bar-tailed godwit	1974 (4%)	not recorded during the winters
Article 4.2 birds: wintering populations of migratory species of European and international importance.		
Pink-footed goose	10 852 (6%)	not recorded during the winters
Shelduck	4 509 (2%)	not recorded during the winters
Knot	9 288 (3%)	23 (0.2%)

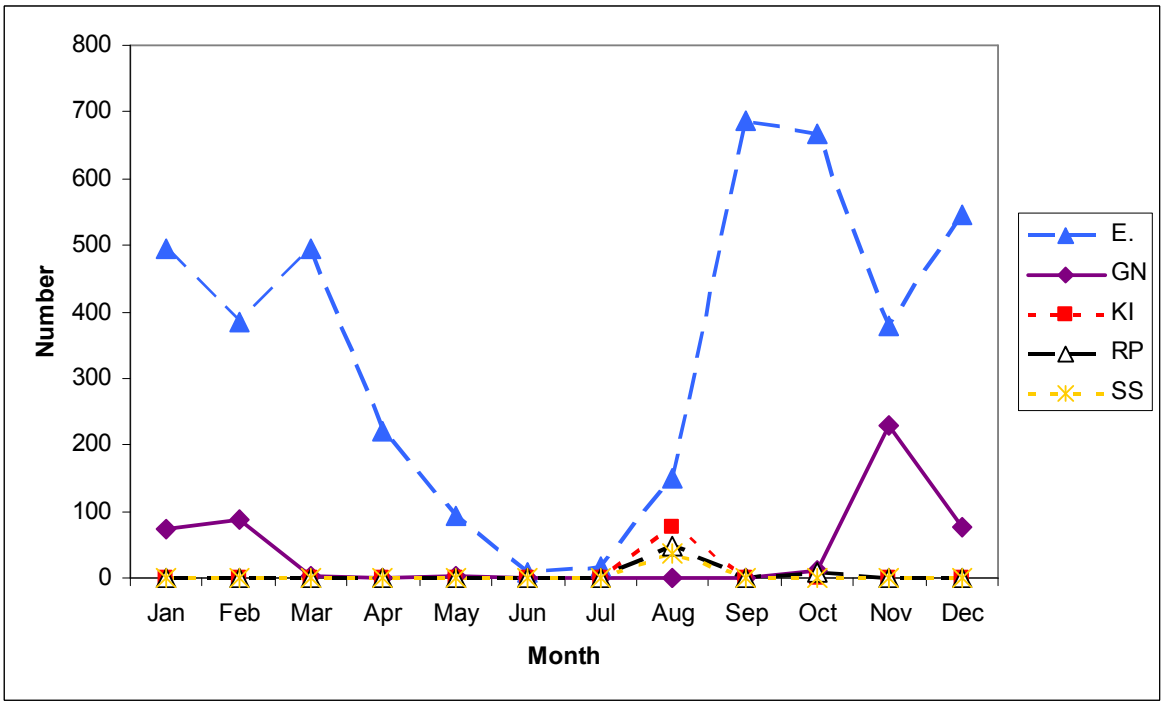
The Firth of Forth SPA qualifying species	Firth of Forth SPA bird assemblage-winter peak means 1993-98 / sandwich tern post-breeding peak mean 1993-98 (percentage of GB population)	East Wemyss to Leven power station bird assemblage-winter peak means 2000-05 / sandwich tern post-breeding peak mean 2000-05 (percentage of SPA population)
Redshank	4 341 (3%)	28 (0.6%)
Turnstone	860 (1%)	7 (0.8%)
Article 4.2 birds: winter waterfowl assemblage of European importance including the following species:		
Great crested grebe	720 (7%)	1 (0.10%)
Cormorant	682 (5%)	53 (7.8%)
Scaup	437 (4%)	3 (0.7%)
Eider	9 400 (13%)	597 (6.4%)
Long-tailed duck	1 045 (4%)	45 (4.3%)
Common scoter	2 880 (8%)	126 (4.4%)
Velvet scoter	635 (21%)	13 (2.0%)
Goldeneye	3 004 (18%)	139 (4.6%)
Red-breasted merganser	670 (7%)	14 (2.1%)
Oystercatcher	7 846 (2%)	157 (2%)
Ringed plover	328 (1%)	not recorded during the winters
Grey plover	724 (2%)	not recorded during the winters
Dunlin	9 514 (2%)	not recorded during the winters
Curlew	1 928 (2%)	21(1.1%)
Wigeon	2 139 (no data)	1(0.04%)
Mallard	2 564 (no data)	not recorded during the winters
Lapwing	4 148 (no data)	not recorded during the winters
Article 4.1 birds: post breeding population of a species of European importance (Annex 1)		
Sandwich tern	1617 (6%)	380 (23.5%)

Raw data for the period 2000/01-2004/05 was also obtained for the East Wemyss to Leven power station core count area (85433). This data was used to identify relative abundance of various species through the year by calculating average count numbers per month over the 5-year period. This was undertaken for a selection of species which were recorded within the survey area, either during vantage point or spatial distribution surveys. The results are shown in Graphs 3.1 to 3.3 below.

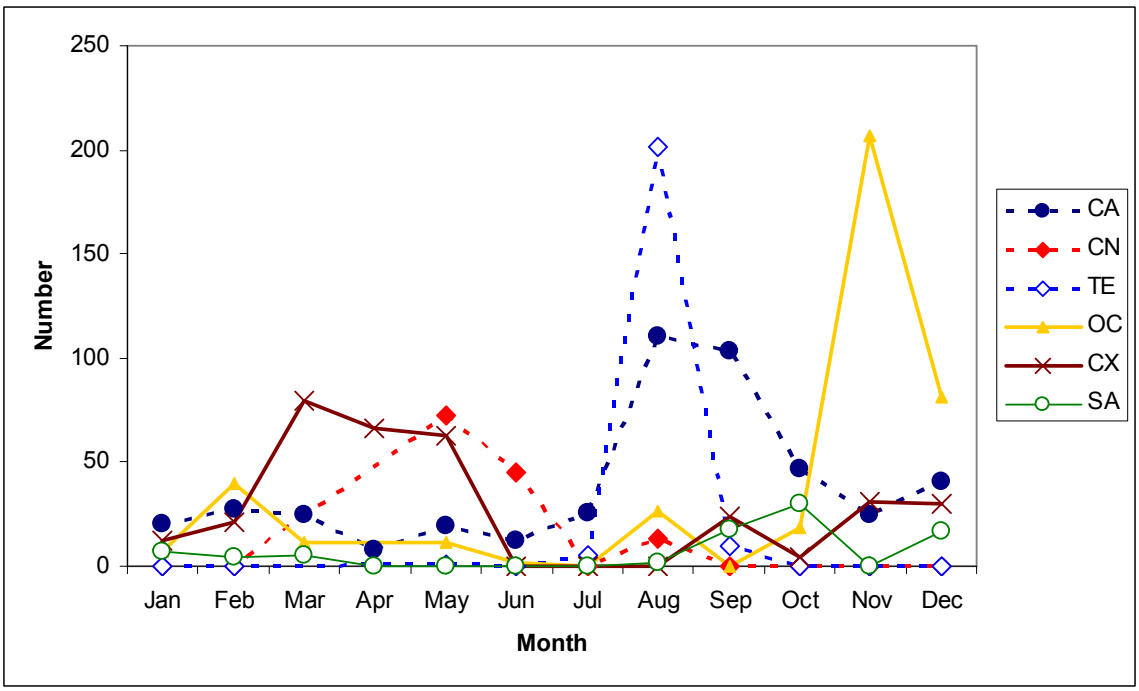
Graph 3.1: Mean Monthly Recorded Counts for Curlew (CU), Long-tailed Duck (LN), Redshank (RK), Red-breasted Merganser (RM), Turnstone (TT) and Velvet Scoter (VS).



Graph 3.2: Mean Monthly Recorded Counts for Eider (E.), Goldeneye (GN), Kittiwake (KI), Ringed Plover (RP) and Sanderling (SS).



Graph 3.3: Mean Monthly Recorded Counts for Cormorant (CA), Common Tern (CN), Sandwich Tern (TE), Oystercatcher (OC), Common Scoter (CX) and Shag (SA).



4 Methodology

The site is considered to be of high sensitivity based on its location on the edge of the Firth of Forth and proximity to the sites designated for bird interests. Furthermore, a publication produced by the Royal Society for the Protection of Birds (RSPB) suggests that the site location is within an area designated “high sensitivity” for the location of wind farms (Appendix B, Bright *et al.* 2006). However, it is also recognised that the scale of the development is comparatively small with only a single turbine proposed. The scope of the survey has been designed to reflect both of these factors.

4.1 Field Surveys

Field methodologies are based on those described in the SNH guidance for wind farm (SNH 2005). Surveys were carried out over a 12 month period to account for seasonal variations in abundance of different species. Different tidal states, times of day and weather conditions were sampled across the survey period to ensure data was collected over a range of conditions.

4.1.1 Vantage Point Surveys

SNH defines Vantage Point (VP) surveys as: “a means of quantifying flight activity of bird species of conservation importance that takes place within the wind farm envelope, with the principal aim of determining the likely collision risk. Activity patterns and time spent flying within the turbine envelope may also allow an assessment of the consequences of displacement assuming that the turbines are built.”(SNH 2005)

The SNH guidance has been applied to investigate bird activity around the site. Through consultation with SNH the generic guidelines have been modified to ensure the data collected is most appropriate for this project. The specific methodology used is described below.

The VP method involves a surveyor being positioned on a prominent point overlooking the survey site. The VP location is indicated in Figure 4 (grid reference NT36599, 98364). From this point the entirety of the site can be observed easily, and the surveyor has good views of the surrounding area within 270 degrees to the north through to the west. This point is fixed and used for every VP survey of the site.

The survey area was defined with a 330m grid square around the grid reference (NT 368 984) of proposed turbine, which is shown in Figure 4. The figure of 330m is derived from the turbine swept area (the rotor diameter of 130m) plus a 100m buffer. Photo 1 in Appendix I shows a panoramic view of the FEP site and the Firth of Forth from the vantage point.

Watches were undertaken during daylight hours, each lasting four hours. During each watch two hierarchical recording methods were used to record data: focal animal sampling for target species and activity summaries for secondary species.

Target species included all species found on the Firth of Forth SPA/SSSI/Ramsar citations, encompassing all waders, wildfowl, auks and terns. In addition, any raptors were included, as well as gannet, kittiwake and fulmar. The remaining bird families were considered secondary species (e.g. gulls, corvids, passerines).

4.1.1.1 Focal Animal Sampling

The survey area was scanned continuously for a target species. Upon detection the target species was tracked through the survey area until it left or landed. The path of the flight was marked on a map of the site as well as the height at which the target species passed through the survey area. The following height bands were used to categorise altitude and each observed flight was estimated to be within one of the height bands as shown in Table 4.1.

Table 4.1: Height bands surveyed during focal animal sampling

Height Bands			
1	2	3	4
0-10m	10-30m	30-85m	85m+

The swept area of the rotors of the wind turbine would be mainly within Height 3 and Height 4, as described in section 4.3 below. These height bands, however, were not determined specifically for the 2B Energy demonstrator offshore turbine, but for a non-specific medium sized onshore turbine with a capacity up to 850kW and a hub height up to 55m and blade diameter up to 52m. These height bands were agreed with SNH and RSPB during the original consultation for the potential development of an onshore turbine within the FEP site. Ideally, there would be a further height bands which would determine birds flying above the 2B Energy turbine swept area, i.e. above 185m (see calculation below in Section 4.3).

4.1.2 Activity Summary

Prior to commencing the focal animal sampling part a census of all perched birds and those on any water bodies within the survey area was undertaken along with their activity (e.g. roosting, preening, loafing, mating or feeding). The survey area was much larger than the present site boundary for this assessment (for the single 2B Energy turbine), as the surveys conducted in 2006 and 2007 were designed to cover the whole of the FEP site and the adjacent coastal area. The area which was surveyed during the activity summary surveys is shown in Figure 5.

The wind strength and direction was also recorded. This was repeated every 30 minutes throughout the VP survey (altered from five minutes in the generic SNH guidance to allow greater time spent tracking target species). This data was recorded as indicated on the survey data form shown in Appendix C.

4.2 Survey Effort

The SNH guidance suggests at least 36 hours of observation for each vantage point, per season (breeding, non-breeding, migratory), indicating that this may be increased or decreased as required. It is considered that the main ornithological interest on this site will occur during the spring and autumn migrations and over-wintering period. Therefore, the survey effort for these seasons was as follows:

- 36hrs for autumn migration (September to November);
- 60hrs for wintering birds (October to March);
- 36hrs for spring migration (March to May);
- 36hrs for summer activity (late-May to early-September).

A schedule of the exact dates and time of each survey is provided in Appendix D. It is considered that this level of survey effort provided a sample of data representative of the actual bird populations which occur on the site.

4.3 Collision Risk Assessment

To determine the collision risk to the species observed flying within the site boundary during the surveys, a collision risk model is used. This modelling method has been developed by W. Band to estimate the number of birds colliding over a period of time. The calculation is in

two stages: number of birds colliding per annum = number of birds flying through rotor (Stage 1) x probability of birds flying through rotor being hit (Stage 2).

As agreed by SNH, the 'Regular Flights through a Wind Farm' Stage 1 method was applied to all target species, except raptors. This approach to Stage 1 of the model is for bird populations which make regular flights through the wind farm, possibly in a reasonably defined direction. This applies for example to over-wintering geese making their twice-daily flights from roost to feeding areas, within habitually-used flight corridors; or to divers making regular feeding trips from nest sites to the coast.

The second approach to Stage 1 is most appropriate for birds such as raptors which occupy a recognised territory, and where observations have led to some understanding of the likely distribution of flights within this territory. This second approach was used for calculating the collision risk to peregrine which were observed flying within the site.

4.3.1 Stage 1: Number of birds flying through rotors

4.3.1.1 Regular flights through a wind farm

To estimate the collision risk for each species recorded, the flights that pass through the 'risk window' of the turbine must be identified. The risk window is "a window of width equal to the width of the wind farm across the general flight direction of the birds and of height equal to the maximum height of the highest turbine" as stated in the SNH guidance[17] based on the Band et al. 2005[18] model. In this case the risk window has been calculated as 330m (rotor diameter of 130m plus 100m buffer either side) multiplied by 130m (rotor diameter), which equals 42,900m².

Birds flying at heights 3 and 4 that were recorded within this risk window within the site boundary where assessed for their collision risk.

Once the number of birds observed flying through the risk window has been calculated from the observed data a scaling factor must be applied to the numbers to account for the potential number that would be flying through the risk window for a whole year. No guidance exists on how to calculate the scaling factor, however, SNH have recommended in the past that factors are derived based on the ecology of each species surveyed. Therefore, the following two approaches were developed for the species encountered during the surveys.

For species considered to be predominantly diurnal the active period was assumed to be predominantly during daylight hours. The amount of available daylight available within each month was calculated using civil twilight values produced by the US Astronomical Observations Dept for Methil (W003 00, N56 10) and aggregated into the winter period (Sept – Nov) and the summer period (March – Aug), and the whole year. This allowed a factor to be applied to the surveyed number of movements to calculate a predicted number of total movements the seasonal period the species is likely to be present. The factors used are given in Table 4.2 and were applied to all non-wading species.

Table 4.2: Adjustment factors for predominantly diurnal species

Season	Total light (days)	Total light (hours)	Survey effort (hrs)	Factor
Winter Species	40.2	964.7	60	16.1
Summer Species	65.0	1558.5	64	24.4

[17] SNH (2002). Windfarms and Birds: Calculating a theoretical collision risk assuming no avoiding action. SNH, Battleby.

[18] Band, W., Madders, M. and Whitfield, D.P. 2005. Developing field and analytical methods to assess avian collision risk at wind farms. In De Lucas, M., Janss, G. and Ferrer, M., eds. *Birds and Wind Power*. www.quercus.pt

All Year	52.8	1261.6	124	10.2

Certain species, particularly waders, are predominantly regulated by tidal cycles and hence require a different correction factor since the surveys would have sampled both active and inactive periods. The factors used to calculate a predicted number of total movements for tidal regulated species (i.e. all waders) for the winter period (Sept – Nov) and the summer period (March – Aug), and the whole year are given in Table 4.3.

Table 4.3: Adjustment factors for predominantly tidal regulated species

Season	Total time (days)	Total time (hours)	Survey effort (hrs)	Factor
Winter Species	90.5	2172	60	36.2
Summer Species	92	2280	64	35.6
All Year	91.3	2190	124	17.7

The observed numbers of flights during the various month of the survey were then adjusted using the scaling factor for the corresponding monthly period.

After the risk window and the scaled number of birds flying through the risk window per annum has been calculated; next the area presented by the wind farm rotors needs to be calculated. In this case the area is calculated for just one turbine based on a radius of 65m.

The total rotor area is then expressed as a proportion of the risk window which is then used to calculate the number of birds passing through the rotors by multiplying it by the total scaled number of birds through the risk window. An example of the Stage 1 model is shown in Appendix E.

4.3.1.2 Birds using the wind farm airspace

Firstly, the 'flight risk volume' has to be calculated, which is the area of the wind farm multiplied by the height of the turbine. Then the volume swept out by the turbine rotor is calculated. The bird occupancy within the flight risk volume is calculated. This is the number of birds present multiplied by the time spent flying in the flight risk volume, within the period for which the collision estimate is being made. As the flights of the peregrine recorded within the site boundary were not timed, we have assumed each flight recorded through the site boundary was 30 seconds, see Appendix F (Stage 1 worked example for peregrine).

The time taken for a bird to make a transit through the rotor and completely clear the rotors is calculated and then used to calculate the number of bird transits through the rotors.

An example of this Stage 1 model is shown in Appendix F.

4.3.2 Stage 2: Probability of bird being hit when flying through the rotor

This stage computes the probability of a bird being hit making a transit through a rotor. The probability depends on the size of the bird (both length and wingspan), the breadth and pitch of the turbine blades, the rotation speed of the turbine, and of course the flight speed of the bird.

To facilitate calculation, many simplifications have to be made. The bird is assumed to be of simple cruciform shape, with wings at the halfway point between nose and tail. The turbine blade is assumed to have a width and a pitch angle (relative to the plane of the turbine), but to have no thickness. The calculations used for Stage 2 of the model are explained in the SNH guidelines and Band et al. 2005. An example of the worksheet used for Stage 2 of the Band model is shown in Appendix E (a worked example for Oystercatcher).

Various turbine and bird parameters are required for Stage 2 of the model. The specifications of the turbine used in the assessment are provided in Table 4.4 and species specific parameters used are provided in Table 4.5 with reference to their source.

Table 4.4: Turbine Parameters

Number of Blades	2
Maximum Chord	5.75m
Total Turbine Height	179m
Hub Height	114m
Pitch (degrees)	20
Rotor Diameter	130m
Rotation Period	5sec

Table 4.5: Species Specific Parameters

Species	Length (m)	Wingspan (m)	Flight Speed (m/s)	References for Flight Speed*
Sandwich Tern	0.38	1.00	11.9	Wakeling & Hodgson (1992)[19]
Common Tern	0.33	0.88	9.8	Becker et al. (1993)[20]
Kittiwake	0.39	1.08	16.7	Oldén & Peterz 1985[21]
Fulmar	0.48	1.07	11.26	Spear & Ainley 1997
Cormorant	0.90	1.45	15.9	Spear & Ainley 1997
Shag	0.72	0.98	15.9	Spear & Ainley 1997
Gannet	0.94	1.72	16.22	Garthe et al. 2007[22]
Oystercatcher	0.42	0.83	16.67	Lower range of wader migration flights (16.67 to 19.44 m/s) as they would be mainly commuting. Taken from Zwarts et al. 1990[23]
Mallard	0.58	0.90	22.35	“most waterfowl fly at speeds of 40 to 60mph”[24]. Average of 50mph (22.35m/s) was used.
Velvet Scoter	0.54	0.94	22.35	Same as above

[19] Wakeling, J.M. & Hodgson, J. 1992. Optimisation of the flight speed of the little, common, and sandwich tern. J. exp. Biol. 169, 261-266.
[20] Becker, P. H., D. Frank, and S. Sudmann. 1993. Temporal and spatial pattern of Common Tern (*Sternahirundo*) foraging in the Wadden Sea. Oecologia 93: 389–393.
[21] Oldén B. & Peterz M. 1985. A statistical methof for determination of flight speed of migrating birds. J. Field Ornithol., 56(1):17-22.
[22] Garthe S, Montevecchi WA, Davoren G (2007) Flight destinations and foraging behaviour of northern gannets (*Sula bassana*) preying on a small foraging fish in a Low Arctic ecosystem. Deep Sea Res Part II 54:311–320
[23] Zwarts L.. Ens B.J., Kersten M. & Piersma T. 1990 Moult, mass and flight range of waders ready to take off for long-distance migrations. Adrea 78:339-364.
[24] http://www.reelfoot.com/migration_121206.htm

Peregrine Falcon	0.45	1.05	20.7	Pers. Comm. W. Band

* All references for Bird Length and Wingspan came from the BTO website.

From the turbine specification in Table 4.4 the swept area of the rotors would be between 49m – 179m from an average sea level. A summary of the height bands used during the field surveys are shown in Table 4.1.

A theoretical no-avoidance collision risk was then be calculated using the 'Band' model as described in the guidance produced by SNH and the parameters described above. The theoretical number of collisions was derived by multiplying the total number of movements through the swept area of the turbine by the probability of collision.

The collision result is accepted to be a gross over-estimation since it does not take into account the avoiding action which would be taken by many individuals. In order to calculate an actual estimate of collision rate using the 'Band' model, an avoidance rate must be applied to the results. SNH suggest that an avoidance rate of 95% is applied[25] to the resultant collision values to give a more accurate collision rate. An avoidance rate comprises two components: near-blade avoidance (i.e. birds taking emergency action to avoid being struck by the rotor) and long-range avoidance (i.e. birds avoiding flying through the wind farm altogether. The later comprises the barrier effect and displacement disturbance from a wind farm. There are currently no robust values of avoidance rates (particularly for how birds avoid colliding); however a value of 95% has been applied under the guidance of SNH.

Collision risk predictions were then compared against a 1% mortality increase in baseline mortality. A 1% mortality increase is generally considered to be a threshold, so that anything over a 1% increase would result in a significant decline in the population. The increase in mortality is calculated from the Firth of Forth and/or Firth of Forth Islands SPA populations or from national populations when the species does not qualify under the SPA; and the natural mortality rates are calculated from figures taken from the interactive version of 'Birds of the Western Palearctic'.

The potential for natural changes in populations of bird species over the operational period of the wind farm cannot be accurately predicted and therefore has not been taken into account.

[25] www.snh.gov.uk/strategy/renewable/sr-we00a2.asp

4.4 Assessment Methodology

The significance of the effects on the ornithological resource attributed to the construction and operational phase of the development is described in accordance with the significance criteria set out in Table 4.6.

Table 4.6: Generic Significance Criteria

Significance	Criteria
Extreme	These effects represent key factors in the decision making process. They are generally, but not exclusively associated with sites and features of national importance and resources/features which are unique and which, if lost, cannot be replaced or relocated.
Major	These effects are likely to be important considerations at a regional or district scale but, if adverse, are potential concerns to the project, depending upon the relative importance attached to the issue during the decision making process.
Moderate	These effects, if adverse, while important at a local scale, are not likely to be key decision making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.
Minor	These effects may be raised as local issues but are unlikely to be of importance in the decision making process. Nevertheless, they are of relevance in the detailed design of the project.
Negligible	Effects which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

5 Results

The data has been grouped into two main types: activity data of birds around the site and near the turbines which could be affected by disturbance or displacement, and vantage point data for birds at risk of colliding with the turbines during operation.

5.1 Activity data

Tabulated summaries of activity data recorded at the FEP site during the vantage points surveys are provided in Appendix H. These summaries provide an indication of non-flying bird activity within the survey area, particularly ducks, auks and divers which rarely left the water's surface, and encompass a larger area than the site boundary as indicated in Figure 5.

The bird assemblages recorded are typical of a coastal area with moderate disturbance from industrial activities. Eiders (*Somateria mollissima*), herring gulls (*Larus argentatus*) and lesser black-backed gull (*Larus fuscus*) were consistently seen during the survey period, with eiders recorded most frequently, seen in fluctuating numbers on 97% of surveys.

Notable wildfowl included goldeneye (*Bucephala clangula*), common scoter (*Melanitta nigra*), sandwich tern (*Sterna sandvicensis)* and red-throated diver (*Gavia stellata)*. Of greatest significance were numbers of cormorant (*Phalacrocorax carbo*) (9.5% September-November of Firth of Forth SPA cited population), red-throated diver (3.3% Sep-Nov of FoF SPA cited population), long-tailed duck (*Clangula hyemalis*) (2.7% Sep-Nov, 2.9% Dec-Feb and 1.7% Mar-May of FoF SPA cited population) and velvet scoter (*Melanitta fusca*) (1.1% Dec-Feb and 1.9% Mar-May of FoF SPA cited population).

Rock pipit (*Anthus petrosus*), linnet (*Carduelis cannabina*), yellow wagtail (*Motacilla flava*), pied wagtail (*Motacilla alba*), robin (*Erithacus rubecula*), wheatear (*Oenanthe oenanthe*) and chiffchaff (*Phylloscopus collybita*) were the only passerines recorded using the site. Of these, the most frequently occurring and abundant was the chiffchaff, a commonly occurring breeding species in the UK. These species were observed foraging on land within the survey area.

Peregrine (*Falco peregrinus*) was the only raptor found to use the site, with evidence of historic nesting within the FEP site.

Within the surveyed area (Figure 5), the sea was found to be the most utilised area where birds would rest. Eider and herring gulls were seen here in often substantial numbers on most of the survey days, with small numbers of common scoter, goldeneye, cormorant and long-tailed duck also frequently present.

The sea wall (see Photo 2, Appendix I) was also regularly used by resting birds, including herring gull, shag and black-headed gull. The feature was found to be used by birds on every survey day; however the frequency of use by each species was low.

With the exception of the peregrine, no breeding birds were observed in the area around the proposed turbine. The habitats present are considered generally unsuitable for breeding birds because of the lack of trees, bushes and other tall vegetation.

5.2 Vantage Point surveys and collision risk

There were a total of 30 species recorded flying within the site boundary, with a total of 2081 flights made during the survey periods. Of these species and flights only 12 species with a total of 73 flights were recorded flying within the collision risk heights (Height bands 3 and 4). Most bird movements recorded during the survey occurred at much lower altitudes, typically less than 10m, and almost exclusively over the sea and parallel to the coastline. Since it is considered that these movements are extremely unlikely to result in turbine collision, they were excluded from collision risk assessment.

10 of these 12 species used in the collision risk assessment were considered to be target species either due to being mentioned in the SPA, Ramsar and/or SSSI or they were requested target species by SNH and/or RSPB. The species observed flying through the site are listed in Table 5.1.

Table 5.1: Species recorded flying through the site boundary. Species in bold

Species	Target / Non-Target	Total Number of Flights	Number of flights at risk height	Peak Month of Flights	RSPB Birds of Conservation Concern (BOCC)*
Black-headed gull	Non-target	1	1	Sept	Amber
Black-throated diver	Target - Requested	1	0	Nov	Amber
Common guillemot	Target - Requested	5	0	Oct & Jul	Amber
Common gull	Non-target	2	0	Jul	Amber
Common Scoter	Target - SPA species	2	0	Mar & May	Red
Common tern	Target - SSSI species	65	5	May	Amber
Cormorant	Target - SPA species	408	4	Nov	Green
Curlew	Target - SPA species	9	0	Dec & Jan	Amber
Dunlin	Target - SPA species	9	0	Sept	Red
Eider	Target - SPA species	189	0	Oct	Amber
Fulmar	Target - SSSI species	14	5	May	Amber
Gannet	Target - Requested	270	20	Oct	Amber
Goldeneye	Target - SPA species	2	0	Jan & Feb	Amber
Grey plover	Target - SPA species	1	0	Oct	Amber
Kittiwake	Target - SSSI species	92	6	Jun	Amber
Long-tailed duck	Target - SPA species	15	0	Nov	Green
Mallard	Target - SPA species	4	2	Oct & Mar	Amber
Manx shearwater	Target - Requested	1	0	Oct	Amber
Oystercatcher	Target - SPA species	424	9	Feb	Amber
Peregrine falcon	Target - Requested	11	6	Nov	Green
Razorbill	Target - Requested	1	0	Sept	Amber
Red-breasted merganser	Target - SPA species	20	0	Dec	Green
Redshank	Target - SPA species	3	0	Oct & Nov & Feb	Amber
Red-throated diver	Target - SPA species	3	0	Sept	Amber
Ringed plover	Target - SPA species	2	0	Apr	Amber
Sandwich tern	Target - SPA species	243	11	Aug	Amber
Scaup	Target - Requested	1	0	Nov	Red

Species	Target / Non-Target	Total Number of Flights	Number of flights at risk height	Peak Month of Flights	RSPB Birds of Conservation Concern (BOCC)*
Shag	Target - Requested	271	2	Oct	Amber
Teal	Target - Requested	2	0	Oct	Amber
Velvet scoter	Target - SPA species	5	1	Oct & Feb	Amber

* Criteria based assessment by RSPB on the conservation status of UK birds [26] Red listed birds are either 1) globally threatened, 2) historical population decline in UK during 1800-1995, 3) Severe (at least 50%) decline in UK breeding population over last 25 years, or longer-term period, 4) Severe (at least 50%) contraction of UK breeding range over last 25 years, or longer-term period. Amber listed birds are either 1) Species with unfavourable conservation status in Europe (SPEC species), 2) historical population decline during 1800-1995, but recovering, 3) Moderate (25-49%) decline in UK breeding population, or longer-term period, 4) moderate (25-49%) contraction of UK breeding range over last 25 years, or longer-term period, 5) moderate (25-49%) decline in UK non-breeding population over last 25 years, or longer-term period, 6) rare breeders (1-300 breeding pairs in UK), 7) rare non-breeder (less than 900 individuals), 8) localised; at least 50% of UK breeding or non-breeding population in 10 or fewer sites, 9) internationally important; at least 20% of European breeding or non-breeding population in UK. Green listed birds are species that occur regularly in the UK but do not qualify under any of the above criteria.

The majority of the target species flights expect peregrine, were birds flying through the site area following the coastline, up to approximately 100m offshore (see Figure 6). All species observed flying through the site area were water birds and thus, were either commuting to and from feeding areas and/or roosting areas along the coast or feeding along the shallow waters of the coastline.

Autumn (September - November) had the most target species activity across the site and spring was found to be the period with least activity (Table 5.2). Graphs G1 to G4 in Appendix G show the total numbers of flights per month for each species observed flying within the site boundary.

Table 5.2: Average number of target species flights per hour of survey during each survey season.

Season	Period*	Average Number of Flights per Hour
Autumn	September-November	25.9
Winter	October-March	20.9
Spring	March-May	7.9
Summer	May-September	19.8

*As dictated by the SNH guidance (2005[27])

However, when looking only at the flights within the collision risk heights summer (May - September) had the most target species activity across the site and spring was still found to be the period with least activity (Table 5.3).

[26] Eaton MA, Brown AF, Noble DG, Musgrove AJ, Hearn R, Aebischer NJ, Gibbons DW, Evans A and Gregory RD (2009) Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man. British Birds 102, pp296–341.
[27] Scottish Natural Heritage (2005). Survey methods for use in assessing the impacts of onshore windfarms on bird communities. SNH, Battleby

Table 5.3: Average number of target species flights at collision risk height per hour of survey during each survey season.

Season	Period	Average Number of Flights per Hour
Autumn	September-November	0.8
Winter	October-March	0.4
Spring	March-May	0.3
Summer	May-September	1.0

The turbine parameters and the species specific parameters used within the collision risk models are shown in Table 4.4 and Table 4.5, and an example of the worksheet used for Stage 1 and Stage 2 of the Band model is shown in Appendix E (a worked example for Oystercatcher).

Table 5.4 shows the calculated collision risk for each of the target species which were recorded flying through the risk window at collision risk heights. The calculated collision risk figure is the predicted number of birds that will collide with the proposed turbine per year. An avoidance factor of 95% has been used for each of the models.

Table 5.4: Collision risk prediction per annum for target species observed flying within the site boundary. All predictions have had an avoidance factor of 95% applied to the model, and have been rounded up to two decimal places.

Species	No. of collisions assuming 95% avoidance
Common tern	0.12
Cormorant	0.04
Fulmar	0.12
Gannet	0.48
Kittiwake	0.11
Mallard	0.02
Oystercatcher	0.12
Peregrine falcon	0.26
Sandwich tern	0.24
Shag	0.02
Velvet scoter	0.01

Twelve species would be affected by the proposed turbine. All of these are on the Amber list of the RSPB Bird of Conservation Concern (BOCC), apart from peregrine falcon and cormorant which are on the Green list. The collision risk predictions for all species, including the SPA species, were low; with the Firth of Forth Islands SPA qualifying gannet, peregrine falcon and the Firth of Forth SPA qualifying sandwich tern having the highest predicted mortality of 0.48, 0.26 and 0.24 collisions per year, respectively. Velvet scoter, which is also a qualifying interest on the Firth of Forth SPA designation, had the lowest collision mortality of 0.01 collisions per year.

6 Impact Assessment

The impact assessment has been sub-divided into the five main types of impact associated with wind turbines and birds. For all aspects of the assessment it is recognised that an inherent degree of uncertainty exists in relation to predicting impacts.

6.1 Displacement from the area through the construction of the turbine

The potential for disturbance during the construction phase will impact birds both inland and offshore. Inland birds could be disturbed by ground works or vehicles and human movements associated with the construction of the turbine.

The activity surveys and historic records indicated that the only target species or high priority species breeding bird within the FEP site was a peregrine falcon. It is assumed in this assessment that structures in the FEP site that provide nesting habitat will remain undisturbed during the construction of the development. The FEP site and the surrounding areas have been under development and/or have been associated with moderate to high disturbance from humans and vehicles for some time. Thus the construction of the 2B Energy turbine is not considered to increase the disturbance sufficiently to adversely effect the breeding of the species within the area.

Other species which use the inland areas around the site are gulls, cormorant and shag which use the seawall and other coastal structures as resting locations. Again these species may have been habituated to some level of both human and vehicle disturbance around the FEP site and thus are not considered here to be adversely effected by the construction of the turbine.

The activity surveys also showed that large numbers of eider and herring gull frequently rest out on the water (within 100m of the coast) around the FEP site. Other species seen in smaller numbers, but frequently, were common scoter, goldeneye, long-tailed duck and cormorant. These species along with all the species observed flying along the coast have the potential to be disturbed and/or displaced from the area during construction. Although most of these species will be habituated to some level of disturbance within the area, due to the activities within FEP site and the Methil dock, species using the sea for resting and/or commuting along the coast may be completely excluded from the area of construction. Although these birds are likely to rest on the water further along the coast and the commuting birds can fly around the construction area, at a small energy cost of further flight, the distribution of birds in the SPA will be affected by the construction of the turbine and thus should be further considered.

The disturbance which will be caused during the construction of the turbine is considered here to have a potential to affect the distribution of the birds within the SPA and thus is consider at this stage to be of minor adverse significance.

6.2 Displacement from the area through the operation of the turbine

The potential displacement of birds from the area can be quantified using the summary data from the activity surveys. However, definitive distances are not available for the degree of displacement due to disturbance. Distances of up to 300m were suggested by Everaert (2003) for large groups of wintering ducks and up to 600m or more for wintering geese (Pedersen and Poulsen 1991). Hötket *et al*. (2006) concluded that geese and waders, particularly, were shown to avoid approaching wind farms in the non-breeding season, with distances up to 500m form the turbines. Individuals or small groups of non-breeding waterfowl and shorebirds have been observed to be less affected by disturbance (Everaert 2006). Recent studies of breeding terns have revealed that disturbance from wind turbines is relatively low, with availability of habitat a more likely factor determining nesting location than distance from a wind turbine (Everaert 2006).

Non-flying birds recorded in the study area from the activity summary surveys were typically distributed on the seaward side of the sea wall, and in many cases within 10m of it. This was particularly the case for cormorant, eider and long-tailed duck, which habitually tend to forage along the rocky subtidal stretch at the base of the seawall. Maximum counts of long-tailed duck indicate that up to 3% of the Firth of Forth SPA population regularly occur within this area during winter, although these numbers tended to be comprised of scattered individuals rather than large groups.

There could be a degree of habituation to the presence of the turbine for birds remaining in the area for extended periods. A review by Drewitt and Langston (2006) noted from studies at a Danish offshore wind farm that the number of common eider initially decreased in the 2 years post-construction, but subsequently recovered. Although it was unclear within the study whether this effect was due to disturbance or availability of prey, the eventual recovery suggests that a degree of habituation to the turbines must have occurred.

Red-throated diver were also observed within the activity summary area and despite the results indicating 3% of the Firth of Forth SPA population occurs within this area, a maximum of three individuals were recorded during a single survey visit. This area is therefore considered to be utilised infrequently by migrating individuals.

Velvet scoter were typically recorded on the outer seaward limits of the survey area, with greater numbers visible 800m – 1km further out into the Firth of Forth among large numbers of common scoter. Small rafts of individuals would occasionally drift into the survey area, but rarely reside for extended periods. For this reason, the effect of displacement on velvet is considered to be minor to negligible.

Overall, the effect of displacement on non-flying species is considered here to of minor significance. However, the disturbance impacts may have an effect on the distribution of the birds within the SPA, and as such should be further considered. The distribution of food resources within the SPA should be considered in relation to the potential exclusion zone for birds around the turbine.

Birds flying along the coast on the regularly use flight-path (as shown in Figure 6) will either be displaced and fly out further into the Firth of Forth or over land, fly higher above the turbine or below the turbine sweep, or they run the risk of collision. The majority of the flights recorded along the coast were below 30m and thus below the turbine. Nevertheless, wildfowl and waders have been shown to avoid an approaching wind farm in the non-breeding season, by distances up to 500m (Hötket *et al*. 2006). Thus, there is also the potential here for the distribution of birds with the SPA to be effected, and a potential energy cost of flight as the birds fly larger distances to avoid the turbine.

A study by Everaert (2006) of breeding terns revealed that disturbance from wind turbines is relatively low. Although this study looked at breeding site and showed that the availability of habitat is a more likely factor determining nesting location than distance from a wind turbine, it can be assumed that foraging terns are also likely to be relatively undisturbed by wind turbines and that the availability and distribution of food resources is likely to the determining factor in their foraging behaviour and flight lines.

6.3 Mortality through collision

The predicted collision rates for birds flying within the site boundary and within the height of the turbines swept area are shown in Table 5.4, above.

Each of these species will be assessed individually below by comparing, where possible, the predicted collision rates with a 1% increase in baseline mortality, which is used in this assessment as a threshold trigger for more detailed consideration of the potential effect on the population. Where the predicted collision mortality is less than a 1% increase in baseline mortality, the effect is considered to be negligible and needs no further

consideration. The increase in mortality is calculated from the Forth of Forth and/or Firth of Forth Islands SPA populations or from national populations when the species does not qualify under the SPA; and the natural mortality rates are calculated from figures taken from the interactive version of 'Birds of the Western Palearctic'. All of the calculation presented are based on adult birds.

6.3.1 Common tern

Common tern is a Firth of Forth Islands SPA species and is mentioned on the SSSI designation. Five flights were recorded within the site which resulted in a low collision risk prediction of 0.12 birds colliding per year. The 'Summer' Scaling Factor used for this species although the birds were only recorded in May. The 'Summer' Scaling Factor was chosen due to common terns being known to be present within this area during the summer months (BTO counts and records). The number of birds associated with a 1% increase in mortality in the baseline mortality for common tern within the SPA is estimated here to be 0.53 birds per year (as shown in Table 6.1) which is higher than the predicted collision risk at 0.12 birds.

Table 6.1: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth Islands SPA population of common terns

Local SPA population around the site	668 (Firth of Forth Islands SPA citation, SNHi SiteLink)
Background mortality (%)	8% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	0.53

The increase in mortality of common terns within the Firth of Forth Islands SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.2 Cormorant

Cormorant is listed in the Firth of Forth SPA designation and as such is considered a target species. A total of 4 cormorant flights were observed within the site at collision heights, as such the collision risk prediction for this species was low at 0.04 birds colliding with the turbine per year (using the 'All Year' scaling factor as this species is present year round). The number of birds associated with a 1% increase in mortality in the baseline mortality for cormorant within the SPA is estimated here to be 2.52 birds per year (as shown in Table 6.2) which is higher than the predicted collision risk at 0.04 birds.

Table 6.2: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth SPA population of cormorant

Local SPA population around the site	682 (Firth of Forth SPA, JNCC website)
Background mortality (%)	37% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	2.52

The increase in mortality of cormorant within the Firth of Forth SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.3 Fulmar

Fulmar is not a SPA species but is mentioned on the SSSI designation and the Firth of Forth Island SPA. Five flights were recorded within the site during the summer months which resulted in a low collision risk prediction of 0.12 birds colliding per year (using the summer scaling factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for fulmar within the SPA is estimated here to be 0.89 birds per year (as shown in Table 6.3) which is higher than the predicted collision risk at 0.12 birds.

Table 6.3: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth Islands SPA population of fulmar

Local SPA population around the site	1,596 (Firth of Forth Islands SPA citation, SNHi SiteLink)
Background mortality (%)	5.52% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	0.89

The increase in mortality of fulmar within the Firth of Forth Islands SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.4 Gannet

Gannet is listed on the Firth of Forth Islands SPA, for this reason this species was considered to be a target species and a collision risk model was construction.

20 flights were recorded within the site during the summer months which resulted in a low collision risk prediction of 0.48 birds colliding per year (using the summer scaling factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for gannet within the SPA is estimated here to be 28.79 birds per year (as shown in Table 6.4) which is considerably higher than the predicted collision risk at 0.48 birds.

Table 6.4: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth Islands SPA population of gannet

Local SPA population around the site	47,200 (based on 23,600 pairs at Bass Rock, part of the Firth of Forth Islands SPA, SNHi SiteLink)
Background mortality (%)	6.1% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	28.79

The increase in mortality of gannet within the Forth of Forth Islands SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.5 Kittiwake

Kittiwake is listed as in the Forth Islands SPA and is mentioned on the SSSI designation. Six flights were recorded within the site during the summer months which resulted in a low collision risk prediction of 0.11 birds colliding per year (using the summer scaling factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for kittiwake within the SPA is estimated here to be 27.72 birds per year (as shown in Table 6.5) which is considerably higher than the predicted collision risk at 0.11 birds.

Table 6.5: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth Islands SPA population of Kittiwake

Local SPA population around the site	16,800 (8,400 pairs Forth Islands SPA, JNCC website)
Background mortality (%)	16.5% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	140.28

The increase in mortality of kittiwake within the Firth of Forth Islands SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.6 Mallard

Mallard is listed in the Firth of Forth SPA designation and as such is considered a target species. A total of 2 mallard flights were observed within the site at collision heights during the winter months, as such the collision risk prediction for this species was low at 0.02 birds colliding with the turbine per year (using the winter scaling factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for mallard within the SPA is estimated here to be 12.31 birds per year (as shown in Table 6.6), which is higher than the predicted collision risk at 0.02 birds.

Table 6.6: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth SPA population of Mallard

Local SPA population around the site	2,564 (Firth of Forth SPA, JNCC website)
Background mortality (%)	48% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	13.33

The increase in mortality of mallard within the Firth of Forth SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.7 Peregrine

Peregrine is not a feature of the SPA or the SSSI and is list on the green BOCC list. This species was requested by SNH to be a target species as studies have indicated that raptors are susceptible to colliding with turbines. Adult peregrine show limited sensitivity to operational wind farms, although low numbers of casualties have been recorded at some inland wind farms in the UK. Displacement effects are localised with, for example, peregrines being found nesting within 250m of a wind turbine at Bryn Titli, Wales.

A total of 6 peregrine flights were recorded within the site at collision heights, as such the collision risk prediction for this species was low at 0.26 birds colliding with the turbine per year. This figure is also regarded as a worse-case scenario for this species as most of the observed flights were inland, as shown in Figure 6.

Estimate population figures were not available for peregrine within the Firth of Forth area. However, 0.26 birds per year is equivalent to approximately one bird every four years. Taking a worst case scenario that this is an adult breeding bird each time, the pair would fail

to breed every four years and one bird would need replacement. As no other information on the pair's history, such as productivity or whether they have an alternative nesting sites, or the population of peregrine within the Firth of Forth area was available at time of writing, the potential impact to the local breeding population through turbine collisions is significant.

Furthermore, as peregrine are thought to be breeding within the area, there is the collision risk associated with juveniles, which will be learning to fly and hunt within the area.

Considering the potential for juveniles to be present within the site boundary and the collision risk to adults the impact to the local population of peregrine is considered to be of moderate adverse significance.

6.3.8 Oystercatcher

Oystercatcher is listed in the Firth of Forth SPA designation and as such is considered a target species. Nine flights were recorded within the site throughout the year, which resulted in a low collision risk prediction of 0.12 birds colliding per year (using the Tidal Regulated 'All Year' Scaling Factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for oystercatcher within the SPA is estimated here to be 5.88 birds per year (as shown in Table 6.8), which is higher than the predicted collision risk at 0.12 birds.

Table 6.8: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth SPA population of Oystercatcher

Local SPA population around the site	7,846 (Firth of Forth SPA, JNCC website)
Background mortality (%)	7.5% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	5.88

The increase in mortality of oystercatcher within the Firth of Forth SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.9 Sandwich tern

Sandwich tern is listed in the SPA designation and as such is considered a target species. 11 flights were recorded within the site during the summer months which resulted in a low collision risk prediction of 0.24 birds colliding per year (using the summer scaling factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for sandwich tern within the SPA is estimated here to be 1.29 birds per year (as shown in Table 6.9), which is higher than the predicted collision risk at 0.24 birds.

Table 6.9: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth SPA population of Sandwich tern

Local SPA population around the site	1617 (Firth of Forth SPA, JNCC website)
Background mortality (%)	8% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	1.29

The increase in mortality of sandwich tern within the Firth of Forth SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.10 Shag

Shag is listed on the Firth of Forth Islands SPA, for this reason this species was considered to be a target species and a collision risk model was construction.

Two flights were recorded within the site (one in summer and one in winter) which resulted in a low collision risk prediction of 0.02 birds colliding per year (using the 'All Year' scaling factor as this species is known to use the site throughout the year, BTO records). The number of birds associated with a 1% increase in mortality in the baseline mortality for shag within the SPA is estimated here to be 7.68 birds per year (as shown in Table 6.10), which is considerably higher than the predicted collision risk at 0.02 birds.

Table 6.10: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth Islands SPA population of Shag

Local SPA population around the site	5,774 (Firth of Forth Islands SPA, JNCC website)
Background mortality (%)	16% ('Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	7.68

The increase in mortality of shag within the Firth of Forth Islands SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.11 Velvet scoter

Velvet scoter is listed in the SPA designation and as such is considered a target species. Only one flight was recorded within the site during the winter which resulted in a low collision risk prediction of 0.01 birds colliding per year (using the 'winter' scaling factor). The number of birds associated with a 1% increase in mortality in the baseline mortality for velvet scoter within the SPA is estimated here to be 3.05 birds per year (as shown in Table 6.11), which is higher than the predicted collision risk at 0.01 birds.

Table 6.11: Figures used in determining a 1% increase in mortality in the baseline mortality for the Firth of Forth SPA population of Velvet scoter

Local SPA population around the site	635 (Firth of Forth SPA, JNCC website)
Background mortality (%)	48% (No back-ground mortality available at time of writing. Background mortality for Mallard was used as worst-case 'Birds of the Western Palearctic' on DVD-ROM)
1% increase in mortality in baseline mortality (number of birds)	3.05

The increase in mortality of velvet scoter within the Firth of Forth SPA is not considered here to be significant, thus the impact through collision mortality for this species is considered to be negligible.

6.3.12 Collision risk conclusion

The ecology and relative population sizes of the species potentially affected suggests that these collision rates are unlikely to cause significant impacts on the integrity of the populations affected, especially species associated with the SPA designation.

Peregrine has been assessed to be significantly impacted by the development, however, this is based on a worse-case scenario as the majority of the flights observed were inland (see Figure 6).

The disturbance effects associated with the construction and the operation of the turbine is considered to be of minor adverse significance through the potential change in the distribution of birds within the SPA. However, overall, it is considered unlikely that a significant impact on the integrity of the Firth of Forth SPA would occur.

6.4 Direct habitat loss

Since the proposals includes only a single wind turbine offshore and associated infrastructure to be constructed on existing hard standing, the direct loss of habitat is considered to be negligible. Hence, it is considered extremely unlikely that any impact would occur on the integrity of the Firth of Forth SPA.

6.5 Barrier effects

Observations at existing wind farms to date have recorded no significant impacts resulting from barrier effects and wind farms (Drewitt and Langston 2006). It is considered that these types of impacts are more likely to occur at densely spaced sites which intersect regularly used flight lines. Given the proposals for this site is a single turbine, in an area which has relatively low number of species and individuals flying at turbine height, it is considered unlikely that a significant impact on the integrity of the Firth of Forth SPA would occur.

7 Mitigation and Monitoring

The overall results of this assessment considered that impacts on the integrity of the Firth of Forth SPA are unlikely to be of significant magnitude.

The impact through turbine collision on the local breeding pair of peregrine is considered to be of moderate adverse significance. Mitigation should be considered to reduce this impact, such as providing alternative nesting sites away from the turbine.

It is recommended that monitoring is undertaken following commissioning of the turbine, in order to review the impacts arising from the operation of the turbine and allow for any unanticipated impacts to be addressed should they occur. This should include visual observation of birds using the general area around the turbine and bird flights in the vicinity of the turbine from a suitable vantage point throughout the year and in different weather conditions. The methodology for the vantage point monitoring should be that given in *Guidance on Methods for Monitoring Bird Populations at Onshore Wind Farms* (SNH 2009), albeit adapted for use at a coastal location with a single turbine. In line with the SNH guidance, it is recommended that monitoring is undertaken both pre- and during construction and then as a minimum in years 1, 2, 3 and 5 post commissioning. Following this, a decision will need to be made with advice from SNH on whether the monitoring should be continued.

8 Conclusions

There are a number of global studies into the impacts of wind farms which have demonstrated significant impacts on bird populations in certain circumstances. In the UK, there are currently 152 wind farms comprising 1879 turbines with a generating capacity of 2202MW (www.bwea.com/ukwed/index.asp). To date, no significant impacts on birds have been recorded at any of these wind farms.

The proposed location for the wind turbine of the coast of the FEP site is in close proximity to the Firth of Forth SSSI, SPA and Ramsar site which have been designated primarily for their ornithological interests. Therefore, it is considered that the interests of the site could be potentially sensitive to impacts from wind farms.

The current proposal is for a single offshore wind turbine, approximately 114m to the hub with a rotor diameter of 130m. The survey data indicates that the rate of collision with the proposed turbine would be low and that this would not cause a significant adverse impact on the integrity of the Firth of Forth designations.

The numbers of non-flying birds in the area tend to comprise scattered individuals feeding close to the seaward side of the sea wall and large groups resting on the water on the seaward side of the site boundary and beyond. Although a degree of habituation to any disturbance is also possible, it cannot be assumed with certainty. However, the overall impact from displacement due to disturbance on non-flying birds is considered, at this stage, unlikely to cause a significant impact on the integrity of the Firth of Forth designations.

FIGURES

A3

Legend

- Proposed turbine location
- Firth of Forth SPA, Ramsar and SSSI

Issue	Date	By	Chkd	Appd
P0	2009-10-27	DB	PW	FM

Metres
0 235 470 940

ARUP

4 Pierhead Street, Capital Waterside
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client
2B Energy

Job Title
Turbine Demonstration Project

Drawing Title
Site Location and Designated Sites

Scale at A3
1:17,000

Drawing Status
Issue

Job No	Drawing No	Issue
121299	Figure 1	P0

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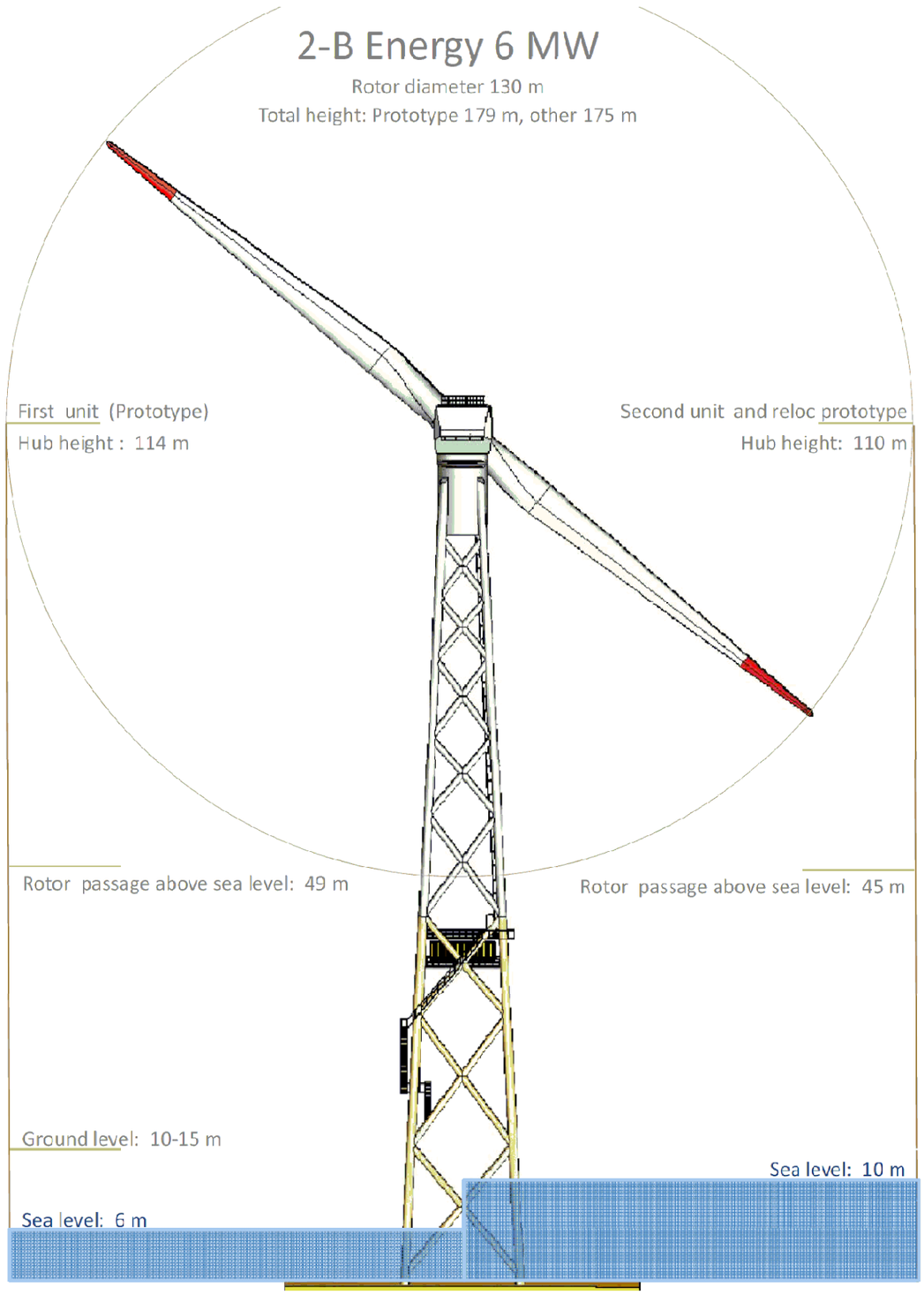
A3



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Metres
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ARUP
13 Fitzroy Street
London W1T 4BQ
Tel +44 20 7636 1531 Fax +44 20 7580 3924
www.arup.com

Client
2B Energy

Job Title
Turbine Demonstration Project

Drawing Title
Turbine Design

Scale at A3

Drawing Status
Issue

Job No	Drawing No	Issue
121299	**Figure 2**	**P1**

A3

Legend

- Proposed turbine location
- BTO Core Count Location 85433

Issue	Date	By	Chkd	Appd
P0	2009-10-27	DB	PW	FM

Metres

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ARUP

4 Pierhead Street, Capital Waterside
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

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Job Title

Turbine Demonstration Project

Drawing Title

BTO Core Count Section 85433

Scale at A3

1:18,000

Drawing Status

Issue

Job No	Drawing No	Issue
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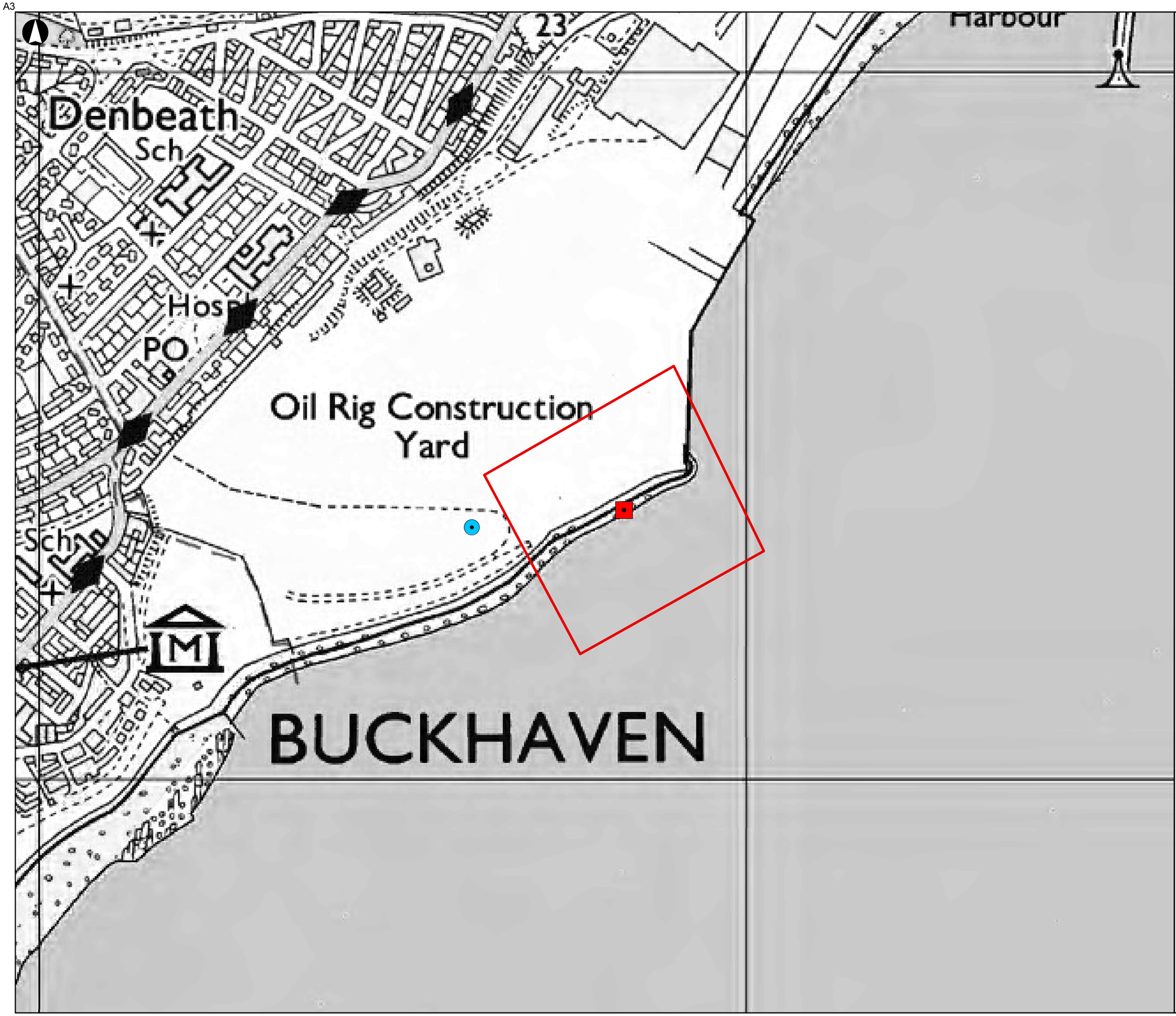
A3



Legend

- Vantage Point
- Proposed turbine location
- Survey area

Issue	Date	By	Chkd	Appd
P0	2009-10-27	DB	PW	FM

Metres

0 70 140 280

ARUP

4 Pierhead Street, Capital Waterside
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

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Job Title

Turbine Demonstration Project

Drawing Title

Survey Area

Scale at A3

1:5,000

Drawing Status

Preliminary

Job No	Drawing No	Issue
121299	004	P0

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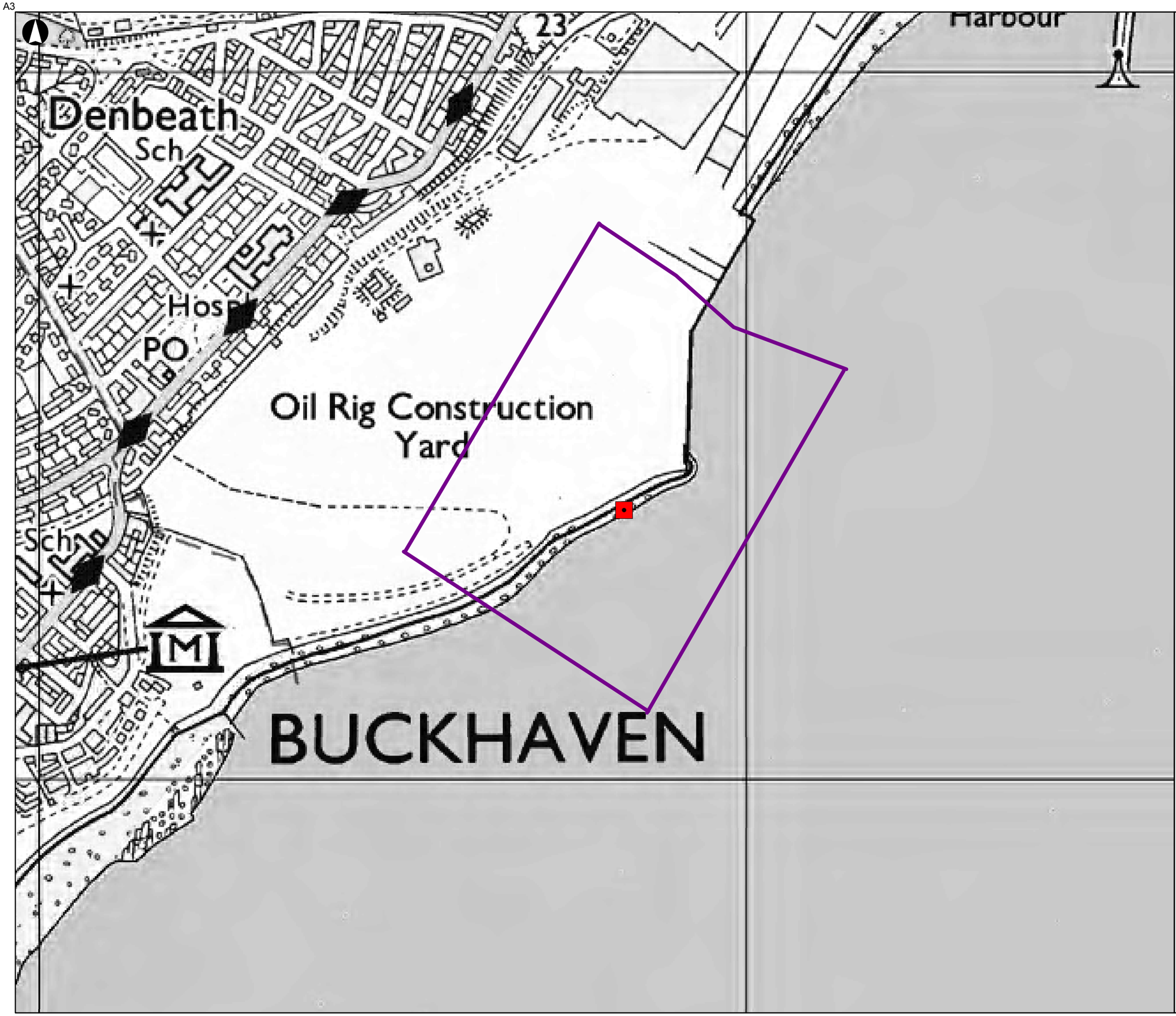

Legend

- Proposed turbine location
- Activity Survey Area

Issue	Date	By	Chkd	Appd
P0	2009-10-27	DB	PW	FM

Metres

0 70 140 280

ARUP

4 Pierhead Street, Capital Waterside
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
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2B Energy

Job Title

Turbine Demonstration Project

Drawing Title

Activity Survey Area

Scale at A3

1:5,000

Drawing Status

Issue

Job No	Drawing No	Issue
121299	Figure 5	P0

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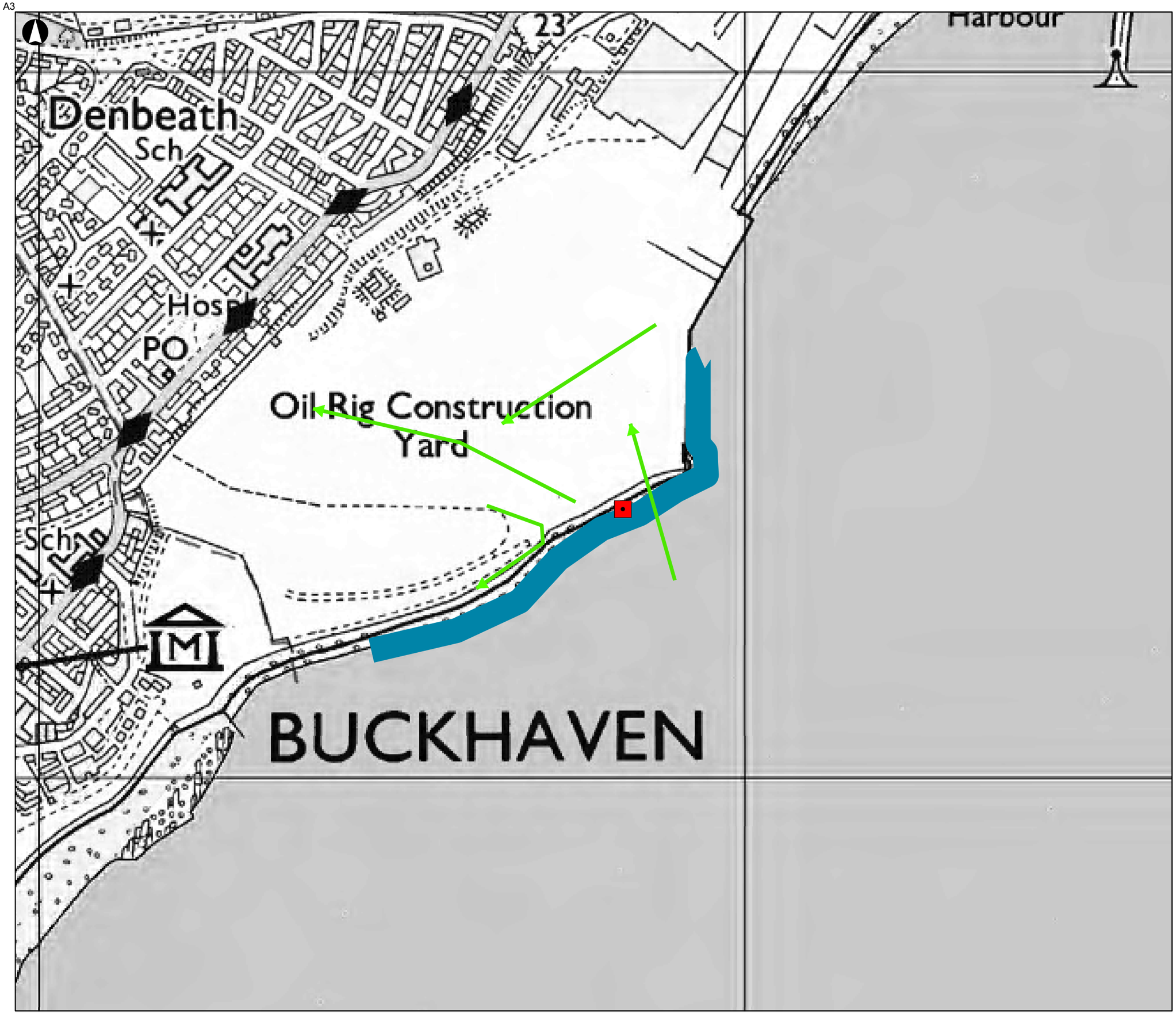

Legend

Proposed turbine location

Bird flight lines

Id

Majority of flight lines

Other flight lines (peregrine and oystercatcher)

Issue	Date	By	Chkd	Appd
P0	2009-10-27	DB	PW	FM

Metres

0 70 140 280

ARUP

4 Pierhead Street, Capital Waterside
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client

2B Energy

Job Title

Turbine Demonstration Project

Drawing Title

Bird Flight Lines

Scale at A3

1:5,000

Drawing Status

Issue

Job No	Drawing No	Issue
121299	**Figure 6**	**P0**

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Appendix A

Firth of Forth Designations

NATURA 2000

STANDARD DATA FORM

FOR SPECIAL PROTECTION AREAS (SPA)
FOR SITES ELIGIBLE FOR IDENTIFICATION AS SITES OF COMMUNITY IMPORTANCE (SCI)
AND
FOR SPECIAL AREAS OF CONSERVATION (SAC)

1. Site identification:

1.1 Type A

1.2 Site code UK9004411

1.3 Compilation date 200110

1.4 Update

1.5 Relationship with other Natura 2000 sites

1.6 Respondent(s) International Designations, JNCC, Peterborough

1.7 Site name **Firth of Forth**

1.8 Site indication and designation classification dates

date site proposed as eligible as SCI	
date confirmed as SCI	
date site classified as SPA	200110
date site designated as SAC	

2. Site location:

2.1 Site centre location

longitude	**latitude**
02 53 00 W	56 01 00 N

2.2 Site area (ha) 6313.72

2.3 Site length (km)

2.5 Administrative region

NUTS code	Region name	% cover
UKA12	Central	27.63%
UKA14	Lothian	47.35%
UKA13	Fife	25.02%

2.6 Biogeographic region

Alpine	Atlantic	Boreal	Continental	Macaronesia	Mediterranean
	X				

3. Ecological information:

3.1 Annex I habitats

Habitat types present on the site and the site assessment for them:

Annex I habitat	% cover	Representativity	Relative surface	Conservation status	Global assessment

3.2 Annex I birds and regularly occurring migratory birds not listed on Annex I

		Population				Site assessment			
		Resident	Migratory						
Code	Species name		Breed	Winter	Stage	Population	Conservation	Isolation	Global
A050	*Anas penelope*			2139 I		C		C	
A053	*Anas platyrhynchos*			2564 I		C		C	
A040	*Anser brachyrhynchus*			10852 I		B		C	
A169	*Arenaria interpres*			860 I		C		C	
A062	*Aythya marila*			437 I		B		C	
A067	*Bucephala clangula*			2465 I		A		C	
A149	*Calidris alpina alpina*			9514 I		B		C	
A143	*Calidris canutus*			9258 I		B		C	
A137	*Charadrius hiaticula*			328 I		C		C	
A064	*Clangula hyemalis*			1045 I		B		C	
A001	*Gavia stellata*			90 I		B		C	
A130	*Haematopus ostralegus*			7846 I		B		C	
A157	*Limosa lapponica*			1974 I		B		C	
A066	*Melanitta fusca*			635 I		A		C	
A065	*Melanitta nigra*			2880 I		B		C	
A069	*Mergus serrator*			670 I		B		C	
A160	*Numenius arquata*			1928 I		B		C	
A017	*Phalacrocorax carbo*			682 I		B		C	
A140	*Pluvialis apricaria*			2949 I		C		C	
A141	*Pluvialis squatarola*			724 I		B		C	
A007	*Podiceps auritus*			84 I		A		C	
A005	*Podiceps cristatus*			646 I		B		B	
A063	*Somateria mollissima*			9400 I		B		C	
A191	*Sterna sandvicensis*				1617 I	B		C	
A048	*Tadorna tadorna*			4509 I		B		C	
A162	*Tringa totanus*			4341 I		B		C	
A142	*Vanellus vanellus*			4148 I		C		C	

4. Site description:

4.1 General site character

Habitat classes	% cover
Marine areas. Sea inlets	
Tidal rivers. Estuaries. Mud flats. Sand flats. Lagoons (including saltwork basins)	75.0
Salt marshes. Salt pastures. Salt steppes	4.5
Coastal sand dunes. Sand beaches. Machair	11.0
Shingle. Sea cliffs. Islets	9.5
Inland water bodies (standing water, running water)	
Bogs. Marshes. Water fringed vegetation. Fens	
Heath. Scrub. Maquis and garrigue. Phygrana	
Dry grassland. Steppes	
Humid grassland. Mesophile grassland	
Alpine and sub-alpine grassland	
Improved grassland	
Other arable land	

Habitat classes	% cover
Broad-leaved deciduous woodland	
Coniferous woodland	
Evergreen woodland	
Mixed woodland	
Non-forest areas cultivated with woody plants (including orchards, groves, vineyards, dehesas)	
Inland rocks. Screes. Sands. Permanent snow and ice	
Other land (including towns, villages, roads, waste places, mines, industrial sites)	
Total habitat cover	**100%**

4.1 Other site characteristics

Soil & geology:

Basalt, Biogenic reef, Gravel, Igneous, Limestone/chalk, Sand, Sandstone/mudstone, Sedimentary, Shingle, Slate/shale

Geomorphology & landscape:

Coastal, Estuary, Intertidal sediments (including sandflat/mudflat), Lagoon, Open coast (including bay)

4.2 Quality and importance

ARTICLE 4.1 QUALIFICATION (79/409/EEC)

Over winter the area regularly supports:

Gavia stellata (North-western Europe - wintering)	2% of the GB population 5 year peak mean 1993/94 - 1997/98
Haematopus ostralegus (Europe & Northern/Western Africa)	2% of the GB population 5 year peak mean 1993/94 - 1997/98
Limosa lapponica (Western Palearctic - wintering)	4% of the GB population 5 year peak mean 1993/94 - 1997/98
Pluvialis apricaria (North-western Europe - breeding)	1% of the GB population 5 year peak mean 1993/94 - 1997/98
Podiceps auritus (North-western Europe)	21% of the GB population 5 year peak mean 1993/94 - 1997/98

On passage the area regularly supports:

Sterna sandvicensis (Western Europe/Western Africa)	6% of the GB population 5 year peak mean 1993/94 - 1997/98

ARTICLE 4.2 QUALIFICATION (79/409/EEC)

Over winter the area regularly supports:

Anser brachyrhynchus (Eastern Greenland/Iceland/UK)	6% of the population 5 year peak mean 1993/94 - 1997/98
Arenaria interpres (Western Palearctic - wintering)	1% of the population 5 year peak mean 1993/94 - 1997/98
Calidris canutus (North-eastern Canada/Greenland/Iceland/North-western Europe)	3% of the population 5 year peak mean 1991/92-1995/96

Tadorna tadorna (North-western Europe)	2% of the population 5 year peak mean 1993/94 - 1997/98
Tringa totanus (Eastern Atlantic - wintering)	3% of the population 5 year peak mean 1993/94 - 1997/98

ARTICLE 4.2 QUALIFICATION (79/409/EEC): AN INTERNATIONALLY IMPORTANT ASSEMBLAGE OF BIRDS

Over winter the area regularly supports:

95000 waterfowl (5 year peak mean 01/08/2000)

Including:

Gavia stellata , Podiceps cristatus , Podiceps auritus , Phalacrocorax carbo , Anser brachyrhynchus , Tadorna tadorna , Anas penelope , Anas platyrhynchos , Aythya marila , Somateria mollissima , Clangula hyemalis , Melanitta nigra , Melanitta fusca, Bucephala clangula , Mergus serrator , Haematopus ostralegus , Charadrius hiaticula , Pluvialis apricaria , Pluvialis squatarola , Vanellus vanellus , Calidris canutus , Calidris alpina alpina , Limosa lapponica , Numenius arquata , Tringa totanus , Arenaria interpres .

4.3 Vulnerability

While the major factor potentially affecting the site is coastal industrial development, such development is subject to detailed planning control, ensuring that the site is not significantly affected. Oil and other industrial developments concentrated along the shore line do pose a threat, however rigorous emergency contingency plans are in place to minimise the impact of any incident. Localised tipping is an ongoing problem but consists mainly of inert building waste and is mostly controlled by the relevant licensing authority. Implementation of the Habitats Regulations will tighten control on these operations. Recreational pressures, including small-scale bait digging, are not currently considered to be a problem, while commercial bait digging is being monitored. The potential for rising sea levels to remove important habitats is recognised, and a number of coastal realignment schemes (planned retreat) are planned for these areas which will go some way to offsetting any habitat loss.

5. Site protection status and relation with CORINE biotopes:

5.1 Designation types at national and regional level

Code	% cover
UK04 (SSSI/ASSI)	100.0

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 7, 2nd edition, as amended by COP9 Resolution IX.1 Annex B). A 3rd edition of the Handbook, incorporating these amendments, is in preparation and will be available in 2006.

3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

1. Name and address of the compiler of this form:

FOR OFFICE USE ONLY.

DD MM YY	
Designation date	Site Reference Number

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
Cambridgeshire PE1 1JY
UK
Telephone/Fax: +44 (0)1733 – 562 626 / +44 (0)1733 – 555 948
Email: RIS@JNCC.gov.uk

2. Date this sheet was completed/updated:

Designated: 30 October 2001

3. Country:

UK (Scotland)

4. Name of the Ramsar site:

Firth of Forth

5. Designation of new Ramsar site or update of existing site:

This RIS is for: Updated information on an existing Ramsar site

6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area:

** Important note: If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site included:

Refer to Annex III of the *Explanatory Notes and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

i) **hard copy** (required for inclusion of site in the Ramsar List): *yes* ✓ -or- *no* □;
ii**) an electronic format** (e.g. a JPEG or ArcView image) Yes
iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** *yes* ✓ -or- *no* □;

b) Describe briefly the type of boundary delineation applied:

e.g. the boundary is the same as an existing protected area (nature reserve, national park etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The site boundary is the same as, or falls within, an existing protected area.

For precise boundary details, please refer to paper map provided at designation

8. Geographical coordinates (latitude/longitude):

56 01 00 N 02 53 00 W

9. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

The site is on the east coast of Scotland

Administrative region: City of Edinburgh; Clackmannanshire; East Lothian; Falkirk; Fife; Stirling; West Lothian

10. Elevation (average and/or max. & min.) (metres): 11. Area (hectares): 6313.68

Min. -2
Max. 4
Mean 0

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Firth of Forth is a large coastal area comprising a complex of estuaries, mudflats, rocky shorelines, beaches and saltmarshes. It stretches from Alloa Inches in the River Forth to Fife Ness and Dunbar in the east. It is considered to act as a single ecological unit. Several large urban areas, including Edinburgh, are adjacent to the site and these include several areas of heavy industry. Furthermore the Forth is one of the most important shipping areas in Scotland. The site is important for a large number of wintering waders and wildfowl, many in nationally and internationally important numbers.

13. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

5, 6

14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Ramsar criterion 5

Assemblages of international importance:

Species with peak counts in winter:
72281 waterfowl (5 year peak mean 1998/99-2002/2003)

Ramsar criterion 6 – species/populations occurring at levels of international importance.

Qualifying Species/populations (as identified at designation):

Species with peak counts in spring/autumn:

Pink-footed goose , *Anser brachyrhynchus*, Greenland, Iceland/UK	7863 individuals, representing an average of 3.2% of the population (5 year peak mean 1998/9-2002/3)
Common shelduck , *Tadorna tadorna*, NW Europe	3596 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9-2002/3)
Common redshank , *Tringa totanus totanus*,	5151 individuals, representing an average of 2% of the population (5 year peak mean 1998/9-2002/3)
Ruddy turnstone , *Arenaria interpres interpres*, NE Canada, Greenland/W Europe & NW Africa	936 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Slavonian grebe , *Podiceps auritus*, Northwest Europe	68 individuals, representing an average of 2% of the population (5 year peak mean 1998/9-2002/3)
Common goldeneye , *Bucephala clangula clangula*, NW & C Europe	1789 individuals, representing an average of 7.1% of the GB population (5 year peak mean 1998/9-2002/3)
Red knot , *Calidris canutus islandica*, W & Southern Africa (wintering)	7295 individuals, representing an average of 1.6% of the population (5 year peak mean 1998/9-2002/3)
Bar-tailed godwit , *Limosa lapponica lapponica*, W Palearctic	1737 individuals, representing an average of 1.4% of the population (5 year peak mean 1998/9-2002/3)

Species/populations identified subsequent to designation for possible future consideration under criterion 6.

Species regularly supported during the breeding season:

Common tern , *Sterna hirundo hirundo*, N & E Europe	889 apparently occupied nests, representing an average of 1.4% of the breeding population (Seabird 2000 Census)

Species with peak counts in spring/autumn:

Goosander , *Mergus merganser merganser*, NW & C Europe	191 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9-2002/3)

Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm.
Details of bird species occuring at levels of National importance are given in Section 22

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Atlantic

b) biogeographic regionalisation scheme (include reference citation):

Council Directive 92/43/EEC

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Soil & geology	shingle, sand, mud
Geomorphology and landscape	lowland, coastal, intertidal sediments (including sandflat/mudflat), open coast (including bay), enclosed coast (including embayment), estuary, lagoon, intertidal rock
Nutrient status	
pH	no information
Salinity	brackish / mixosaline, saline / euhaline
Soil	mainly mineral
Water permanence	usually permanent
Summary of main climatic features	Annual averages (Edinburgh, 1971–2000) (www.metoffice.com/climate/uk/averages/19712000/sites/edinburgh.html) Max. daily temperature: 12.2° C Min. daily temperature: 5.1° C Days of air frost: 54.5 Rainfall: 676.2 mm Hrs. of sunshine: 1405.8

General description of the Physical Features:

The Firth of Forth is a complex estuarine site, stretching for over 100 km from the River Forth at Stirling eastwards past Edinburgh and along the coasts of Fife and East Lothian to a wide estuary mouth. A wide range of coastal and intertidal habitats is found within the site, including saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle and brackish lagoons. Extensive mudflats occur particularly in the Inner Firth, notably at Kinneil Kerse and Skinflats on the south shore and Torry Bay on the north shore. Typically, the flats support a rich invertebrate fauna, with eelgrass *Zostera* spp. growing on the main mudflats. In the Outer Firth, the shoreline diversifies, with sandy shores, some rocky outcrops, mussel beds and some artificial sea-walls. The North Berwick coast includes cliffs and dune grassland, with extensive dune systems at Aberlady.

17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

The catchments of the River Forth and Firth of Forth Estuary cover a total area greater than 3600 km2. The area can be split into two distinct sections; the River Forth drainage basin and those catchments that drain into the southern side of the Forth estuary.

The River Forth rises in the south-central Highlands. Glacial drift deposits are present in the middle and eastern parts of the catchment, and sands and gravels are found throughout the lowland valleys. The catchments along the southern side of the Forth Estuary include the major rivers Carron, Avon, Almond and Water of Leith. These areas are low-lying and are more urbanised and industrialised than the River Forth catchment itself. Consequently,
dominant land uses are agriculture and built-up areas.
The Firth of Forth is a complex estuarine site, stretching for over 100 km from the River Forth at Stirling eastwards past Edinburgh and along the coasts of Fife and East Lothian to a wide estuary mouth. A wide range of coastal and intertidal habitats is found within the site, including saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle and brackish lagoons. Extensive mudflats occur particularly in the Inner Firth, notably at Kinneil Kerse and Skinflats on the south shore and Torry Bay on the north shore. Typically, the flats support a rich invertebrate fauna, with eelgrass *Zostera* spp. growing on the main mudflats. In the Outer Firth, the shoreline diversifies, with sandy shores, some rocky outcrops, mussel beds and some artificial sea-walls. The North Berwick coast includes cliffs and dune grassland, with extensive dune systems at Aberlady.

18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

Shoreline stabilisation and dissipation of erosive forces

19. Wetland types:

Marine/coastal wetland

Code	Name	% Area
G	Tidal flats	74
E	Sand / shingle shores (including dune systems)	11
D	Rocky shores	9.5
H	Salt marshes	4.5
J	Coastal brackish / saline lagoons	1

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

The site is mostly invertebrate-rich intertidal mud and sandflats. Fairly extensive areas of saltmarsh exist primarily on the south coast while at Alloa Inches there is a small *Phragmites* reedbed.

Ecosystem services

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

None reported

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in **12**. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Birds

Species currently occurring at levels of national importance:

Species regularly supported during the breeding season:

Great cormorant , *Phalacrocorax carbo carbo*, NW Europe	134 apparently occupied nests, representing an average of 1.6% of the GB population (Seabird 2000 Census)
Herring gull , *Larus argentatus argentatus*, NW Europe and Iceland/W Europe)	1777 apparently occupied nests, representing an average of 1.2% of the GB population (Seabird 2000 Census)
Roseate tern , *Sterna dougallii dougallii*, W Europe	11 apparently occupied nests, representing an average of 21.1% of the GB population (Seabird 2000 Census)

Species with peak counts in spring/autumn:

Black-throated diver , *Gavia arctica arctica*, N Europe & W Siberia	8 individuals, representing an average of 1.1% of the GB population (5 year peak mean 1998/9-2002/3 - spring peak)
Great crested grebe , *Podiceps cristatus cristatus*, NW Europe	298 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)
Great cormorant , *Phalacrocorax carbo carbo*, NW Europe	745 individuals, representing an average of 3.2% of the GB population (5 year peak mean 1998/9-2002/3)
Common eider , *Somateria mollissima mollissima*, NW Europe	6918 individuals, representing an average of 9.4% of the GB population (5 year peak mean 1998/9-2002/3)
Red-breasted merganser , *Mergus serrator*, NW & C Europe	569 individuals, representing an average of 5.7% of the GB population (5 year peak mean 1998/9-2002/3)
Eurasian oystercatcher , *Haematopus ostralegus ostralegus*, Europe & NW Africa -wintering	8596 individuals, representing an average of 2.7% of the GB population (5 year peak mean 1998/9-2002/3)
Ringed plover , *Charadrius hiaticula*, Europe/Northwest Africa	604 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)
Ruff , *Philomachus pugnax*, Europe/W Africa	28 individuals, representing an average of 4% of the GB population (5 year peak mean 1998/9-2002/3)
Eurasian curlew , *Numenius arquata arquata*, N. a. arquata Europe (breeding)	4007 individuals, representing an average of 2.7% of the GB population (5 year peak mean 1998/9-2002/3)
Spotted redshank , *Tringa erythropus*, Europe/W Africa	2 individuals, representing an average of 1.4% of the GB population (5 year peak mean 1998/9-2002/3)
Common greenshank , *Tringa nebularia*, Europe/W Africa	27 individuals, representing an average of 4.5% of the GB population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Red-throated diver , *Gavia stellata*, NW Europe	104 individuals, representing an average of 2.1% of the GB population (5 year peak mean 1998/9-2002/3)
Whooper swan , *Cygnus cygnus*, Iceland/UK/Ireland	77 individuals, representing an average of 1.3% of the GB population (5 year peak mean 1998/9-2002/3)

Greater scaup , *Aythya marila marila*, W Europe	211 individuals, representing an average of 2.7% of the GB population (5 year peak mean 1998/9-2002/3)
Long-tailed duck , *Clangula hyemalis*, W Siberia/N Europe	541 individuals, representing an average of 3.3% of the GB population (5 year peak mean 1998/9-2002/3)
Black (common) scoter , *Melanitta nigra nigra*,	2125 individuals, representing an average of 4.2% of the GB population (5 year peak mean 1998/9-2002/3)
Velvet scoter , *Melanitta fusca fusca*, Baltic/W Europe	804 individuals, representing an average of 26.8% of the GB population (5 year peak mean 1998/9-2002/3)
European golden plover , *Pluvialis apricaria apricaria*, P. a. altifrons Iceland & Faroes/E Atlantic	2521 individuals, representing an average of 1% of the GB population (5 year peak mean 1998/9-2002/3)
Grey plover , *Pluvialis squatarola*, E Atlantic/W Africa -wintering	773 individuals, representing an average of 1.4% of the GB population (5 year peak mean 1998/9-2002/3)
Sanderling , *Calidris alba*, Eastern Atlantic	258 individuals, representing an average of 1.2% of the GB population (5 year peak mean 1998/9-2002/3)
Dunlin , *Calidris alpina alpina*, W Siberia/W Europe	12617 individuals, representing an average of 2.2% of the GB population (5 year peak mean 1998/9-2002/3)
Black-tailed godwit , *Limosa limosa islandica*, Iceland/W Europe	202 individuals, representing an average of 1.3% of the GB population (5 year peak mean 1998/9-2002/3)

Species Information

None reported

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23. Social and cultural values:

Describe if the site has any general social and/or cultural values e.g. fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Aesthetic
Archaeological/historical site
Environmental education/ interpretation
Non-consumptive recreation
Scientific research
Sport fishing
Sport hunting
Tourism
Transportation/navigation

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? No

If Yes, describe this importance under one or more of the following categories:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

Ownership category	On-site	Off-site
Non-governmental organisation (NGO)	+	+
Local authority, municipality etc.	+	+
National/Crown Estate	+	
Private	+	+
Public/communal	+	+

25. Current land (including water) use:

Activity	On-site	Off-site
Nature conservation	+	
Tourism	+	+
Recreation	+	+
Current scientific research	+	
Commercial forestry		+
Fishing: commercial		+
Fishing: recreational/sport	+	
Gathering of shellfish	+	+
Bait collection	+	
Arable agriculture (unspecified)		+
Permanent arable agriculture		+
Hunting: recreational/sport	+	+
Industry		+
Sewage treatment/disposal	+	+
Harbour/port	+	+
Transport route	+	+
Urban development		+
Non-urbanised settlements		+
Military activities	+	+

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

Explanation of reporting category:

1. *Those factors that are still operating, but it is unclear if they are under control, as there is a lag in showing the management or regulatory regime to be successful.*
2. *Those factors that are not currently being managed, or where the regulatory regime appears to have been ineffective so far.*

NA = Not Applicable because no factors have been reported.

Adverse Factor Category	Reporting Category	Description of the problem (Newly reported Factors only)	On-Site	Off-Site	Major Impact?
No factors reported	NA				

For category 2 factors only. What measures have been taken / are planned / regulatory processes invoked, to mitigate the effect of these factors?
Is the site subject to adverse ecological change? NO

27. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

Conservation measure	On-site	Off-site
Site/ Area of Special Scientific Interest (SSSI/ASSI)	+	
Special Protection Area (SPA)	+	
Land owned by a non-governmental organisation for nature conservation	+	
Management agreement	+	
Special Area of Conservation (SAC)		+

b) Describe any other current management practices:

The management of Ramsar sites in the UK is determined by either a formal management plan or through other management planning processes, and is overseen by the relevant statutory conservation agency. Details of the precise management practises are given in these documents.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

No information available

29. Current scientific research and facilities:

e.g. details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

WeBS counts are done between September and April each year.

An annual late summer bird count is also carried out.

Aberlady Bay is often used for undergraduate and postgraduate research projects

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitor centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

Aberlady Bay and Torry Bay Local Nature Reserves and the John Muir Country Park all have full-time rangers/wardens who lead some guided walks and other educational activities.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Many people use the areas adjoining the Firth for recreation. Walking, dog-walking, horse-riding and bathing are all common in many parts of the Forth. There is some evidence to suggest that the distribution of some bird species may be influenced by increased activity on the coast particularly in East Lothian. On the whole these activities are not considered detrimental to the site and visitor access is managed to minimise any negative effects. This includes specific locations and periods when public access may be restricted (e.g. the tern colony at Aberlady Bay).

The sea is also used for activities such as wind-surfing, canoeing and yachting. There is no evidence to suggest any of these are detrimental.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept. of Agriculture/Dept. of Environment, etc.

Scottish Executive, Environment and Rural Affairs Department

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Scottish Natural Heritage, 2 Anderson Place, Edinburgh, EH6 5NP

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see **15** above), list full reference citation for the scheme.

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Please return to: **Ramsar Secretariat, Rue Mauverney 28, CH-1196 Gland, Switzerland**

Telephone**: +41 22 999 0170** • Fax: **+41 22 999 0169** • email: **ramsar@ramsar.org**

FIRTH OF FORTH
SITE OF SPECIAL SCIENTIFIC INTEREST

Fife, Clackmannanshire, Stirling, Falkirk, West Lothian, Edinburgh, East Lothian

Midas Reference: 8163

PLANNING AUTHORITY:	Fife, Clackmannanshire, Stirling, Falkirk, West Lothian, City of Edinburgh, East Lothian Councils
DATE NOTIFIED UNDER 1981 ACT:	15 August 2000
NATIONAL GRID REFERENCE:	NS 865920 to NO 615075 & NT 678794
OS 1:50,000 SHEET NO:	59, 65, 66, 67
1:25,000 SHEET NO:	NS 396, 393, 383, 394, 406, 407, 395, 385, 408, 409
AREA:	7420 ha.

DESCRIPTION:

Biological: Habitat: coastland
Biological: Habitat: grassland
Biological: Species: botanical
Biological: Species: wintering wildfowl and waders
Biological: Species: breeding birds
Biological: Species: invertebrates

Geological: Dinantian
Geological: Permo-Carboniferous Igneous
Geological: Permo-Carboniferous "Fish/Amphibia"
Geological: Palaeobotany
Geological: Westphalian
Geological: Mineralogy of Scotland
Geological: Quaternary
Geological: Coastal Geomorphology of Scotland

HABITATS:

The Firth of Forth SSSI comprises an extensive mosaic of intertidal and coastal habitats. Extensive mudflats make up much of the intertidal area with areas of sand, shingle, rock and boulders. Associated coastal habitats include saltmarsh, grassland and sand dunes.

The mudflats are invertebrate rich and form important feeding grounds for the abundant waders and wildfowl in the Forth. Mussel beds occur on the lower shores

in some areas and marine algae such as *Fucus*, *Ascophyllum* and *Enteromorpha* species, and eelgrass *Zostera* species are supported on these mudflats.

The site is considered to be of special interest for the following habitats and species:

SALTMARSH/SAND DUNE

Important areas of **saltmarsh** are supported at Kinneil Kerse, Skinflats, Tyninghame and Aberlady. Dumbarnie Links contains the largest area of saltmarsh on the north shore of Firth of Forth. The largest area of pioneer saltmarsh in the Forth occurs on Alloa Inch. Saltmarsh communities in the Forth are characteristically zoned from low to high water mark and are dominated by sea aster *Aster tripolium*, common saltmarsh grass *Puccinellia maritima*, saltmarsh rush *Juncus gerardii,* and sea club-rush *Scirpus maritimus*. Several of the saltmarsh plant communities are scarce in the east coast of Scotland.

Beach head saltmarsh occurs at scattered localities at Blackness Bay, Burntisland Bay, Torry Bay, and Ruddons Point. Here, greater sea-spurrey *Spergularia media*, sea plantain *Plantago maritima*, glasswort *Salicornia europaea* and sea arrowgrass *Triglochin maritima* are common.

The main areas of **sand dune** vegetation occur in the outer Firth. Between Gullane and Broadsands is the largest and most complex sand dune system in the Lothians, with its noteworthy lichen rich dune slacks. Aberlady Bay contains the most extensive complex of sand dune, saltmarsh and mudflat in SE Scotland. The largest area of calcareous sand dunes in Fife, including representative areas of damp dune slack, herb-rich pasture, and intact foredune ridge occurs at Dumbarnie Links, which supports many local rarities and several 'southern' species which are rare in Scotland. Calcareous sand dunes are also found at Ruddons Point and its herb-rich dune pasture is of a type not found elsewhere in Fife.

FEN & LAGOON

The intertidal bays of Skinflats and Kinneil Kerse support a range of other estuarine habitats and plant communities including brackish **fen** and **coastal sluiced saline lagoons**. The lagoons and brackish fen are characterised by transition zone species such as common reed *Phragmites australis*, sea club-rush *Scirpus maritimus*, false fox-sedge *Carex otrubae*, common spike-rush *Eleocharis palustris* and abundant spiked water-milfoil *Myriophyllum spicatum*. Coastal lagoons are a rare habitat in SE Scotland and brackish fens are uncommon.

Extensive freshwater fen transition communities, uncommon elsewhere on the Forth, occur in the upper Forth estuary with reed sweet grass *Glyceria maxima*, meadowsweet *Filipendula ulmaria*, yellow iris *Iris pseudacorus* and hemlock water-dropwort *Oenanthe crocata*.

GRASSLAND

Between Burntisland and Kirkcaldy is the largest and most diverse coastal grassland in west Fife, with abundant **calcareous grassland** associated with the cliffs and rock outcrops. Calcareous cliff grassland also occurs along the East Wemyss to Anstruther coastline and on Dunbar coast. In these grasslands, abundant rock rose *Helianthemum nummularium* is typical with species such as thyme *Thymus praecox,* crested hairgrass *Koeleria macrantha*, burnet saxifrage *Pimpinella saxifraga*, agrimony *Agrimonia eupatoria* and purple milk-vetch *Astragalus danicus*. Species rich coastal and semi-improved grassland is also found at Blackness Bay, where it forms the most diverse coastal grassland in West Lothian and Falkirk.

Extensive tall herb-rich **neutral grassland** occurs between Burntisland and Kirkcaldy where meadow crane's-bill *Geranium pratense*, false brome *Brachypodium sylvaticum* and the locally rare hemp agrimony *Eupatorium cannabinum* are common. Neutral grasslands also occur at Skinflats and Kinneil Kerse.

Dune grassland has developed between East Wemyss and Anstruther, Aberlady, Tyninghame and the North Berwick coast, with characteristic species Lyme-grass *Leymus arenarius*, Marram grass *Ammophila arenaria*, cowslip *Primula veris*, lesser meadow-rue *Thalictrum minus*, bloody cranesbill *Geranium sanguineum* and restharrow *Ononis repens*. Mineral enriched grasslands are an unusual habitat in East Lothian.

Maritime grassland is of limited occurrence, but occurs along the Burntisland to Kirkcaldy coastline. Thrift *Armeria maritima*, kidney vetch *Anthyllis vulneraria* and distant sedge *Carex distans* are typical species.

OTHER HABITATS OF INTEREST:

Heathland occurs at Tyninghame, which is an unusual habitat in East Lothian, and extensive reedbeds have formed on Tullibody Inch. Scrub and woodland occur in small amounts in some areas.

SPECIES:

VASCULAR PLANTS

The diversity of habitats within the Forth supports a high number of vascular plants, many of which are nationally or locally rare. **Nationally scarce** species include eelgrasses – narrow-leaved eelgrass *Zostera angustifolia*, eelgrass *Z. marina*, dwarf eelgrass *Z. noltii*, which are supported on the extensive mudflats. Locally rare sea wormwood *Artemisia maritima* can also be found in these areas.

The grasslands are rich in flowering plant species and support many locally rare species such as shining cranesbill *Geranium lucidum*, bulbous buttercup *Ranunculus bulbosus*, yellow horned-poppy *glaucium flavum*, pyramidal orchid *Anacamptis pyramidalis*, viper's bugloss *Echium vulgare* and wild clary *Salvia hormioides*. Nationally scarce Thyme broomrape *Orobanche alba* and Maiden Pink *Dianthes deltoides* are also located in some grasslands.

INVERTEBRATES

Large numbers of insects occur throughout the site reflecting the range of habitats encountered. Several **nationally scarce** species of invertebrates occur, including the Sand Dart moth *Agrotis ripae*, and the northern brown argus butterfly *Aricia artaxerxes*, scarce and declining in Britain, which has two Fife colonies, between Burntisland and Kirkcaldy, and East Wemyss and Anstruther. Several species of beetles are rare or very local in Scotland, including *Cleonus piger*, *Lebia chlorocephala*, *Ceutorhynchus rugulosus* and *Scymnus schmidti*.

ORNITHOLOGICAL

The Firth of Forth supports abundant wildfowl and waders and is particularly important for its wintering bird species. The Firth of Forth is the second most important estuarine area for wintering birds in Scotland, and eleventh in the UK, and is significant both in terms of waterfowl density and abundance.

Internationally and nationally important numbers of wintering and moulting wildfowl and waders occur in the inner Forth, at Kinneil Kerse, Skinflats, Torry Bay and Alloa Inches. The invertebrate rich mudflats are used for feeding at low tide and higher ground including saltmarsh used as high tide roosts and feeding sites. Shelduck form a population of international importance, and nationally important numbers of wintering knot, redshank and great crested grebe occur here. Important populations of teal and goldeneye occur in the inner Forth.

Several species of national importance utilise the shoreline, intertidal area and offshore waters of the Forth, including common and velvet scoter, divers, eider, bar-tailed godwit, cormorant, long-tailed duck, ringed plover, grey plover, oystercatcher, turnstone, dunlin, red-breasted merganser and curlew. Regionally important wildfowl and waders include pochard, wigeon, golden plover, pintail, mallard and lapwing.

Nationally important numbers of wintering divers, grebes and sea ducks frequent the offshore areas of the outer Forth. Wintering pinkfooted geese are supported at Aberlady Bay and Knot and Bar-tailed Godwit occur at Aberlady Bay and on the Burntisland - Kirkcaldy coast, where the largest concentration of waders on the north shore of the outer Forth can be found. The shallow, sheltered waters of Largo Bay attract nationally important numbers of eider, goldeneye, scaup (quarter of British wintering population) and red-breasted merganser. The rocky East Lothian coastline, between Gullane and Broadsands and North Berwick, supports nationally important numbers of turnstone and purple sandpiper.

There are several breeding birds of importance in the Forth. Nationally important breeding eider occur at Aberlady Bay, on the North Berwick Coast, and between Gullane and Broadsands where there are also important moulting eider. Important breeding colonies of shelduck occur at Aberlady Bay, Alloa Inch and Skinflats, with a large flock of post-breeding moulting shelduck, a rare feature in Britain, occurring at Kinneil Kerse. Nationally important breeding ringed plover occur at Gullane to Broadsands, Skinflats and Tyninghame. There are also important breeding colonies of

three species of tern, common, Arctic and little, supported at Aberlady and Tyninghame.

The cliffs at Tantallon on the North Berwick coast support one of largest colonies of Fulmar in the Forth and the only large colony on the mainland. There is also a colony of cliff nesting house martins of regional importance. The harbour at Dunbar holds the only mainland Kittiwake colony in the Forth.

GEOLOGY/GEOMORPHOLOGY:

GEOMORPHOLOGY

The coastline at Dunbar is of note for the outstanding complexity of rocky coastal landforms which it exhibits. Of particular interest is a series of rock platforms representing different relative sea levels in the area but the associated cliffs, stacks, skerries and beaches are also of value. The exceptional diversity and intricacy of the landforms is related to the variety of sedimentary and volcanic rock types found here combined with structural weaknesses in these rocks and local variations in exposure and altitude.

CARBONIFEROUS

The coastal margins of the Forth demonstrate an exceptional variety of rocks and fossils that have been crucial in understanding the palaeogeography and palaeoecology of Scotland during the Carboniferous geological period. At St Monance, between Elie and Anstruther on the Fife coast and on the southern margin of the Forth at South Queensferry, coastal exposures provide an insight into the Lower Carboniferous, or Dinantian sequences, beneath and surrounding the Forth. The Abden, Burdiehouse and Seafield Tower Limestones, the Pumpherston Shell Bed and Oil Shale, and the Dunnet Sandstones are all examples of names given to Lower Carboniferous rock layers, some of which (particularly the oil-shales, thicker limestones and coals) had economic significance.

Although of importance in understanding the Lower Carboniferous geology of the Forth area, and of Scotland as a whole, the sedimentary rock sequence has world-wide significance for fossil remains. At Burntisland in Fife, the Abden Bone Bed has yielded a rich and diverse fish fauna, other ‘fossil fish’ localities include Ardross Castle also in Fife, Cheese Bay near Gullane and Wardie Shore. Wardie is of international importance, yielding at least eighteen species of fish, including sharks, which are generally complete and in a fine state of preservation. Wardie and Cheese Bay have also yielded some of Europe’s earliest amphibian remains. Granton shore yielded the first ever recognised body fossils of the conodont animal, an eel-like fish, the remains of which have been used worldwide in dating rock layer sequences. A rich and diverse fossil flora has been found at Pettycur in Fife, Oxroad Bay near North Berwick and at Weak Law near Gullane. The Pettycur locality yields one of the best preserved Lower Carboniferous plant petrifaction fossil floras known in the world.

Westphalian rock layer sequences on the coast at Buckhaven and at Joppa, help illustrate the palaeogeography and palaeoenvironment of the area during Upper

Carboniferous when the great coal forests flourished around 308 million years ago and document the start of desert conditions over the area as a prelude to the Permian period.

In intimate association with the Lower Carboniferous sedimentary rocks there are various nationally significant volcanic rocks. Between East Wemyss and Anstruther and at North Berwick there are exceptional exposures of volcanic vents and igneous intrusions that document crustal instability and magmatic processes at the start of the Carboniferous. The vents at North Berwick are of particular note in that they contain blocks of rock that were derived from the lower levels of the crust. These have allowed an understanding of the structure of the lower crust in eastern Scotland. Burntisland, the east Fife Coast, South Queensferry and Gullane, all provide exposures illustrating a range of other nationally important volcanic features and structures.

Elie Ness in Fife is of note mineralogically for the occurrence of xenocrysts of pyrope garnet, the famous 'Elie Ruby', found in a volcanic neck. The 'rubies' together with a range of other unusual minerals, provide an insight into the conditions under which the host rock, an alkali basalt, crystallised.

QUATERNARY

Kincraig Point, within East Wemyss to Anstruther Coast SSSI, is a GCR site for its Quaternary interest. It demonstrates an exceptionally well-displayed sequence of raised shorelines, eroded in the volcanic agglomerate bedrock following the retreat of the last ice sheet between about 16,000 and 13,000 radiocarbon years ago. The erosional character of the shorelines is unusual and, as striking landforms, they complement the detailed sedimentary records of coastal change during the late glacial and postglacial periods that occur in more enclosed estuary situations in eastern Scotland.

Dunbar Coast SSSI, is a GCR site for its Quaternary interest. It is notable for a series of extensive shore platforms, including features that pre-date the last glaciation. Three of the platforms occur above present sea level, the highest with a crag and tail formation on its surface. These landforms are representative of the suite of erosional features found along the east coast of Scotland and demonstrate former sea-level changes and different phases of marine erosion. Dunbar is one of the best examples in eastern Scotland illustrating the development of multiple shore platforms, as well as highlighting the contribution of older elements to the form of the present coastal landscape.

PREVIOUS NOTIFICATIONS

Sites notified under Section 23 of the National Parks and Access to the Countryside Act 1949, and Section 28 of the Wildlife and Countryside Act 1981.
Site boundary amendments with net increase in area - I
Site boundary amendments with net decrease in area - D

ABERLADY BAY NCR Grade 1 1983 LNR 1952	**ALLOA INCHES** 1971, 1988 [I]	**BLACKNESS BAY** NCR Grade 1 1987 [I]
BURNTISLAND–KIRKCALDY COAST NCR Grade 1 1955, 1971 1989 [I]	**DUMBARNIE LINKS** 1955, 1971 1982	**DUNBAR COAST** GCR site 1984
EAST WEMYSS – ANSTRUTHER COAST NCR Grade 1 Part GCR site 1953, 1971 1991 [I]	**FORTH BRIDGE – GRANTON** NCR Grade 1 1965, 1974 1986	**GOSFORD BAY – PORT SETON** NCR Grade 1 1978 1984 [I]
GULLANE-BROADSANDS NCR Grade 1 1983	**KINNEIL KERSE** NCR Grade 1 1978 1988 [I]	**LEITH – PRESTONPANS** NCR Grade 1 Part GCR site 1972 1986 [I]
NORTH BERWICK COAST NCR Grade 1 GCR site 1957, 1972, 1978 1984	**RUDDONS POINT** 1983	**SKINFLATS** NCR Grade 1 Part of site RSPB Reserve 1973 1988 [I]
TORRY BAY NCR Grade 1 1978 1991	**TYNINGHAME SHORE** NCR Grade 1 Part of John Muir Country Park declared 1977 1952, 1972, 1978 1984 [D]	**WARDIE SHORE** 1987 GCR site

REMARKS

Sites indicated (NCR) are part of the Firth of Forth Nature Conservation Review Grade 1 site.

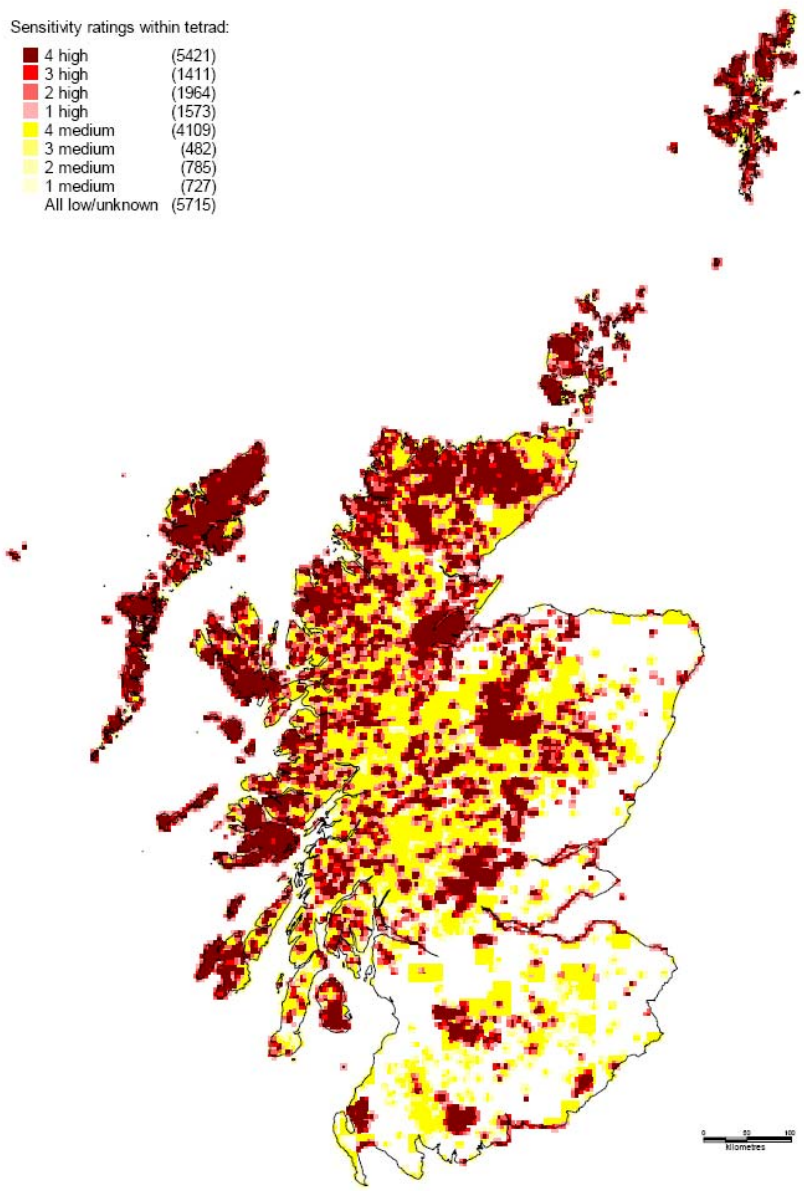
Sites indicated (GCR) are, or include, Geological Conservation Review Sites.

Site includes the Firth of Forth Special Protection Area

Site includes the Firth of Forth Ramsar Site.

Appendix B

Sensitivity Map



Appendix A: Composite sensitivity map of Scotland for location of onshore windfarms with respect to a suite of sensitive bird species (presented here at tetrad level of resolution to protect locations of sensitive species). Taken from Bright *et al.* (2006).

Appendix C

VP Survey Recording Form

Table 1: Activity Summary

Weather _____

Start Time _____ Finish Time _____ Date _____

VP Location _____ Time of low tide _____

Initial census of perched and birds on the water

Subsequent Activity Summaries

Time (min)	Change in perched or floating birds	Wind Speed and Dir.
30		
60		
90		
120		
150		
180		

Table 2: Target Species Movements

Weather
Start Time
Finish Time
Date
VP Location
Time of low tide

Time	Species	No. of Individs	Route Id	Height of birds 1(0-10m), 2(10-30m), 3(30-85m) 4(85+)	Activity

Appendix D

Survey Dates and Weather Conditions

Date	Survey Hours	Weather Conditions
20/09/2006	4	blustry, moderate wind from S, bright, fairly warm, 50% overcast
11/10/2006	4	grey, moderate breeze from east. Choppy sea
18/10/2006	4	sunny, 40-80% cloud, slight wind from SW
25/10/2006	4	grey/low light, drizzle/rain, v slight wind N
01/11/2006	4	10% cloud, slight breeze from SW
15/11/2006	4	overcast 80% cloud, cold, no wind, rain later
30/11/2006	3	Overcast, v. strong wind SW, dry, heavy sea.
05/12/2006	4	50% cloud, slight/moderate breeze from SW, dry with sunny spells
21/12/2006	4	60% overcast, slight breeze from W, cold, calm seas, partly sunny, dry
06/01/2007	4	80% clouds, sunny spells, slight breeze from SW, dry, choppy sea
27/01/2007	4	dry, bright, 20% cloud, 20mph WSW
06/02/2007	4	sunny, slight breeze from West, 20% cloud, calm sea, cold
19/02/2007	4	overcast, moderate breeze from SE, dry, choppy sea
11/03/2007	4	99 % cloud, 10 degrees C 15mph SW wind, showers
22/03/2007	4	80% overcast, 10 degrees C, wind mod NE, sea calm
28/03/2007	4	cold, fog, sea calm but with swell, slight SE wind
03/04/2007	4	90% cloud, 12C, 8mph NE, dry
18/04/2007	4	70% overcast, sunny spells, slight breeze from SW
24/04/2007	3.5	60% cloud, 12mph SW, sunny intervals/showers, 16C
08/05/2007	4	sunny, slight wind W, occasional heavy showers
15/05/2007	4	clear, 15% cloud cover, slight breeze E
30/05/2007	4	raining, mod NW, 100% cloud, <10C
11/06/2007	4	hazy, 30%cloud, bright, v. mild, no wind
28/06/2007	4	100% cloud, light, drizzle, strong W, 13C
09/07/2007	4	slight SW wind, cloud cover 40%, dry
23/07/2007	4	strong S, sunny 20% cloud, 18C
07/08/2007	4	cloud cover 7, wind moderate SW, 18C, good visibility
23/08/2007	4	5% cloud, sunny, slight SW wind 18C
30/08/2007	3.3	60% cloud, slight W wind, sea calm, sunny
11/09/2007	4	80% cloud, slight north east wind, dry
18/09/2007	4	80% cloud, moderate north west wind, dry

Appendix E

Stage 1 and 2 Worked Example for Oystercatcher

Populate heavy bordered boxes

OYSTERCATCHER

Risk window (2B + CB squares, approximately 100m from turbine)
W = width x height (m²)

1 | 42900

Width = 330m (100m buffer either side of turbine with 65m blades)
Height = 130m (turbine height)

Number of Birds flying through risk window per annum (n)

2 | 159.3

Based on 9 flights throughout the year, thus using the Tidal Regulated 'All Year' Scaling Factor of 17.7

Area of rotors (A)
$A = N \times \pi R^2$

3 | 13273.22896

Number of turbines (N)= 1
Rotor radius (R) = 65m

Total rotor area as a proportion A / W of the rick window

4 | 0.309399276

Number of birds passing through rotor
n x (A / W)

49.28730474 The Number of Bird transits Per annum through the rotors of the WF

Collision rate

Number of transits * probability of bird strike from stage 2	2.389351633
Avoidance factor	**95%**
Collison rate with avoidance	**0.119467582**

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 12/03/2010

K: [1D or [3D] (0 or 1)	1	
NoBlades	2	
MaxChord	5.75	m
Pitch (degrees)	20	
BirdLength	0.42	m
Wingspan	0.83	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	16.67	m/sec
RotorDiam	130	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.51	

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

			Upwind:			Downwind:		
r/R	c/C	α	collide		contribution	collide		contribution
radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
0.025	0.575	8.16	33.27	0.80	0.00100	31.01	0.74	0.00093
0.075	0.575	2.72	11.84	0.28	0.00213	9.58	0.23	0.00172
0.125	0.702	1.63	8.92	0.21	0.00268	6.16	0.15	0.00185
0.175	0.860	1.17	8.08	0.19	0.00339	4.70	0.11	0.00197
0.225	0.994	0.91	7.58	0.18	0.00409	3.67	0.09	0.00198
0.275	0.947	0.74	6.27	0.15	0.00414	2.55	0.06	0.00168
0.325	0.899	0.63	5.34	0.13	0.00416	1.80	0.04	0.00141
0.375	0.851	0.54	4.63	0.11	0.00417	1.28	0.03	0.00115
0.425	0.804	0.48	4.09	0.10	0.00417	0.92	0.02	0.00094
0.475	0.756	0.43	3.66	0.09	0.00417	0.69	0.02	0.00078
0.525	0.708	0.39	3.30	0.08	0.00416	0.51	0.01	0.00065
0.575	0.660	0.35	2.99	0.07	0.00412	0.45	0.01	0.00062
0.625	0.613	0.33	2.71	0.06	0.00406	0.54	0.01	0.00082
0.675	0.565	0.30	2.45	0.06	0.00398	0.61	0.01	0.00098
0.725	0.517	0.28	2.22	0.05	0.00387	0.65	0.02	0.00113
0.775	0.470	0.26	2.01	0.05	0.00374	0.68	0.02	0.00126
0.825	0.422	0.25	1.81	0.04	0.00359	0.69	0.02	0.00136
0.875	0.374	0.23	1.63	0.04	0.00342	0.68	0.02	0.00144
0.925	0.327	0.22	1.45	0.03	0.00322	0.67	0.02	0.00149
0.975	0.279	0.21	1.28	0.03	0.00300	0.65	0.02	0.00153

Overall p(collision) = Upwind 7.1% Downwind 2.6%

Average 4.8%

Appendix F

Stage 1 and 2 Worked Example for Peregrine

Populate heavy bordered boxes

Area visable from vps combined
A *cum* (ha)

1 | 10.89 |

	survey time (Mins)	bird obs time@30-85+m (Mins)
proportion of time between 30-85+m t	7369.98	3.5

(obs time/survey time)
0.0004749

2 flight activity per ha (F)
F = t/A *cum*
4.36088E-05

Flight risk area (ha)
1.327322896

3 proportion of time at 30-85+m
F*flight risk area
5.78829E-05

	hub height	blade diameter
	114	130

4 proportion of time in turbine area

	rotor top	rotor bottom
((top of rotor-bottom of rotor)/(200-30)*F	179	49

4.42634E-05

	days likely present	hours active
	365	12

5 bird occupancy period in windfarm n (hrs)
(days peresent*hrs active per day)* prop time in turbines

n (mins)	n(secs) (used in calc later)
11.63242425	697.945455

0.193873737

6 flight risk volume V_w (m3)
(flight risk area*risk window)*10000 to make into meters
1725519.765

No of turbines	piR^2	pi	Blade radius	$radius^2$
1	13278.57143	3.142857143	65	4225

7 combined volume swept by rotors V_r (m^3)

	rotor depth (assume 2m	bird length
32466.10714	2	0.445

8 occupancy of rotor swept area b (bird secs)
(n*(Vr/Vw)
13.13202687

	flight speed (m/s)
	20.7

9 Time to fly through and clear rotors time
(rotor depth+bird length)/flight speed(m/s)
0.118115942

10 Number of transits through rotors per year
(b/time)
111.1791232

Collision rate
Number of transits * probability of bird strike from stag 5.116317377

Avoidance factor 95%

Collison rate with avoidance 0.255815869

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 05/02/2010

K: [1D or [3D] (0 or 1)	1	
NoBlades	2	
MaxChord	5.75	m
Pitch (degrees)	20	
BirdLength	0.445	m
Wingspan	1.05	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	20.7	m/sec
RotorDiam	130	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.42	

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

			Upwind:			Downwind:		
r/R	c/C	α	collide		contribution	collide		contribution
radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
0.025	0.575	10.14	43.27	0.84	0.00105	41.01	0.79	0.00099
0.075	0.575	3.38	15.18	0.29	0.00220	12.92	0.25	0.00187
0.125	0.702	2.03	11.19	0.22	0.00270	8.43	0.16	0.00204
0.175	0.860	1.45	9.94	0.19	0.00336	6.56	0.13	0.00222
0.225	0.994	1.13	9.19	0.18	0.00400	5.28	0.10	0.00230
0.275	0.947	0.92	7.54	0.15	0.00401	3.82	0.07	0.00203
0.325	0.899	0.78	6.37	0.12	0.00400	2.84	0.05	0.00178
0.375	0.851	0.68	5.49	0.11	0.00398	2.14	0.04	0.00155
0.425	0.804	0.60	4.80	0.09	0.00394	1.63	0.03	0.00134
0.475	0.756	0.53	4.23	0.08	0.00388	1.25	0.02	0.00115
0.525	0.708	0.48	3.75	0.07	0.00380	0.96	0.02	0.00098
0.575	0.660	0.44	3.33	0.06	0.00370	0.74	0.01	0.00082
0.625	0.613	0.41	2.99	0.06	0.00361	0.58	0.01	0.00070
0.675	0.565	0.38	2.70	0.05	0.00352	0.48	0.01	0.00063
0.725	0.517	0.35	2.44	0.05	0.00342	0.49	0.01	0.00068
0.775	0.470	0.33	2.20	0.04	0.00329	0.54	0.01	0.00081
0.825	0.422	0.31	1.98	0.04	0.00315	0.57	0.01	0.00092
0.875	0.374	0.29	1.77	0.03	0.00299	0.60	0.01	0.00101
0.925	0.327	0.27	1.57	0.03	0.00281	0.60	0.01	0.00108
0.975	0.279	0.26	1.39	0.03	0.00261	0.60	0.01	0.00113

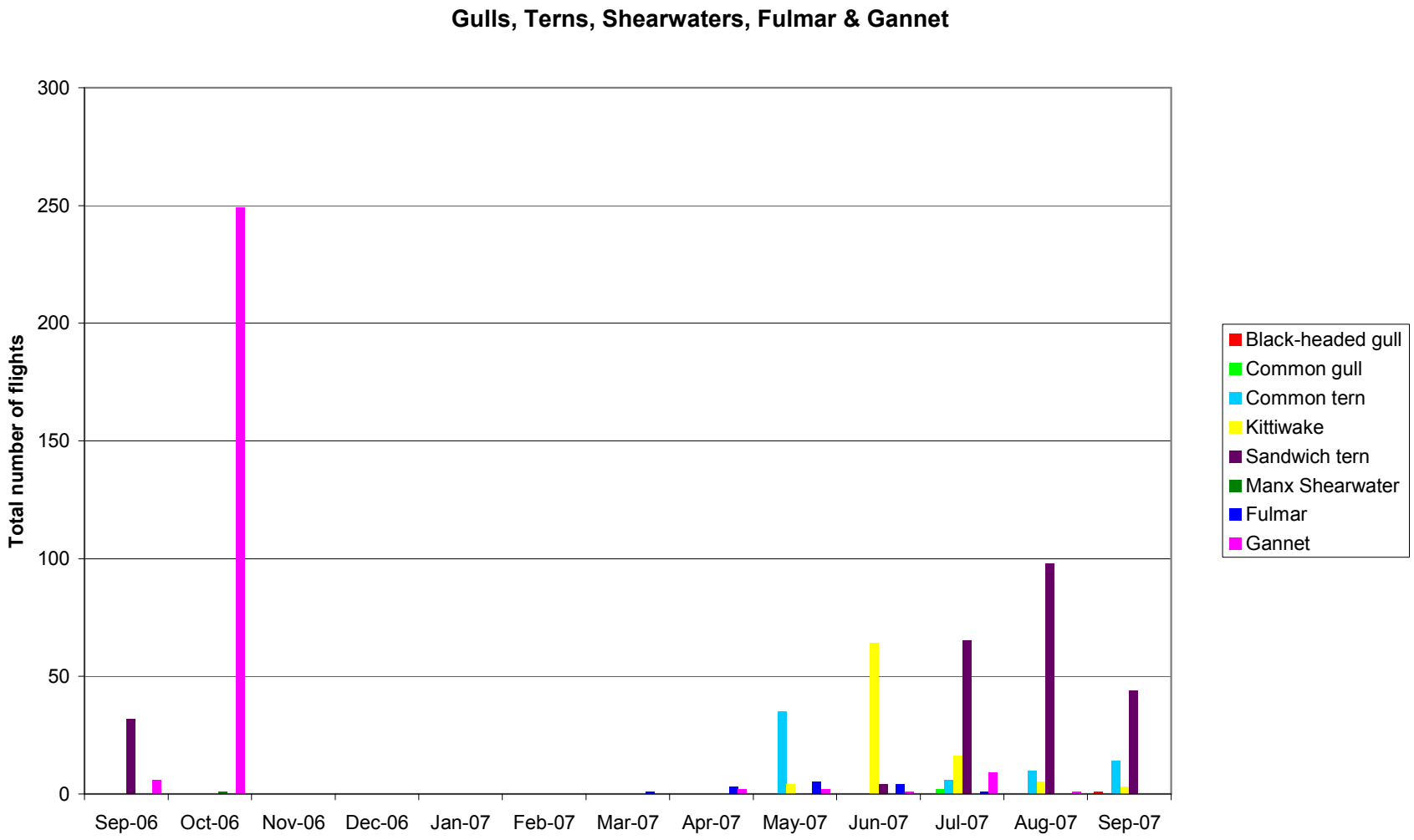
Overall p(collision) = Upwind 6.6% Downwind 2.6%

Average 4.6%

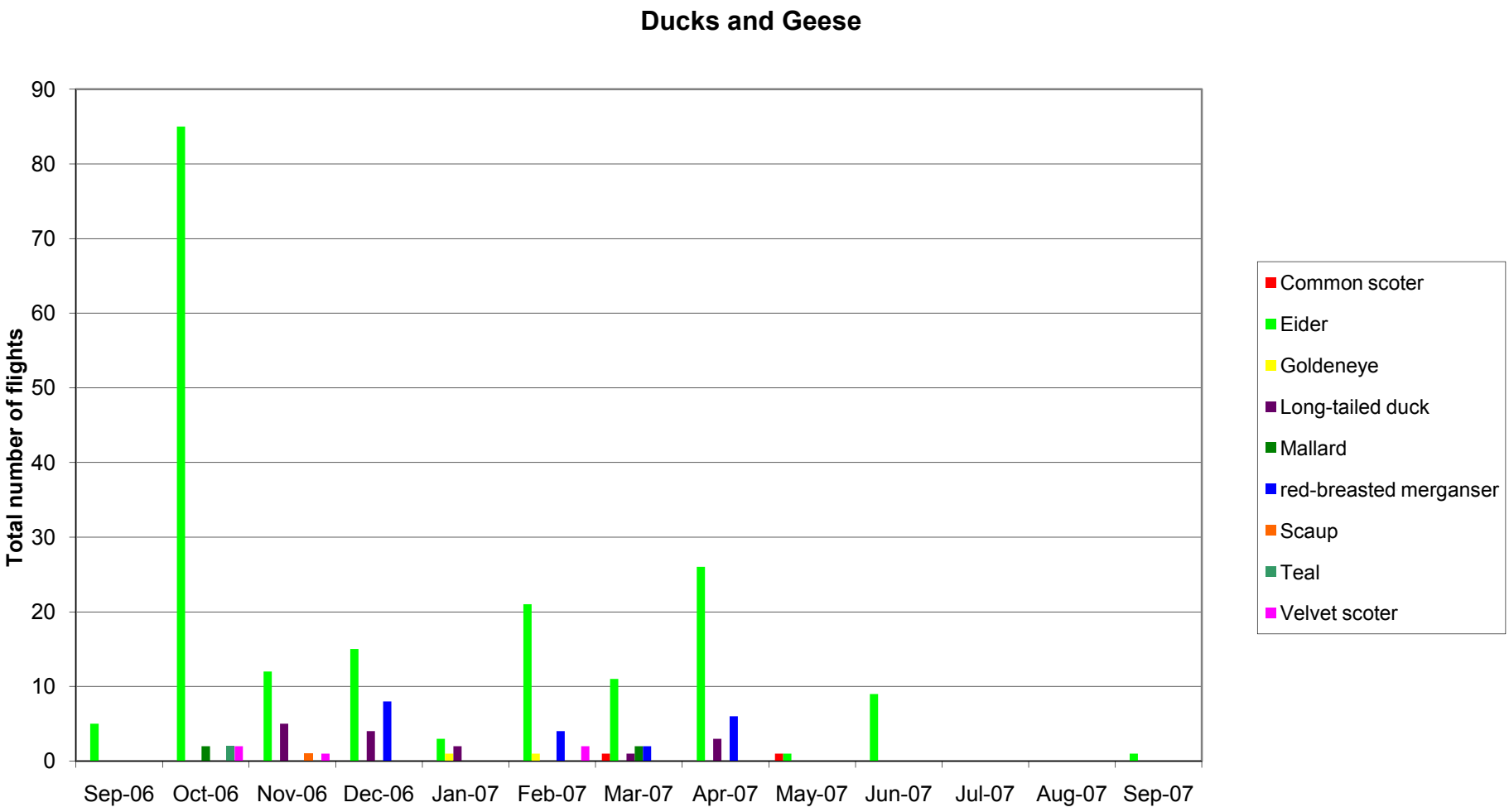
Appendix G

Monthly Species Flight Totals

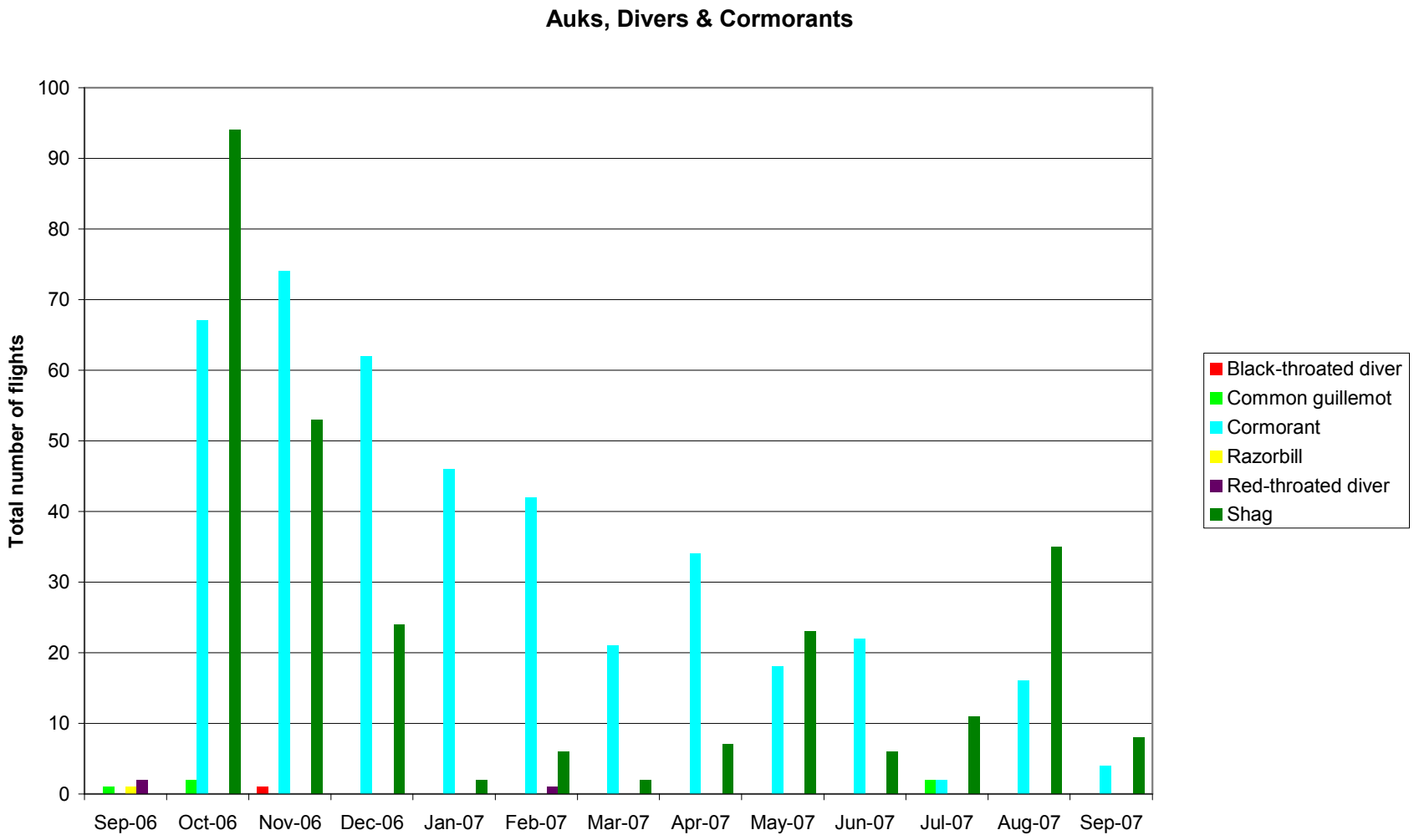
G1 – Total numbers of flights per month of Gulls, Terns, Shearwaters, Fulmar and Gannet.



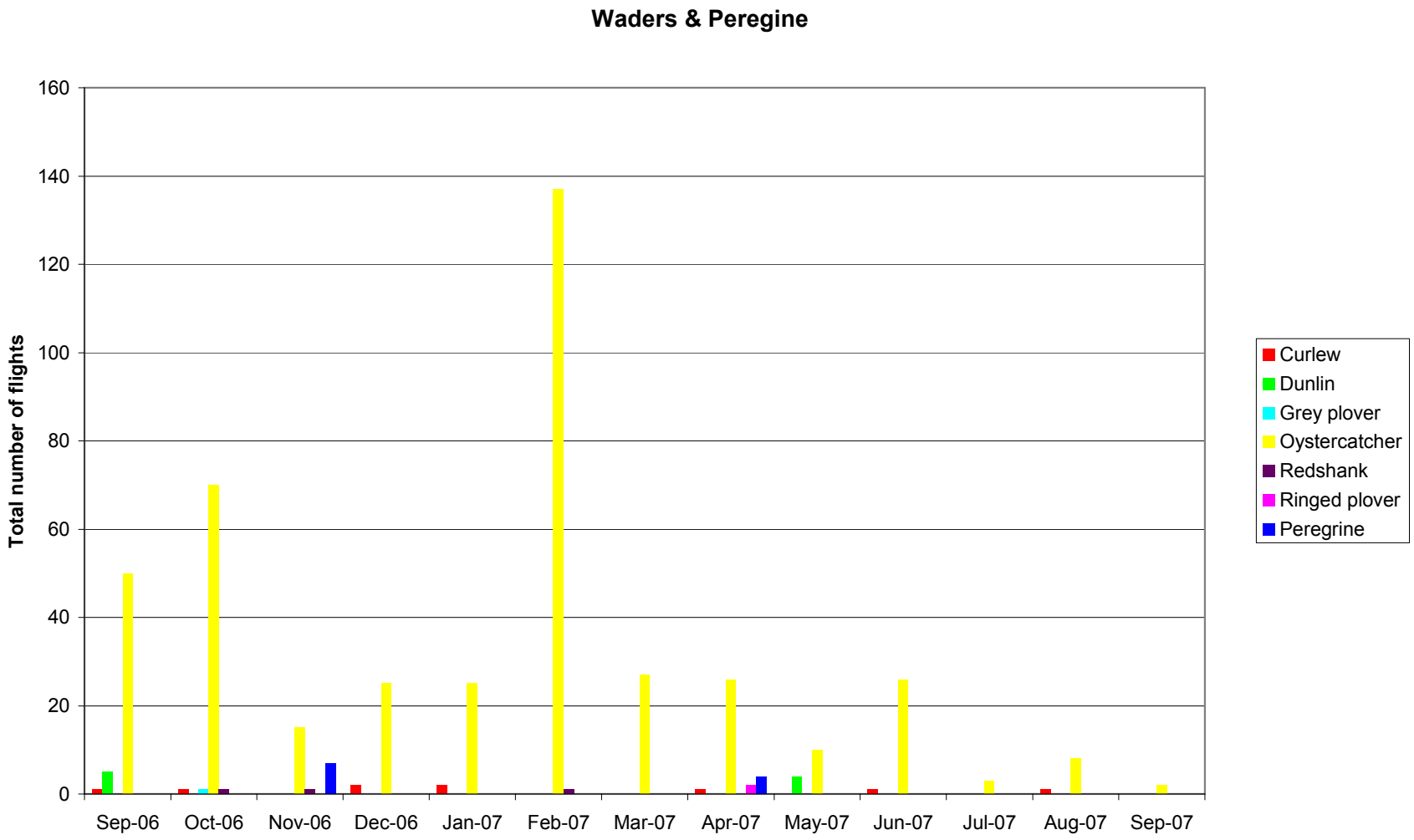
G2 – Total numbers of flights per month of Ducks and Geese.



G3 – Total numbers of flights per month of Auks, Divers and Cormorants.



G4 – Total numbers of flights per month of Waders and Peregrine.



Appendix H

Activity Summaries

Activity Summary Table – Maximum number of individuals of each species recorded on each survey date

Species	28/09/06	11/10/06	18/10/06	25/10/06	01/11/06	15/11/06	30/11/06	05/12/06	21/12/06	06/01/07	27/01/07	06/02/07	19/02/07	11/03/07	22/03/07	28/03/07	03/04/07	18/04/07	24/04/07	08/05/07	15/05/07	30/05/07	11/06/07	28/06/07	09/07/07	23/07/07	07/08/07	23/08/07	30/08/07	11/09/07	18/09/07
Eider	13	6	22	19	32	20	4	18	10	14	14	19	8	6	16	9	5	13	7	15	67	9	12	3	15	2	6	14	8	0	15
Red-throated diver	3	0	1	0	2	0	0	1	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Guillemot	3	2	3	2	0	0	0	0	0	1	0	6	0	0	0	0	0	7	5	2	27	6	1	8	8	0	2	0	0	0	2
Herring gull	2	2	61	6	93	5	68	6	7	7	15	7	4	3	8	8	2	5	30	11	99	103	0	0	59	3	211	4	3	123	410
Cormorant	2	2	1	2	5	0	4	4	4	10	2	3	4	0	1	0	1	0	1	3	6	0	1	0	0	0	1	0	0	0	5
Black-headed gull	0	10	2	7	0	1	4	0	0	1	0	0	8	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	3	4	1
Razorbill	8	0	0	1	0	0	0	0	0	0	0	0	0	0	3	5	0	2	0	0	0	1	0	2	0	0	0	0	0	0	2
Shag	1	3	6	1	1	2	0	2	0	1	2	1	1	0	0	0	0	0	0	0	2	0	0	0	0	0	1	7	2	0	2
Lesser black-backed gull	1	0	0	0	8	0	0	2	0	0	0	0	0	0	0	0	0	0	3	2	4	0	0	0	55	0	96	1	0	91	53
Greater black-backed gull	0	2	2	0	0	2	0	0	2	2	0	2	0	0	2	1	0	0	0	0	0	3	0	0	0	0	7	0	1	1	3
Rock pipit	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Pied wagtail	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	2	0	0	0	0	0	2
Chiffchaff	0	0	2	1	1	0	0	2	1	2	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Linnet	0	0	1	0	30	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Yellow wagtail	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peregrine	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-breasted	0	0	0	0	1	0	0	3	1	2	0	4	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species	28/09/06	11/10/06	18/10/06	25/10/06	01/11/06	15/11/06	30/11/06	05/12/06	21/12/06	06/01/07	27/01/07	06/02/07	19/02/07	11/03/07	22/03/07	28/03/07	03/04/07	18/04/07	24/04/07	08/05/07	15/05/07	30/05/07	11/06/07	28/06/07	09/07/07	23/07/07	07/08/07	23/08/07	30/08/07	11/09/07	18/09/07
merganser																															
Long-tailed duck	0	0	0	0	0	13	0	2	6	13	0	4	0	0	5	3	1	10	5	0	0	0	0	0	0	0	0	0	0	0	0
Common gull	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
Oystercatcher	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crow	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Common scoter	0	0	0	0	0	0	0	0	2	0	0	0	0	0	12	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0
Goldeneye	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Robin	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Redshank	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turnstone	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Velvet scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Wheatear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ringed plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Swallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	6	0	0	0	0	0	0	0	0	0
Common tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Grey heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Puffin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Kittiwake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	1	0	0	0	0

Species	28/09/06	11/10/06	18/10/06	25/10/06	01/11/06	15/11/06	30/11/06	05/12/06	21/12/06	06/01/07	27/01/07	06/02/07	19/02/07	11/03/07	22/03/07	28/03/07	03/04/07	18/04/07	24/04/07	08/05/07	15/05/07	30/05/07	11/06/07	28/06/07	09/07/07	23/07/07	07/08/07	23/08/07	30/08/07	11/09/07	18/09/07
Woodpigeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Sandwich tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0

Appendix I

Photos

Photo 1: Panoramic view of FEP site and Firth of Forth.

Photo 2: Sea wall along edge of docks.

Technical Appendix A9

Water Management Plan

2-B ENERGY

INDICATIVE SURFACE AND COASTAL WATER MANAGEMENT PLAN FOR METHIL OFFSHORE DEMONSTRATION WIND TURBINE

Prepared By:

Arcus Renewable Energy Consulting Ltd
Suite 2F
Swinegate Court East
3 Swinegate
York
North Yorkshire
YO1 8AJ

T. 01904 715470

E. info@arcusrenewables.co.uk
W. www.arcusrenewables.co.uk

MARCH 2010

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INDICATIVE WATER MANAGEMENT PLAN FOR METHIL OFFSHORE DEMONSTRATION PROJECT

1 INTRODUCTION

This Surface and Coastal Water Management Plan (SCWMP) forms an appendix to the Environmental Impact Assessment (EIA) for Methil Offshore Demonstration Wind Turbine (hereafter referred to as 'the Development'). The SCWMP presented in this document is intended to demonstrate measures that could be used across the Development site to adequately protect coastal hydrological conditions, and related resources. Detailed proposals for such measures will be documented prior to construction, and will provide the same or greater protection for the water environment as those described in this document. The measures are proportionate to the risk and, where greater risk is highlighted at specific locations prior to construction, specific measures would be agreed for those locations.

The methods set out in the SCWMP are based on good practice and the following guidance:

- The Construction Industry Research and Information Association (CIRIA), 'Environmental Good Practice On Site (C650)' (2005); and
- CIRIA, 'Control of Water Pollution from Construction Sites (C532)' (2001).

The SCWMP takes into account specific activities during the construction and operational phases of the Development, including:

- Turbine foundation; and
- Hardstanding areas and buildings (including construction compounds and associated infrastructure).

Recommendations are provided on the detailed coastal water quality monitoring programme that should be undertaken to ensure that construction activities associated with the activities mentioned above do not unduly affect the coastal water quality.

Drainage from the site will include elements of Sustainable Urban Drainage Systems (SUDS) design. SUDS replicate natural drainage patterns and have a number of benefits:

- SUDS will attenuate run-off, thus reducing peak flow and any flooding issues that might onsite; and
- SUDS will treat run-off, which can reduce sediment and pollutant volumes in runoff before discharging into the coastal environment.

2 THE MANAGEMENT OF SURFACE WATERS

2.1 Location of Silt Traps

Silt traps will be utilised to trap and filter sediment-laden run-off from excavation works at the Development. They will be installed in drainage ditches between the excavation areas and the shoreline.

3 THE MANAGEMENT AND MOVEMENT OF FRESH CONCRETE AND CHEMICALS

To ensure that the potential for accidental spillages is minimised, the following management measures are proposed.

3.1 Accidental Spillage

Concrete and chemicals handling will be conducted within a bunded area of Fife Energy Park and this area will be underlain by an impermeable ground membrane layer. The bund will have a 110% capacity to attenuate stored liquids (including fresh concrete/cement). This will reduce the potential for accidental spillages to contaminate coastal water or groundwater. Inflatable temporary bunding will be deployed should concrete/chemicals spillage occur elsewhere, associated with the construction of the onshore infrastructure.

Speed limits for vehicles transporting concrete onsite will be limited to 5 miles per hour, in accordance with PPG14: Marinas and Craft. Maximum vehicle load capacities will not be exceeded.

Any equipment observed to be leaking while onsite will be immediately relocated to a designated area for repair.

Measures to manage fresh concrete during pouring operations are described in Section 5.2: *Concrete Pouring for Onshore Building Foundations*, below.

3.1.1 Emergency Spillage Procedure

The appointed construction contractor will agree an emergency spillage procedure with SEPA prior to the construction phase of the Development. Measures may include:

- Informing SEPA of any spillages as soon as possible;
- Absorbable spill pillows, pads and socks can be placed in or over the spillage to absorb and/or contain the spill;
- A number of different types of general spillage absorbent granules and chemical binders can be placed on the spillage; and
- An absorbent boom will be stored onsite for any fuel or oil releases in coastal waters.

3.2 Vehicle Washing

Vehicle washing will take place offsite, therefore reducing the possibility of sediment-laden washout entering the Firth of Forth.

4 DISPOSAL OF WASTE MATERIALS

Waste, such as packaging, from transportation of construction materials and from general site operations would be stored in a designated area of Fife Energy Park and removed from site by a suitably licensed contractor.

Any sediment generated during the excavation of the turbine foundation and electricity cable trench will be tested in accordance with The Environmental Protection Act 1990 (Amendment) (Scotland) Regulations 2001[1] and reused for regarding onsite, wherever possible.

5 CONSTRUCTION OF TURBINE BASE

5.1 Turbine Foundation Excavation

Before the turbine foundation is excavated, an insulating metal jacket will be sunk into the seabed (15 m from the shoreline) to enclose the working area. This enclosure will be dewatered and any sediment removed and stockpiled onshore before the piled foundations are installed. Stockpiles will be compacted to reduce the potential for sediment transfer into the Firth of Forth. Due to the industrial history of Methil Docks, any sediment removed during the excavation of the turbine foundation will be tested in accordance with The Environmental Protection Act 1990 (Amendment) (Scotland) Regulations 2001 before being used within the ongoing groundworks at Fife Energy Park. Should the excavated sediment test positive for elevated levels of contaminants it will be removed from the stockpiled area by a licensed contractor.

Offshore Drilled Piles

The ground conditions in the area of the turbine are anticipated to be a solid geology of weathered sandstone with a superficial layer of sandy and colliery spoil deposits. As a result of the hard bedrock, the piled foundations which are found at each leg of the support structure are likely to be drilled and grouted steel piles. The piles would be installed in

[1] (1990) "The Environmental Protection Act, Part II" [online] Available at: http://www.opsi.gov.uk/legislation/scotland/ssi2001/20010099.htm. [Accessed 24/08/2009]

advance of the main structure installation and be grouted in place to provide adequate bearing and support for the turbine structure.

The piles will be installed from a 'jack-up' barge or platform. They would be comprised of tubular steel of approximately 20 m long x 2m in diameter. The piles are to be placed within the drilled holes, which are held open either by seawater or drilling mud. For drilled piles it is normal practice for a temporary (sometimes permanent) steel casing to be vibrated, twisted or surged into the seabed before drilling thus creating a seal with the solid geology below the superficial deposits. The casing or drill sleeve, is designed to contain fine material and to prevent the excavated hole from collapsing at the surface. Therefore, this ensures that there should be little release of fines or contamination of seawater by the drilling fluids associated with piling activity.

The most likely drilling method would be to utilise reverse circulatory drilling. Reverse circulatory drilling is usually employed with large diameter piles where normal direct circulation will not develop sufficient return velocity to flow or transport the cuttings to the surface. Using this method, seawater or drilling mud is pumped into the steel casing to maintain the desired head of pressure. The fluid them moves slowly down the casing and through the drill teeth, being accelerated to a high velocity up through the drill stem. This technique can remove high density drill cuttings, but the low velocity along the walls helps to prevent erosion and minimises collapse of the excavation.

Pile cuttings will be collected on the platform and transferred to shore. After the hole has been drilled, the pile is placed and grouted.

5.2 Concrete Pouring for Onshore Building Foundations

Methods to protect coastal waters from the transportation of concrete are considered in Section 3: *The Management and Movement of Fresh Concrete and Chemicals*.

To prevent pollution it is important that all concrete pours are planned and that specific procedures are adopted where there may be a risk of coastal water or groundwater contamination, in accordance with CIRIA C532. These procedures will include:

- Onshore buildings and site compound foundations are constructed in holes in the ground that are typically de-watered, and hence water flow is typically into the foundation area. This will prevent concrete leaching to surface water in the event of shutter collapse;
- Ensuring that all excavations are sufficiently dewatered before concrete pours begin and that dewatering continues while the concrete cures. However, construction good practice will be followed to ensure that fresh concrete is isolated from the dewatering system; and
- Ensuring that covers are available for freshly placed concrete to avoid the surface of the concrete washing away during heavy rain events.

Any additional areas excavated onshore will be back-filled with compacted layers of material from the original excavation, where this is suitable, and capped.

6 RELOCATION

Relocation activities will be undertaken in accordance with good practice, and agreed with the relevant consultees in advance of the works commencing.

7 MONITORING PROGRAMME

A coastal water monitoring programme will be established in agreement with SEPA prior to the construction phase of the Development. An indicative monitoring programme is set out below.

Monitoring would be undertaken at locations on the Firth of Forth northeast of the Development infrastructure and southwest of other non-natural influences, where possible. It is anticipated that there would be up to 2 monitoring points, with details to be agreed with SEPA prior to implementation.

The following sampling frequency is proposed in order to represent baseline hydrochemical conditions and set threshold values for surface water and groundwater constituents:

- Once per month for two months prior to the construction phase.

Values for coastal water chemical constituents will be agreed with SEPA prior to the construction phase of the Development.

The following sampling frequencies are proposed in order to monitor coastal water conditions against baseline conditions:

- Once per month during minor excavation works, e.g., onshore buildings erection;
- Twice per month during major excavation works, e.g., turbine foundations; and
- Once after the construction phase.

7.1 Water Analysis Suite

Subject to agreement with SEPA, the following coastal water constituents will be tested for in a UKAS accredited laboratory:

- pH;
- Biological Oxygen Demand;
- Volatile Organic Compounds;
- Dissolved Oxygen Content;
- Heavy Metals;
- Iron;
- Magnesium;
- Aluminium;
- Chloride;
- Sodium; and
- Calcium

Following adoption of a coastal water monitoring programme, in agreement with SEPA, any activity detrimental to water quality will be detected at the earliest opportunity during the construction phase of the Development. This will allow action to be taken to prevent any further effect on water quality.

8 CONCLUSIONS AND RECOMMENDATIONS

The purpose of this SCWMP is to detail appropriate water management measures to control surface water run-off, and drain hardstandings and structures during the construction and operation of Methil Demonstration Project. The measures detailed throughout this report would ensure that any effects on the coastal and groundwater environment are minimised.

This document would be adapted to meet the additional requirements of the construction contractor, when appointed, to ensure that all measures implemented are effective and site-specific. Consultation with bodies including SNH and SEPA would be carried out to confirm agreement with the measures proposed prior to construction commencement.

The SCWMP is considered to be a live document, such that modifications can be made following additional information and advice from consultees.

Technical Appendix A10

Cultural Heritage

Project Code: MOWT10
Date of report: March 2010
Client: Arcus Renewable Energy Consulting Ltd, on behalf of 2-B Energy

METHIL WIND TURBINE DEMONSTRATION PROJECT

Fife Energy Park, Methil, Fife

John McCarthy
BA(Hons) MPhil AIFA

HEADLAND ARCHAEOLOGY Ltd

PROJECT SUMMARY SHEET

Client	RENEWABLE ENERGY CONSULTANTSING LTD, ON BEHALF OF ARUP SCOTLAND LTD 2-B ENERGY
National Grid Reference	NT 368 984 (CENTRE)
Address	FIFE ENERGY PARK, METHIL, FIFE
Parish	WEMYSS
Council	FIFE
Planning Application Ref No	N/A
NMRS No	NT39NE 14
Oasis No	N/A
SMR No	N/A
HB/SAM No	N/A
Listing Category	N/A
Project Manager	MARK ROBERTS
Text	JOHN MCCARTHY, EIA SPECIALIST
Illustrations	JOHN MCCARTHY, EIA SPECIALIST
Typesetting	THOMAS SMALL, SENIOR ILLUSTRATOR
Fieldwork	JOHN MCCARTHY, EIA SPECIALIST
Specialists	N/A
Schedule	
Fieldwork	09/02/2010
Report	12/02/2010

Signed off by: .....

Mark Roberts BA(Hons) MIFA, Project Manager

Date:.....

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METHIL WIND TURBINE DEMONSTRATION PROJECT

Fife Energy Park, Methil, Fife

by John McCarthy

This report presents the results of an archaeological desk-based assessment of the site of the site of a proposed wind turbine demonstration project. It has looked at both the on and off-shore areas that may be affected by the proposed development.

Within the onshore area six cultural heritage assets have been identified. Two of these are 19th century sites which have been completely removed. The remaining four sites are 20th century industrial sites of limited interest. As most of the onshore area was in the intertidal zone until the early 20th century or has been disturbed by mining activity, there is negligible potential for previously unrecorded archaeological features to be present. Within the onshore study area (i.e. within 500m of the proposed application boundary) there are no scheduled monuments and 46 listed buildings.

Within the offshore part of the proposed application boundary (2km from the onshore area) there are a total of 34 recorded maritime losses. Of these only four have approximate co-ordinates derived from SeaZone data, the locations of the remainder are uncertain.

1 INTRODUCTION

This report presents the results of an archaeological desk-based assessment of land at Methil, Fife. It has been prepared for Arcus Consulting Ltd, acting on behalf of 2-B Energy who are proposing to build a wind turbine demonstration site within the Fife Energy Park. The development will will initially consist of one turbine, an operations building and an anemometry mast or wind station. The intial turbine will be located adjacent to the shore near the operations building (Turbine A). A subsequent phase will see the erection of a second further offshore (Turbine B). Within five years of operation, Turbine A will be relocated to a site further offshore (Turbine C). Turbines B and C will be subject to a separate planning application. This report specifically considers the onshore and offshore components of the initial, Phase 1 application.

2 SITE DESCRIPTION

The proposed development site is 54ha in area and is situated on the coast of the Firth of Forth, on the western shore of Largo Bay. This area of the Scottish coast is characterised by sandy bays interrupted by rocky headlands (Robertson 1996, 1). The application area is flat and low-lying and lies between the towns of Methil and Buckhaven, in an area of partially reclaimed semi-derelict industrial land. Most of the site is empty but there are some large warehouses in the northeast part. The underlying geology of the site belongs to the Scottish coal measures with overlying sand and gravel deposits.

3 AIMS

The desk-based assessment has been undertaken in order to inform the design of the proposed development by identifying any cultural heritage assets present within the application area and by providing an indication of the archaeological potential.

4 METHODS

The following data sources have been used in the preparation of this report:

- Databases of designated cultural heritage features maintained by Historic Scotland;
- Records held by the National Monuments Record of Scotland (NMRS) including aerial photographs;
- Records held by the local Historic Environment Record;
- Maps held by National Library of Scotland;
- UK Hydrographic Office/SeaZone data;
- Other readily available published sources.

Data has been collected from the above sources for an area extending 500m from the onshore application area and up to 2km into the Firth of Forth. These are referred to as the onshore and offshore study areas respectively.

The potential for cultural heritage assets within the proposed development area has been discussed below in terms of the onshore and offshore areas of the existing landscape.The onshore area is defined as the area currently above the high water mark and the offshore as that area

currently below it. A small number of sites from the NMRS database within the intertidal zone have not been included in the assessment as they will not be affected in any way by construction in the offshore area. (these sites are all modern apart from two fish traps at Scoonie, over 3km from Turbine A)

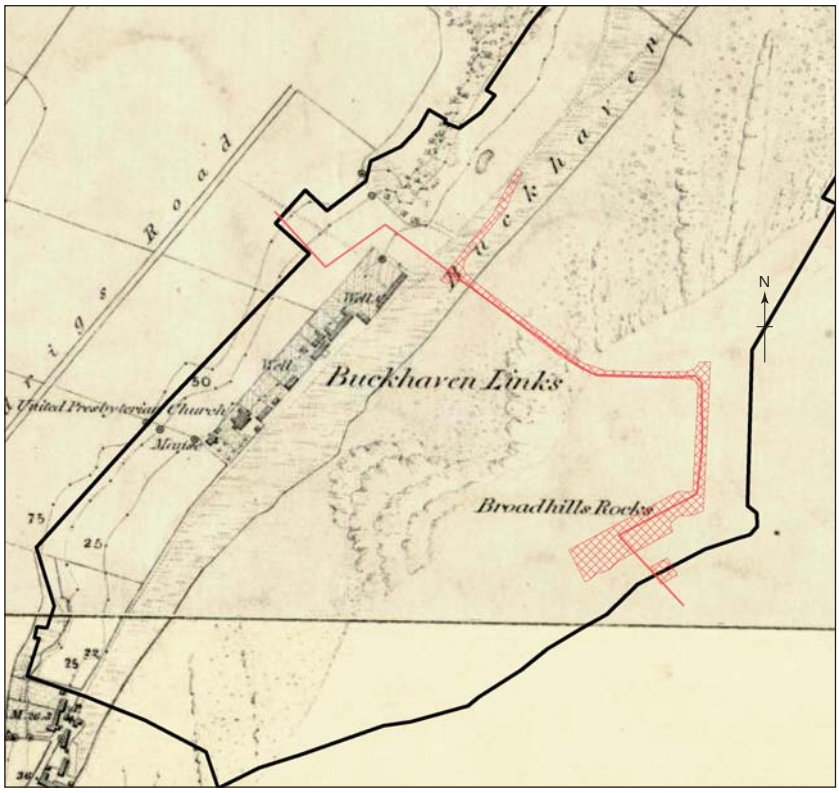
The site was visited on the 9th February 2010 to verify the findings of the desk-based element of the study, gather information regarding current land use and identify any factors that might affect the archaeological potential of the development site.

5 RESULTS

5.1 Limitations of data

The extension of the shoreline in this area during the extension of the Wellesley colliery in 1905 has obliterated the original topography of the site and rendered identification of previously unrecorded sites highly unlikely. The identification of cultural heritage assets must therefore rely entirely on cartographic or other documentary evidence at this stage. There have been no previous archaeological excavations in Buckhaven, Methil or Leven. However, it is considered that these limitations have not affected the reliability of the assessment.

The ability of this study to identify previously unknown wrecks within the offshore area is limited by the unavailability of marine geophysical and geotechnical survey data at this point. Such data should be reviewed as and when it becomes available – its absence restricts the reliability of the assessment.



Illus 1
The 1st edition Ordnance Survey 6 map of 1855 shows the extent of land reclamation within the application boundary since 1855. The proposed construction areas are shown in red. and the boundary of the Fife Energy Park in black.

5.2 Historic background and identified cultural heritage assets

Onshore (Illus 2)

Prehistoric and Roman

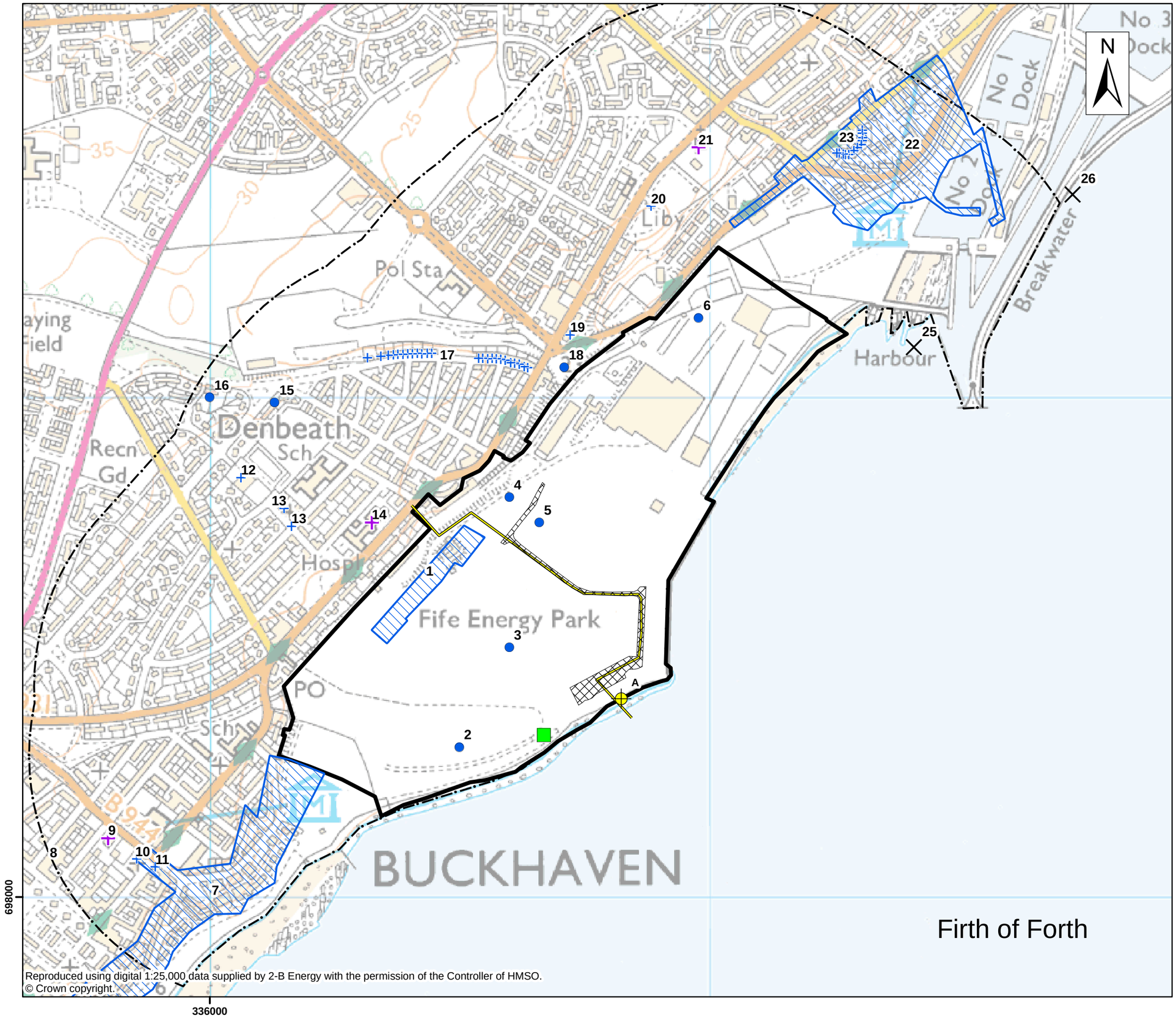
There are two sites of prehistoric/Roman date within the onshore part of the study area. These both lie within the onshore study area.

A Bronze Age cist cemetery (HA15) was discovered about 400m east of the application boundary in 1906 (presumably during the clearance of the village at Buckhaven Links). The cemetery was located on the summit of a small prominence known as 'the Sussan Brae' and has been completely removed. However the location of this site is uncertain as it is recorded a second time at a different location under the NMRS entry for the White Swan Hotel (HA19) a C(S) listed building dating to the early 20th century. In this entry it is suggested that the construction of the hotel led to the discovery of the cemetery. This would place the cemetery 600m to the east and almost immediately adjacent to the boundary of the Fife Energy Park. The original sources referring to the discovery of the cemetery from The Reliquary and the Proceedings of the Society of Antiquaries (1948-9, 242-3 and 1949-50, 226) only give the location of these finds as the 'Sussan Brae'. As none of the maps consulted appear to use this name it is difficult to be certain exactly where the cemetery was.

A Roman coin (HA 16 Licinius I – 308-324AD) minted in Alexandria was discovered in a garden around 500m west of the application boundary some time before 1960. Outwith the study area a similar Roman coin (NT39NE 9) was found in1951 in the playground of Buckhaven Primary School. The coin was of Maximian, of AD 305, also minted at Alexandria. The school is about 160m to the west of the application boundary. It is quite possible that this coin is a modern loss, especially as it was recovered from a school.

Medieval and Post-Medieval

No medieval or post-medieval assets have been recorded within the application boundary. However, there



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Key

- B-Listed Building
- C(S)-Listed Building
- Undesignated cultural heritage asset (polygon)
- Undesignated cultural heritage asset (point)
- Approximate location of ship loss
- Proposed turbine location
- Wind station location
- Proposed construction areas
- Proposed cable routes
- Application boundary
- Onshore study area

Metres
0 300

Sites and Monuments Record information derived from Fife Council data dated 04/02/2010

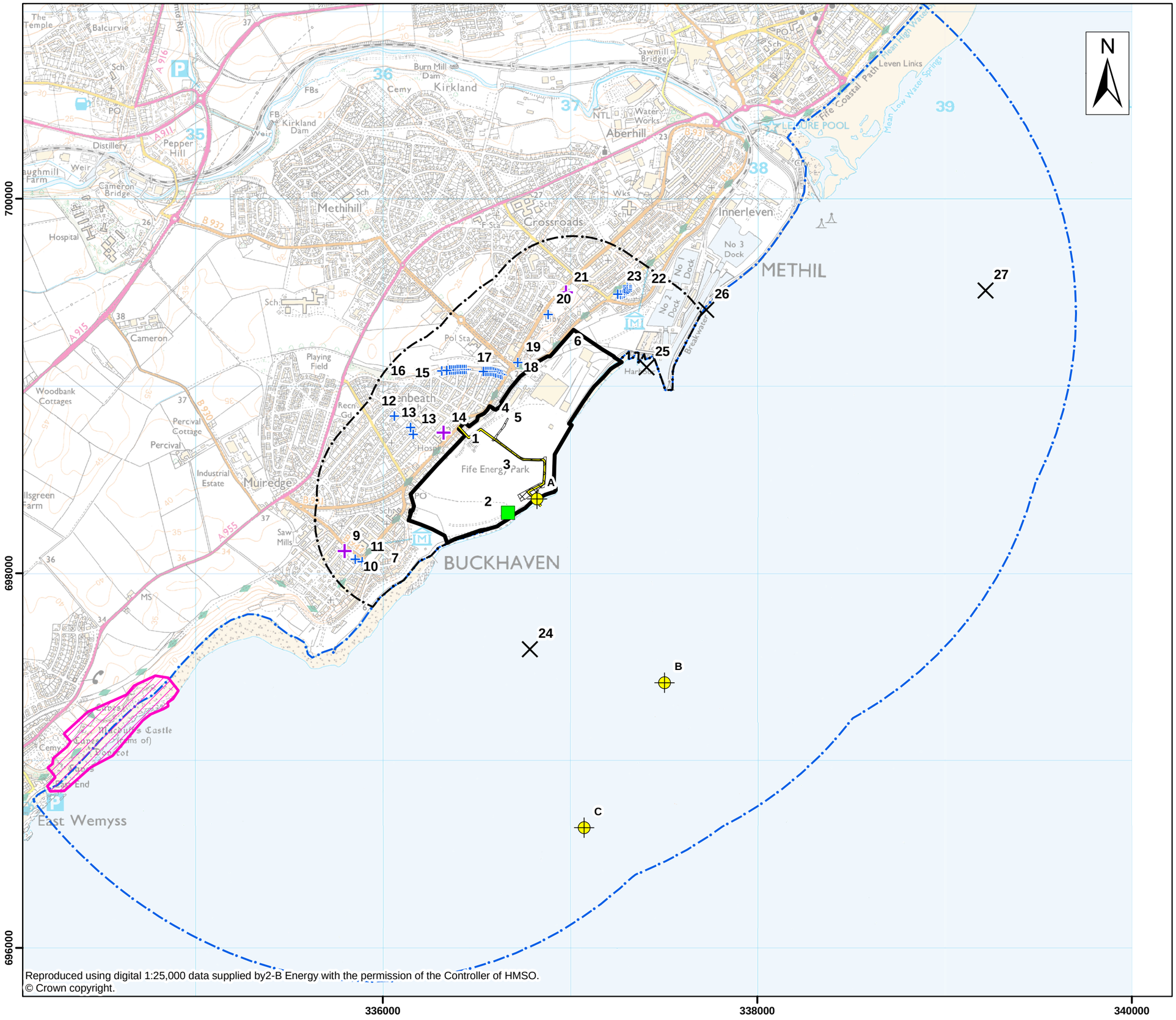
Scheduled monument area information derived from Historic Scotland data dated 27/01/2010 © Crown Copyright Historic Scotland

Listed Building data provided by Historic Scotland dated 27/01/2010 © Crown Copyright Historic Scotland

Seazone data (derived from UK Hydrographic Office) provided by Arcus Renewable Energy Consulting 28/01/2010

Methil Wind Turbine Demonstration Project

Illus 2: Cultural heritage assets within the onshore study area



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Key

- B-Listed Building
- C(S)-Listed Building
- Approximate location of ship loss
- Areas of Regional Importance
- Proposed turbine location
- Wind station location
- Proposed construction areas
- Proposed cable routes
- Application boundary
- Onshore study area
- Offshore study area

Metres
0 750

Sites and Monuments Record information derived from Fife Council data dated 04/02/2010

Scheduled monument area information derived from Historic Scotland data dated 27/01/2010 © Crown Copyright Historic Scotland

Listed Building data provided by Historic Scotland dated 27/01/2010 © Crown Copyright Historic Scotland

Seazone data (derived from UK Hydrographic Office) provided by Arcus Renewable Energy Consulting 28/01/2010

Methil Wind Turbine Demonstration Project

Illus 3: Cultural heritage assets within the maritime study area

is extensive evidence of activity of these periods in the study area.

The town of Methil (HA22) is known to have existed as early as 1212, although it was originally further inland and relocated to the coast sometime around the early eighteenth century. Buckhaven (HA7) was later in date and was first mapped around 1600. From an early date the production of salt, coal and fish were important to the two towns. These industries grew and were supplemented in the eighteenth and nineteenth centuries with net and rope manufacture and baking. There are few records of medieval sites in the immediate vicinity of the proposed development. Some cropmark remains of rig and furrow cultivation (NT39NE 141) have been recorded outwith the onshore study area 670m west of the application boundary. These are likely to represent medieval or post-medieval agricultural use of the land in the area.

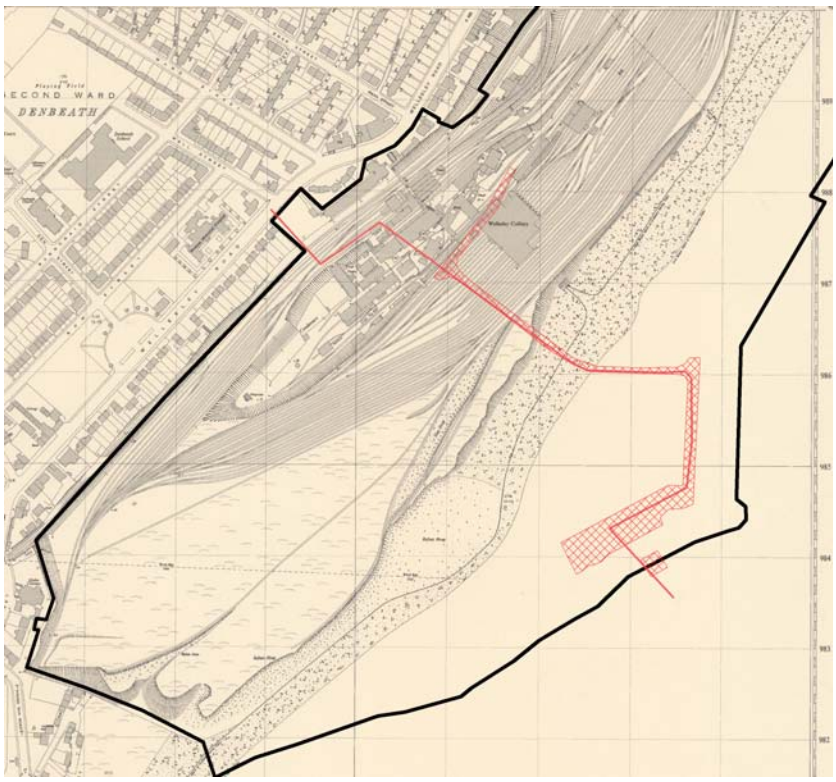
19th century (Illus 1)

There are three cultural heritage assets dating to the 19th century recorded within the application boundary. These comprise a short-lived settlement (HA1), a colliery (HA5) and a bathing house (HA 6). No surface trace of these survives.

The proposed development lies within a stretch of beach between the two settlements which was labelled as Buckhaven Links on the 1st edition Ordnance Survey (1855). Buckhaven Links (HA1) first appears on Greenwood's map of 1828 but the only clear picture of the town is from the 1st edition of the Ordnance Survey of 1855, where a string of approximately nine detached and semi-detached houses appears in a row to the immediate west of the coast road. At the southern end of this row a United Presbyterian church occupies a large plot of land with an adjacent building described as a manse to the south of this. Although there are few cartographic or documentary references to the settlement, its layout suggests a foundation not later than the eighteenth or nineteenth century and it is likely that it was laid out in a single event, possibly to serve as a fishing or mining settlement. A reference to a church and manse built by the United Presbyterian Church in Buckhaven in 1861 and 1868 respectively is likely to refer to these buildings (Small 1904, 276).

The extent of development of Buckhaven (HA7), Buckhaven Links (HA1) and Methil (HA22) at the time of the 1st edition of the Ordnance Survey in 1855 is shown on Figures 1 and 2. Also shown on the 1st edition Ordnance Survey further north along the beach is a small bathing house (HA6) to the immediate south of the coastal path. By the time of the second edition of the Ordnance Survey in 1895 Buckhaven Links had nearly twice as many buildings as it had in 1855 although new construction was largely confined within the existing footprint of the town due to the subdivision and redevelopment of garden plots. By this stage the manse building is labelled as 'Old Manse', suggesting that it was no longer used for its original purpose of providing accommodation to a minister.

In the latter half of the 19th century the coal mining industry in the wider area expanded enormously, with the establishment of the Pirnie pit (c.1860), the Muiredge pit (first productive in 1864), the Rosie pit (1872-75), and the Leven pits (1877-8). This period also saw the establishment of railways which served the collieries and much of the population of Buckhaven and Methil left the fisheries to work in the mines. Denbeath Colliery (HA5) was built in 1872 to the immediate northeast of Buckhaven Links and within the site boundary. Around the same time railway sidings were put in place to the colliery and an adjacent creosote works.



Illus 4
The 1948 Ordnance Survey map (1:25.000) shows railway sidings across the area now occupied by the Fife Energy Park

20th century

There are three cultural heritage assets dating to the 20th century within the application boundary. These comprise a bing (HA2), a 1970s oil rig construction yard (HA3) and a brickworks (HA4). No surface traces of either the bing or the brickworks have been removed.

In 1905 the Wemyss Coal Company bought the Denbeath colliery and cleared away the entire settlement at Buckhaven links and the creosote works. They also closed the coastal road between Buckhaven and Methil at the same time,

to make way for a third shaft and a Baum washery (for cleaning coal). The former site of Buckhaven Links and Denbeath Colliery was renamed as the Wellesley Colliery and a number of railway sidings were built to transport the coal to the washery and on to the harbour at Methil were added (Illus 4). Methil rapidly developed into Scotland's largest coal port by 1913, exporting three million tons of coal in 1923 (Smith 2001, 131 and 653). The Ordnance Survey map of 1914 shows Buckhaven Links and the creosote works entirely cleared with a massive expansion of the colliery and a new planned town of Denbeath to the immediate NW of the application boundary.

From some time shortly before this, coal spoil was being dumped to the east of the application area. This began to extend the shoreline in this area though initially the change was slight. At the same time a large bing (HA2) began to be created which would later be used to actively accelerate this process of expansion.

The coast of Fife in this area preserves a large number of cultural heritage assets relating to WWI and WWII (Robertson 1996, 2). Within the immediate vicinity of the onshore part of the application boundary there are several such sites. The Buckhaven and Methil WWI monument (HA20) unveiled in 1922 stands about 70m west of the application boundary. A WW2 concrete built Extended Defence Officers Post or XDO post (HA18) is situated about 30m to the west of the application boundary, by a road junction on the coast side of the road. The XDO post has been buried with only the top visible above ground and trees have been planted round it with the intention of concealing the structure. The XDO post was the control position for a submarine mine field which was laid in the approaches to Methil Docks.

Wellesley Colliery closed in 1964, as did most of the other collieries in the area during the 1960s. For a period around the 1960s the eastern edge of the application area was used as a refuse tip expanding the shoreline further. At some point between 1967 and 1984 most of the colliery infrastructure was removed. The site of the colliery was then developed as an industrial yard (HA3) for the construction of oil rig structural elements beginning in 1972 (Smith 2001, 653) and has passed through various owners until its closure in 2001. After its acquisition by Scottish Enterprise some 300m of repairs to coastal defences at the site have been completed. A comprehensive programme of earthworks and site platforming have also been undertaken with the addition of a series of embankments between the Park and neighbouring residential properties and an extension of the reclaimed area of approximately 28 hectares. Burntisland Fabrications currently operates in buildings in the north-eastern part of the site producing major fabrications for use in offshore gas and oil installations.

Offshore (Illus 3)

All known maritime cultural heritage assets within the offshore study area are wrecks. Of these only four have had their sites of loss recorded with any accuracy. These are summarised in Table 1 below and shown on Illustration 3. These sites are recorded in the SeaZone data which is derived from UK Hydrographic data. Although these sites can be mapped their locations are not precise and it is unknown whether there are any surviving remains at these locations.

HA No	Name	Type	Date of build	Date of loss
24	Cosmo	Cabin Cruiser	Unknown	1994
25	Number Four	Steam Sand Dredger	Unknown	1898
26	Karen	Schooner	1920	1940
27	SS Ashgrove	Twin-screw Vessel	1882	1912

Table 1
Maritime losses recorded by the UK Hydrographic Office

There are thirty-three further maritime losses recorded in the NMRS database. However these have been poorly located and are not mapped on the illustrations in this report. Table 3 in the appendix summarises all known maritime losses from the NMRS database.

5.3 Potential for unrecorded archaeological features

Onshore

Although there are a number of prehistoric, Roman and medieval sites in the vicinity of the proposed development the potential for pre-modern sites to be present is considered to be negligible. The greater part of the onshore application area is depicted as a predominantly rocky beach on the First Edition Ordnance Survey map. In this context there is no potential for traces of pre-19th century activity to survive. The northwest part of the site, marked Buckhaven Links on the First Edition map, may, from its name, be assumed to be part of a dune system. Based on the heights marked on the First Edition and sea-change curves (Shennan & Horton 2002) the dunes covered an area that is likely to have been submerged or in the intertidal zone during the prehistoric period. Land in the intertidal zone is likely to see a limited range of human activity and consequently the potential for prehistoric sites is limited; fish-traps being the most common site type. The dunes could potentially have masked substantial remains of later date. However, there is no indication, such as place name evidence, that this may be the case and the potential for any such site to survive is negated by development of the site in the early 20th century. It may be assumed that the links area saw considerable ground preparation before the construction of the railway sidings serving Wellesley Colliery. Geotechnical reports for the application area have shown thick deposits of made ground within parts of the application area. These are up to 24m thick eastern side of the application boundary and around 10-15m

thick towards the west of the application area (Scottish Enterprise Fife 2005 and 2007). Sites created since the process of land reclamation began, such as sites relating to WWII in particular, are more likely to have survived as they may have been built on top of this overburden but extensive landscaping within the Fife Energy Park as well as reinforcement of coastal defences is likely to have destroyed any such sites. Those parts of the application area not affected by the sidings have for the most part been disturbed by later buildings, some of which still stand. Again it is highly unlikely that substantial remains survive undisturbed.

It is considered to be highly unlikely that there will be any surviving cultural heritage assets within the onshore part of the proposed development boundary.

Offshore

The potential for offshore cultural heritage assets can be divided into two broad categories, those shoreline elements related to sites originally created at inland or coastal locations, mines and wrecking events.

Submerged archaeology and relict landscapes

The most significant factor which must be taken into consideration is the relative change in sea level which has occurred during the period of human occupation of Scotland. Changes in relative sea level since the end of the Pleistocene appear to have been complex, with changes in absolute sea level interacting with changes in land level due to isostatic rebound. Sea level from around the beginning of the period of human occupation has fallen since the first human colonisation of Scotland (Flemming 2004, 12) and in this area of Scotland the relative sea level was up to 5m higher (Shennan and Horton 2002). It is therefore probable that the old shoreline prior to land reclamation was further west for most of the prehistoric period and it is unlikely that prehistoric remains exist even within the westernmost part of the site.

Minefield

The XDO post to the immediate west of the onshore part of the Fife Energy Park was used as a control post for the submarine mine field laid in the approaches to Methil Docks during WWII. Although this minefield was removed after the war the recovery of an unexploded mine by a fishing vessel in 2006 (news.bbc.co.uk Monday, 25 September 2006) shows that there may still be remnants of this field. It has not been possible to establish the extents of the minefield in the course of the current study.

Maritime losses

The topography and location of the Firth of Forth means that it has been an important transport corridor since the arrival of humans in Scotland. The coast in this area would have been extensively used during human history and the shelter provided by Largo Bay would have been particularly attractive. A good example of this can be seen Wemyss caves (Illus 3). This area includes a number of archaeological sites from several periods of human history in a dense concentration. A large variety of maritime activities have taken place along this coast including military operations, trading, mining and fishing. Since medieval times and possibly earlier the port of Methil has been an important centre for trading and fishing. The final resting places of most of the known maritime losses in the offshore study areas have never been identified. Detailed records of maritime losses only began during the 19th century and even this record is incomplete.

As stated above there is a low potential for remains of offshore sites near the current shore line due to land reclamation during the 20th century but this will have had little impact on the potential for preservation of remains further offshore. As the depth of the Firth increases with distance from the shore, the action of the waves and weather upon cultural heritage sites at the bottom of the Firth decreases and the potential for preservation increases. In some areas, submerged remains can often be buried in sediments as part of localised coastal and fluvial processes.

The construction of offshore turbine bases, wet storage areas and the laying of submerged cables as well as the anchoring of vessels involved in construction all have the potential to directly impact upon unknown sites within the offshore study area. In addition the disturbance of sediment has the potential to indirectly damage such sites, either by covering sites or uncovering those which were previously covered, although under certain circumstances this can be a positive effect.

It is considered that there is a low potential for unknown cultural heritage assets within the vicinity of Turbine A. Any cultural heritage assets would most likely comprise of ship wrecks and related remains, within the offshore part of the study area.

6 CONCLUSIONS

Although a number of sites of cultural heritage interest have been identified within the onshore part of the application boundary, it is likely that subsequent industrial operations have removed them entirely. Within the offshore study area a large number of maritime losses have been reported, and there are likely to have been numerous unrecorded losses. Few of these sites have been identified on the bed of the Firth and there is a moderate potential for sites within this area. It is recommended that as and when marine geotechnical and geophysical survey data becomes available these should be reviewed in order to allow previously unrecorded maritime losses to be identified.

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7.2 Unpublished Sources

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Ordnance Survey 1914 *Sheet XXVII*.8 25." (Surveyed 1913)

Ordnance Survey 1914 *Sheet XXVII*.12 25." (Surveyed 1913)

Ordnance Survey 1938 *Sheet XXVII*.12 25." (Surveyed 1938)

Ordnance Survey 1938 *Sheet XXVII NE 6*." (Surveyed 1938)

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Ordnance Survey 1967 *NT3698 1:25,000*. (Surveyed 1963)

Ordnance Survey 1967 *NT3798 1:25,000*. (Surveyed 1963)

7.4 Aerial Photographs

The vertical aerial photographs held by the NMRS and examined in the course of the assessment are summarised below.

Sortie	Frames	Date
106G/DY/009	60067	1944
58/6511	0061	1964
ASS/518/88	094	1988

Table 2
Aerial Photos

7.5 Monuments Records

Data regarding designated assets was downloaded from Historic Scotland's website on 27/01/2010. © Historic Scotland

NMRS data has been gathered by examination of the following quarter sheets held in the NMRS Library, Edinburgh, in conjunction with Pastmap. These were examined on 5/02/2010.

APPENDICES

Appendix 1

Maritime losses recorded in the NMRS in the vicinity of the application boundary

NMRS No	Name	Type	Period	NGRE	NGRN
NT39NE 8009	Unknown: Methil, Firth of Forth	Craft	20th Century	337700	699400
NT39NE 8001	Unknown: Methil Breakwater, Firth of Forth	Dredger	20th Century	337410	699100
NT39NE 8003	Thorgny: Buckhaven, Firth of Forth	Barque	19th Century	336300	697900
NT39NE 8004	Antelope: Methil Harbour, Firth of Forth	Steamship	19th Century	337500	699500
NT39NE 8005	Scio: Methil, Firth of Forth	Brig	19th Century	337000	699000
NO30SE 8001	Surprise: Leven, Firth of Forth	Paddle steamship	19th Century	338000	700000
NT39NE 8010	Jantje: Buckhaven, Firth of Forth	Craft	19th Century	336000	697000
NT39NE 8011	Gripen: Methil, Firth of Forth	Craft	19th Century	337500	699500
NT39NE 8012	Industry: Buckhaven, Firth of Forth	Craft	19th Century	336000	697000
NT39NE 8013	Euphemia: Buckhaven, Firth of Forth	Craft	19th Century	336000	697000
NT39NE 8015	Robert Anderson: Methil, Firth of Forth	Schooner	19th Century	337000	699000
NT39NE 8016	Veritas: Methil, Firth of Forth	Barque	19th Century	337000	699000
NT39NE 8017	Raleigh: Methil Pier, Firth of Forth	Steamship	19th Century	337500	699100
NT39NE 8018	Anna: Buckhaven, Firth of Forth	Brigantine	19th Century	336000	697000
NT39NE 8020	Myrtle: Buckhaven, Firth of Forth	Lugger	19th Century	336000	697000
NT39NE 8021	Pilot Boat No 2: Buckhaven, Firth of Forth	Cutter	19th Century	336000	697000
NT39NE 8022	Onward: Buckhaven, Firth of Forth	Lugger	19th Century	336000	697000
NT39NE 8023	Pilot Boat No 2: Buckhaven, Firth of Forth	Cutter	19th Century	336000	697000
NT39NE 8024	Thetis: Methil Roads, Firth of Forth	Brig	19th Century	336000	698000
NT39NE 8025	Nornen: Methil, Firth of Forth	Barque	20th Century	337000	699000
NT39NE 8026	Isafold: Methil Harbour, Firth of Forth	Schooner	20th Century	337500	699500
NT39NE 8027	Kitty: Buckhaven, Firth of Forth	Sloop	19th Century	336000	697000
NT39NE 8028	Alert: Methil Pier, Largo Bay, Firth of Forth	Sloop	19th Century	337000	699000
NT39NE 8031	Dart: Methil, Firth of Forth	Ketch	19th Century	337000	699000
NT39NE 8032	Achilles: Methil Harbour, Firth of Forth	Galliot	19th Century	337500	699500
NO30SE 8003	Unknown: Leven, Firth of Forth	Craft	19th Century	338000	700000
NT39NE 8033	Admiral: Methil, Firth of Forth	Schooner	19th Century	337000	699000
NO30SE 8005	Sisters: Leven, Firth of Forth	Craft	19th Century	338000	700000
NO30SE 8007	Catharina: Leven, Firth of Forth	Schooner	19th Century	338000	700000
NT39NE 8034	Venskabet: Methil Harbour, Firth of Forth	Sloop	19th Century	337500	699500

Appendix 2

Concordance of cultural heritage assets

HA No.	Name	Type	Description	Status	LB No	NMRS No
1	Buckhaven Links	Village (19th century)	Buckhaven Links first appears on Greenwood's map of 1828 but the only clear picture of the town is from the 1st edition of the Ordnance Survey of 1855, where a string of approximately nine detached and semi-detached houses appears in a row to the immediate west of the coast road. At the southern end of this row a United Presbyterian church occupies a larger plot of land and there is a building described as a manse to the south of this. Although there are few cartographic or documentary references to the settlement, its layout suggests a foundation not later than the eighteenth or nineteenth century and it is likely that it was laid out in a single event, possibly to serve as a fishing or mining settlement. A reference to a church and manse built by the United Presbyterian Church in Buckhaven in 1861 and 1868 respectively is likely to refer to these buildings (Small 1904, 276).	–	–	–
2	Coal Bing	Coal Bing	A coal bing derived from 20th century mining at Dunbeath/Wellesley Colliery.	–	–	NT39NE 140
3	RGC Construction Yard	Construction Yard	A late 20th century construction yard.	–	–	NT39NE 14
4	Wemyss Brickworks	Brickworks	A brickworks dating to the late 19th/early 20th century	–	–	NT39NE 54
5	Denbeath/ Wellesley Colliery	Colliery	Denbeath Colliery was built in 1872 to the immediate NE of Buckhaven Links and within the site boundary. In 1905 the Wemyss Coal Company bought the colliery and expanded it over the cleared sites of Buckhaven Links and the creosote works. They also closed the coastal road between Buckhaven and Methil at the same time, to make way for a third shaft and a Baum washery (for cleaning coal). The site of Buckhaven Links and Denbeath Colliery was renamed as the Wellesley Colliery and a number of railway sidings were built to transport the coal to the washery and on to the harbour at Methil were added. Wellesley Colliery closed in 1964, as did most of the other collieries in the area during the 1960's.	–	–	NT39NE 59
6	Bathing House	Bathing House	A small bathing house or changing hut which appears on the 1st edition of the Ordnance Survey.	–	–	–
7	Buckhaven	Town	For the purposes of this study all development within the village of Buckhaven up to 1855 is considered as one site with the exception of listed buildings which are listed separately. Buckhaven was still a small fishing village by the time of the 1st edition Ordnance Survey in 1855. The town was laid out in a linear strip along the coast and ran up to the edge of what is now the Fife Energy Park.	–	–	NT39NE 44, 52, 137, 138
8	Buckhaven Community Centre	Community Centre	A two-storey former Miners' Welfare Institute built in 1925.	C (S) Listed Building	46070	NT39NE 80
9	St. Andrew's Theatre/Church	Church/Theatre	Ecclesiastical building no longer in use as such. Formerly St Andrew's Church, home of the Buckhaven Free Church congregation which formed in 1866. In 1870 the Episcopal Church at North Street, St Andrews was purchased for the sum of £130, it was transported to Buckhaven in Thomas Walker's boat 'The Sea King', and re-erected in 1872. In 1972 the congregation united with nearby St David's Parish Church (listed separately) and St Michael's, and the building closed until 1987 when it was converted and extended to a theatre.	B-Listed Building	22711	NT39NE 40

HA No.	Name	Type	Description	Status	LB No	NMRS No
10	Buckhaven Parish Church	Church	Ecclesiastical building in use as such. Formerly St David's Church. In 1972 the congregations of St Andrews and St Michael's Churches united with St David's to form the Buckhaven Parish Church. Church interior "upgraded" during the 1980s under a Community Programme scheme.	C (S) Listed Building	46068	NT39NE 77
11	Royal Bank buildings	Bank	A late 19th century two-storey building in use as a bank.	C (S) Listed Building	46069	NT39NE 79
12	Denbeath Miner's Welfare Institute	Welfare Institute	A two-storey building dating to 1924. In spite of unsympathetic extensions, this building retains its integrity and historic interest, now as a bowling pavilion with green.	C (S) Listed Building	46072	NT39NE 96
13	Denbeath Parish Church	Church and Hall	The former Denbeath Parish Church is prominently situated on a corner site in an area of Denbeath developed by the Wemyss Coal Company.	C (S) Listed Building	50126	–
14	Randolph Wemyss Memorial Hospital	Hospital	Commissioned by Lady Eva Wemyss as a memorial to her husband, the Randolph Wemyss Memorial Hospital was opened on 28 August, 1909. Single storey and attic, 7-bay hospital in Scots Renaissance style.	C (S) Listed Building	22716	–
15	Denbeath	Cist, Urns, Beaker	A Bronze Age cist cemetery was found in 1906, on the eastern top of a height known locally as 'the Sussan Brae' now named Denbeath. The location of this site is uncertain. See the entry for the White Swan Hotel and the text above. Over a dozen cists were found, some containing urns. Four urns, including portions of a Beaker, are now in the National Museum of Antiquities of Scotland. The site of the cemetery, located at NT 3613 9900 from the descripton above, is now part of a new housing development area. No further finds have been reported.	–	–	NT39NE 1
16	Denbeath	Roman Coin	A fairly worn bronze coin of Licinius I, minted at Alexandria, which was found, perhaps before 1960, in a Methil garden, was presented to Kirkcaldy Museum by Inspector D T Donaldson, Fife Constabulary, Kirkcaldy. The location shown is very approximate and it is likely that the findspot was actually outwith the study area.	–	–	NT39NE 2
17	1-51 Cowley Street	Cottages	A row of cottages erected for workers of Bowman & Company owners of Denbeath Colliery. The cottages were leased to the Wemyss Coal Company in 1905, after which they provided accommodation for employees of the Wemyss Private Railway.	C (S) Listed Building	46071	NT39NE 97-120
18	Methil XDO Post	XDO Post	A WW2 concrete built Extended Defence Officers Post (XDO post) is situated on the S side of Methil, by a road junction on the coast (S) side of the road. The XDO post has been buried with only the top visible above ground and trees have been planted round it with the intention of concealing the structure. The XDO post was the control position for a submarine mine field which was laid in the approaches to Methil Docks.	–	–	NT39NE 15
19	The White Swan Hotel	Hotel/Bronze Age Cemetery	An early 20th century 2-storey 9-bay hotel. According to the listed building report a Bronze Age cemetery was discovered during the construction of the hotel in 1906. However this would appear to be the same site recorded separately as NT39NE 1. It is difficult to be certain exactly where the cemetery was (see text above).	C (S) Listed Building	22713	NT39NE 7
20	Buckhaven and Methil War Memorial	War Memorial	A World War I war memorial with a soldier on a plinth, with World War II role-of-honour added. The statue was unveiled in 1922.	C (S) Listed Building	46077	NT39NE 56

HA No.	Name	Type	Description	Status	LB No	NMRS No
21	Methil parish Church	Church	Ecclesiastical building in use as such. This Cruciform-plan, aisless Romanesque Church was built for the Baird Trust in 1925. The previous Methil Parish Church was situated in Lower Methil, and the foundation stone of that building (dated 1837) is now located in the Narthex of the present church.	B-Listed Building	22712	NT39NE 50
22	Methil	Town	For the purposes of this study all development within the village of Methil up to 1855 is considered as one site with the exception of listed buildings which are listed separately. Methil was still a small fishing village by the time of the 1st edition Ordnance Survey in 1855. It had a small harbour, a church, tavern, school and ropewalk. However many of its buildings were in ruin at this time. The extent of its development at this stage is largely within the onshore outer study area but not within Fife Energy Park.	–	–	NT39 NE 11, 53, 66, 68, 69, 75, 131, 132, 133
23	313-338 High Street, Lower Methil	Terrace	An early 20th century terraced crescent of two-storey local authority houses (25) with crowstepped gables and Scottish 17th century details.	C (S) Listed Building	46074	NT 39NE 84-95
24	Cosmo	Cabin Cruiser	The Cosmo was a cabin cruiser which ran aground off Buckhaven in 1994. It is not considered to be of cultural heritage interest.	–	–	–
25	Number Four	Steam Sand Dredger	The Number Four was a steam sand dredger which ran aground on rocks near Methil Breakwater on the 8th December 1898 and which later broke up and became a total loss.	–	–	NT39NE 8001
26	Ashgrove	Vessel	The SS Ashgrove was an iron hulled twin-screw vessel of 1,702 tonnes, 286.94 metres long and 10.51 metres wide, built in Hull in 1882. She ran aground in a storm against the unfinished new harbour wall of Methil on January the 16th, 1912. Two of the crew and a stowaway perished but the rest of the crew were saved in a dramatic rescue.	–	–	NT39NE 8009
27	Karen	Schooner	The Karen was a wooden schooner built in 1920 by Kragh Christensen and owned by an M Pederson. The ship caught fire after an explosion in the hold and sank on the 5th of February 1940.			NT39NE 8002

Technical Appendix A14

Shadow Flicker

APPENDIX A14: SHADOW FLICKER

1.1 INTRODUCTION

This Technical Appendix presents the following information in support of **Chapter 14: Shadow Flicker** of the Methil Offshore Demonstration Wind Turbine Environmental Statement:

- Percentage of Bright Sunshine: Calculations for the percentage of bright sunshine (see Table A14.3 below) that occurs in Fife during each month of the year using (1) Sunshine data for the years 2000-2009, sourced from the UK Met office website. (2) Sunrise and sunset times sourced from the US Naval Almanac website. See Table A14.2 below.
- Results for the Assessment Locations: Charts showing the months and times of the day during which effects would occur based on the theoretical hours per annum, along with discussion of the results for the worst-case scenario for each assessed location.

1.2 PERCENTAGE OF BRIGHT SUNSHINE

Table A14.1: Sunshine data in hours from the UK Met Office Historical Station, Leuchars – Fife for the years 2000 – 2009.

Yr / Month	2000 hrs	2001 hrs	2002 hrs	2003 hrs	2004 hrs	2005 hrs	2006 hrs	2007 hrs	2008 hrs	2009 hrs	Average Bright Sunshine per month (hrs)
Jan	96.7	69.8	50.1	66.5	57.8	73.8	40.5	73.3	48.8	67.6	64.5
Feb	95.3	99.7	80.5	102.7	119.7	96.8	61.2	75.6	92.6	65.9	89.0
Mar	126.6	120.5	123.6	160.0	130.2	112.5	75.4	136.2	142.1	162.5	128.9
Apr	142.8	159.8	151.0	199.6	107.9	170.1	204.8	191.3	161.9	127.2	161.6
May	228.2	245.5	176.1	183.4	210.4	220.6	217.4	187.9	188.6	222.7	208.0
Jun	181.8	201.5	166.2	226.5	185.6	174.3	192.8	67.0	170.9	157.7	172.4
Jul	165.0	149.7	145.9	173.5	164.9	217.6	203.3	147.9	109.8	180.9	165.8
Aug	169.5	147.6	148.9	201.8	134.5	184.4	158.0	165.3	94.9	168.1	157.3
Sep	124.2	121.2	125.4	151.6	154.0	113.0	129.5	150.3	93.7	135.6	129.8
Oct	120.8	94.7	90.9	140.2	95.1	52.1	76.8	123	126.5	89.8	100.9
Nov	97.3	79.5	65.8	93.5	82.1	89.3	92.9	69.8	99.5	78.1	84.7
Dec	51.3	64.4	20.2	57.1	76.2	50	66.8	42.1	49.6	38.9	51.6

Source: http://www.metoffice.gov.uk/climate/uk/stationdata/leucharsdata.txt

Table A14.2: Sunrise and sunset hours per month for 2009 (Location: N 56° 20' W 03° 01')

Source: http://aa.usno.navy.mil/data/docs/RS_OneYear.php

Day	Jan.			Feb			Mar		
	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight
	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m
01	08:44	15:47	07:03	08:08	16:44	08:36	07:04	17:46	10:42
02	08:44	15:48	07:04	08:06	16:46	08:40	07:02	17:48	10:46
03	08:44	15:50	07:06	08:04	16:49	08:45	06:59	17:50	10:51
04	08:43	15:51	07:08	08:02	16:51	08:49	06:57	17:52	10:55
05	08:43	15:52	07:09	08:00	16:53	08:53	06:54	17:54	11:00
06	08:42	15:54	07:12	07:58	16:55	08:57	06:52	17:56	11:04
07	08:42	15:55	07:13	07:56	16:57	09:01	06:49	17:58	11:09
08	08:41	15:57	07:16	07:54	17:00	09:06	06:46	18:01	11:15
09	08:40	15:59	07:19	07:52	17:02	09:10	06:44	18:03	11:19
10	08:39	16:00	07:21	07:49	17:04	09:15	06:41	18:05	11:24
11	08:39	16:02	07:23	07:47	17:06	09:19	06:39	18:07	11:28
12	08:38	16:04	07:26	07:45	17:08	09:23	06:36	18:09	11:33
13	08:37	16:05	07:28	07:43	17:11	09:28	06:33	18:11	11:38
14	08:36	16:07	07:31	07:40	17:13	09:33	06:31	18:13	11:42
15	08:34	16:09	07:35	07:38	17:15	09:37	06:28	18:15	11:47
16	08:33	16:11	07:38	07:36	17:17	09:41	06:25	18:17	11:52
17	08:32	16:13	07:41	07:34	17:20	09:46	06:23	18:19	11:56
18	08:31	16:15	07:44	07:31	17:22	09:51	06:20	18:21	12:01
19	08:29	16:17	07:48	07:29	17:24	09:55	06:17	18:23	12:06
20	08:28	16:19	07:51	07:26	17:26	10:00	06:15	18:26	12:11
21	08:27	16:21	07:54	07:24	17:28	10:04	06:12	18:28	12:16
22	08:25	16:23	07:58	07:22	17:31	10:09	06:09	18:30	12:21
23	08:24	16:25	08:01	07:19	17:33	10:14	06:07	18:32	12:25
24	08:22	16:27	08:05	07:17	17:35	10:18	06:04	18:34	12:30
25	08:20	16:29	08:09	07:14	17:37	10:23	06:02	18:36	12:34
26	08:19	16:31	08:12	07:12	17:39	10:27	05:59	18:38	12:39
27	08:17	16:33	08:16	07:09	17:41	10:32	05:56	18:40	12:44
28	08:15	16:35	08:20	07:07	17:44	10:37	05:54	18:42	12:48
29	08:13	16:38	08:25				05:51	18:44	12:53
30	08:12	16:40	08:28				05:48	18:46	12:58
31	08:10	16:42	08:32				05:46	18:48	13:02
			238:16:00			268:29:00			367:49:00

Day	Apr			May			Jun		
	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight
	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m
01	05:43	18:50	13:07	04:28	19:52	15:24	03:33	20:48	17:15
02	05:40	18:52	13:12	04:26	19:54	15:28	03:32	20:49	17:17
03	05:38	18:54	13:16	04:23	19:56	15:33	03:31	20:50	17:19
04	05:35	18:56	13:21	04:21	19:58	15:37	03:30	20:51	17:21
05	05:32	18:58	13:26	04:19	20:00	15:41	03:29	20:53	17:24
06	05:30	19:00	13:30	04:17	20:02	15:45	03:28	20:54	17:26
07	05:27	19:03	13:36	04:15	20:04	15:49	03:28	20:55	17:27
08	05:25	19:05	13:40	04:13	20:06	15:53	03:27	20:56	17:29
09	05:22	19:07	13:45	04:11	20:08	15:57	03:26	20:57	17:31
10	05:19	19:09	13:50	04:08	20:10	16:02	03:26	20:58	17:32
11	05:17	19:11	13:54	04:06	20:12	16:06	03:25	20:59	17:34
12	05:14	19:13	13:59	04:04	20:14	16:10	03:25	20:59	17:34
13	05:12	19:15	14:03	04:03	20:16	16:13	03:24	21:00	17:36
14	05:09	19:17	14:08	04:01	20:18	16:17	03:24	21:01	17:37
15	05:07	19:19	14:12	03:59	20:19	16:20	03:24	21:01	17:37
16	05:04	19:21	14:17	03:57	20:21	16:24	03:24	21:02	17:38
17	05:02	19:23	14:21	03:55	20:23	16:28	03:24	21:02	17:38
18	04:59	19:25	14:26	03:53	20:25	16:32	03:24	21:03	17:39
19	04:57	19:27	14:30	03:52	20:27	16:35	03:24	21:03	17:39
20	04:54	19:29	14:35	03:50	20:29	16:39	03:24	21:04	17:40
21	04:52	19:31	14:39	03:48	20:30	16:42	03:24	21:04	17:40
22	04:49	19:33	14:44	03:47	20:32	16:45	03:24	21:04	17:40
23	04:47	19:35	14:48	03:45	20:34	16:49	03:24	21:04	17:40
24	04:44	19:38	14:54	03:44	20:35	16:51	03:25	21:04	17:39
25	04:42	19:40	14:58	03:42	20:37	16:55	03:25	21:04	17:39
26	04:40	19:42	15:02	03:41	20:39	16:58	03:26	21:04	17:38
27	04:37	19:44	15:07	03:39	20:40	17:01	03:26	21:04	17:38
28	04:35	19:46	15:11	03:38	20:42	17:04	03:27	21:03	17:36
29	04:33	19:48	15:15	03:37	20:43	17:06	03:28	21:03	17:35
30	04:30	19:50	15:20	03:35	20:45	17:10	03:28	21:03	17:35
31				03:34	20:46	17:12			
			427:06:00			507:26:00			526:33:00

Day	Jul			Aug			Sept		
	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight
	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m
01	03:29	21:02	17:33	04:15	20:21	16:06	05:16	19:07	13:51
02	03:30	21:02	17:32	04:17	20:19	16:02	05:18	19:05	13:47
03	03:31	21:01	17:30	04:19	20:17	15:58	05:20	19:02	13:42
04	03:32	21:01	17:29	04:21	20:14	15:53	05:22	18:59	13:37
05	03:33	21:00	17:27	04:22	20:12	15:50	05:23	18:57	13:34
06	03:34	20:59	17:25	04:24	20:10	15:46	05:25	18:54	13:29
07	03:35	20:58	17:23	04:26	20:08	15:42	05:27	18:52	13:25
08	03:36	20:57	17:21	04:28	20:06	15:38	05:29	18:49	13:20
09	03:37	20:56	17:19	04:30	20:04	15:34	05:31	18:46	13:15
10	03:39	20:55	17:16	04:32	20:01	15:29	05:33	18:44	13:11
11	03:40	20:54	17:14	04:34	19:59	15:25	05:35	18:41	13:06
12	03:41	20:53	17:12	04:36	19:57	15:21	05:37	18:38	13:01
13	03:43	20:52	17:09	04:38	19:54	15:16	05:39	18:36	12:57
14	03:44	20:51	17:07	04:40	19:52	15:12	05:41	18:33	12:52
15	03:46	20:50	17:04	04:42	19:50	15:08	05:43	18:30	12:47
16	03:47	20:48	17:01	04:44	19:47	15:03	05:45	18:28	12:43
17	03:49	20:47	16:58	04:46	19:45	14:59	05:47	18:25	12:38
18	03:50	20:45	16:55	04:48	19:43	14:55	05:49	18:22	12:33
19	03:52	20:44	16:52	04:50	19:40	14:50	05:51	18:20	12:29
20	03:54	20:42	16:48	04:52	19:38	14:46	05:53	18:17	12:24
21	03:55	20:41	16:46	04:54	19:35	14:41	05:55	18:14	12:19
22	03:57	20:39	16:42	04:56	19:33	14:37	05:57	18:12	12:15
23	03:59	20:37	16:38	04:58	19:30	14:32	05:59	18:09	12:10
24	04:00	20:36	16:36	05:00	19:28	14:28	06:01	18:06	12:05
25	04:02	20:34	16:32	05:02	19:25	14:23	06:03	18:04	12:01
26	04:04	20:32	16:28	05:04	19:23	14:19	06:05	18:01	11:56
27	04:06	20:30	16:24	05:06	19:20	14:14	06:07	17:58	11:51
28	04:07	20:28	16:21	05:08	19:18	14:10	06:09	17:56	11:47
29	04:09	20:27	16:18	05:10	19:15	14:05	06:11	17:53	11:42
30	04:11	20:25	16:14	05:12	19:12	14:00	06:13	17:50	11:37
31	04:13	20:23	16:10	05:14	19:10	13:56			
			525:44:00			466:18:00			382:24:00

Day	Oct			Nov			Dec		
	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight	Rise	Set	Hrs of Daylight
	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m	h:m
01	06:15	17:48	11:33	07:19	16:31	09:12	08:20	15:42	07:22
02	06:17	17:45	11:28	07:21	16:29	09:08	08:21	15:41	07:20
03	06:19	17:42	11:23	07:24	16:27	09:03	08:23	15:40	07:17
04	06:21	17:40	11:19	07:26	16:25	08:59	08:24	15:40	07:16
05	06:23	17:37	11:14	07:28	16:23	08:55	08:26	15:39	07:13
06	06:25	17:35	11:10	07:30	16:21	08:51	08:27	15:38	07:11
07	06:27	17:32	11:05	07:32	16:19	08:47	08:29	15:38	07:09
08	06:29	17:29	11:00	07:34	16:17	08:43	08:30	15:37	07:07
09	06:31	17:27	10:56	07:36	16:15	08:39	08:32	15:37	07:05
10	06:33	17:24	10:51	07:39	16:13	08:34	08:33	15:37	07:04
11	06:35	17:22	10:47	07:41	16:11	08:30	08:34	15:36	07:02
12	06:37	17:19	10:42	07:43	16:09	08:26	08:35	15:36	07:01
13	06:39	17:17	10:38	07:45	16:07	08:22	08:36	15:36	07:00
14	06:41	17:14	10:33	07:47	16:05	08:18	08:37	15:36	06:59
15	06:43	17:11	10:28	07:49	16:04	08:15	08:38	15:36	06:58
16	06:45	17:09	10:24	07:51	16:02	08:11	08:39	15:36	06:57
17	06:47	17:06	10:19	07:53	16:00	08:07	08:40	15:36	06:56
18	06:50	17:04	10:14	07:55	15:59	08:04	08:41	15:36	06:55
19	06:52	17:02	10:10	07:57	15:57	08:00	08:42	15:37	06:55
20	06:54	16:59	10:05	07:59	15:56	07:57	08:42	15:37	06:55
21	06:56	16:57	10:01	08:01	15:54	07:53	08:43	15:37	06:54
22	06:58	16:54	09:56	08:03	15:53	07:50	08:43	15:38	06:55
23	07:00	16:52	09:52	08:05	15:51	07:46	08:44	15:39	06:55
24	07:02	16:50	09:48	08:07	15:50	07:43	08:44	15:39	06:55
25	07:04	16:47	09:43	08:09	15:49	07:40	08:44	15:40	06:56
26	07:06	16:45	09:39	08:11	15:47	07:36	08:45	15:41	06:56
27	07:09	16:43	09:34	08:13	15:46	07:33	08:45	15:42	06:57
28	07:11	16:40	09:29	08:14	15:45	07:31	08:45	15:42	06:57
29	07:13	16:38	09:25	08:16	15:44	07:28	08:45	15:43	06:58
30	07:15	16:36	09:21	08:18	15:43	07:25	08:45	15:44	06:59
31	07:17	16:33	09:16				08:45	15:46	07:01
			322:23:00			247:26:00			218:05:00

Table A14.3 Calculations for the percentage of bright sunshine each month for Fife

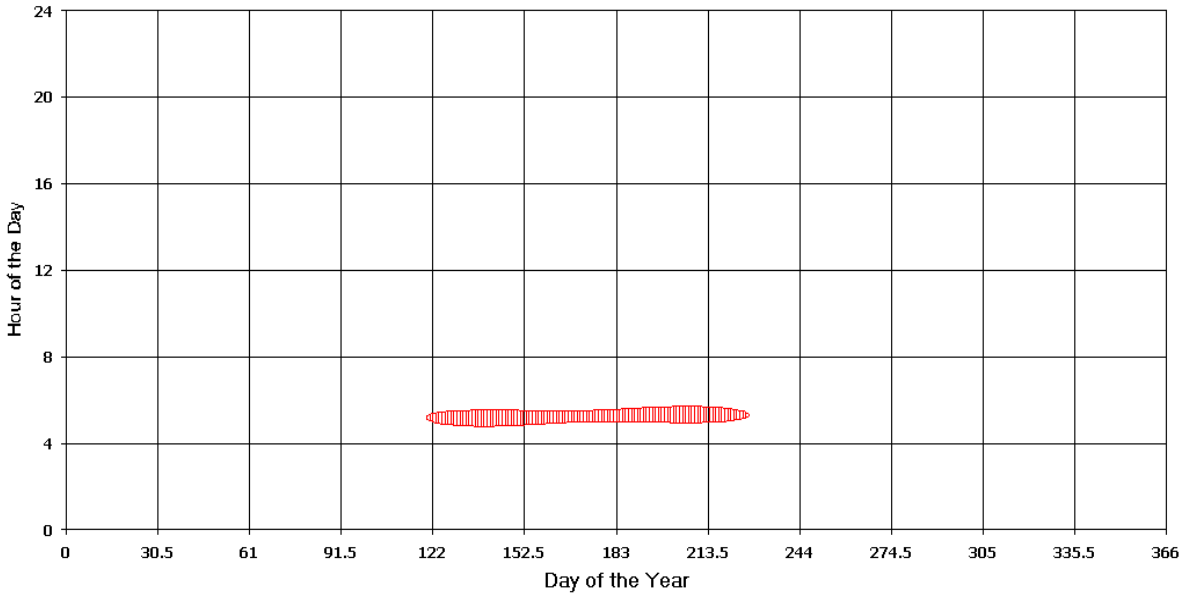
Average bright sunshine hours per month (over 2000-2009)	Hours of daylight each month for 2010	RATIO = Average bright sunshine hours per month / Hours of daylight per month	Percentage of bright sunshine
64.5	238.2	0.27	26
89.0	268.3	0.33	33
128.9	367.5	0.35	35
161.6	427.0	0.38	37
208.0	507.3	0.41	41
172.4	526.3	0.33	32
165.8	525.4	0.32	31
157.3	466.2	0.34	33
129.8	382.2	0.34	34
101.9	322.2	0.31	31
85.7	247.3	0.34	34
52.6	218.0	0.24	23

1.3 RESULTS FOR THE ASSESSMENT LOCATIONS

Location 1, Lady Wynd

Chart A14.1 shows the times that shadow flicker have been predicted to occur at Location 1, Lady Wynd on a north-facing window. As shown on the graph, the effects could occur for short periods during early mornings at sunrise hours, during the months of May, June and July.

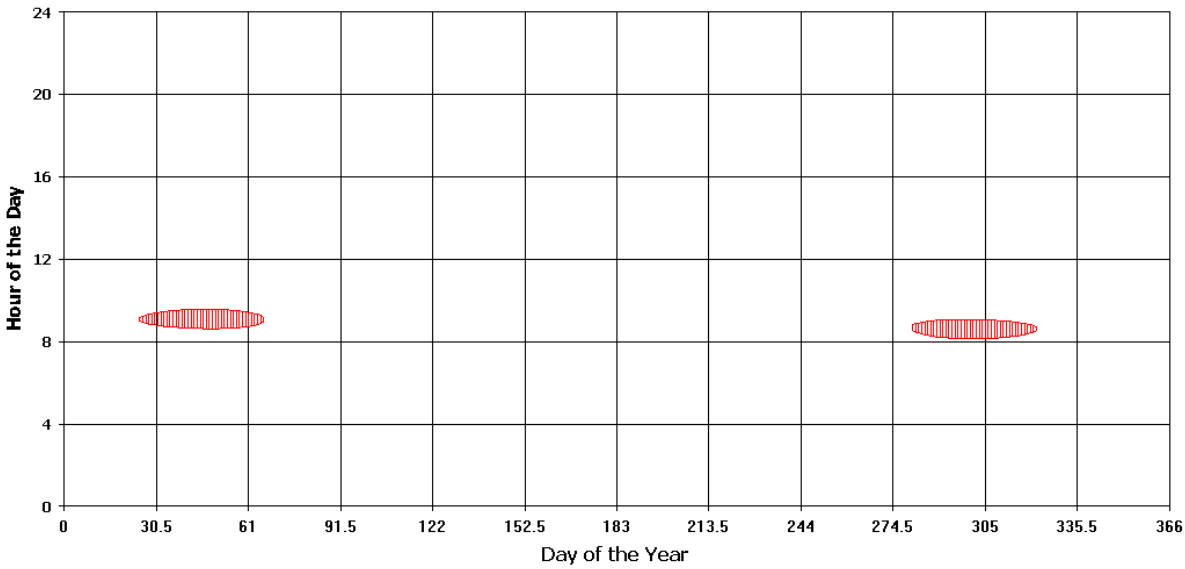
Chart A14.1 Shadow Times at Location1, Lady Wind for north-facing window



Location 2, Wellesley Road

Chart A14.2 shows the times that shadow flicker have been predicted to occur at Location 2, Wellesley Road on an east-facing window. As shown on the graph, the effects could occur for short periods from late January to early March and from mid-October to mid-November during early mornings.

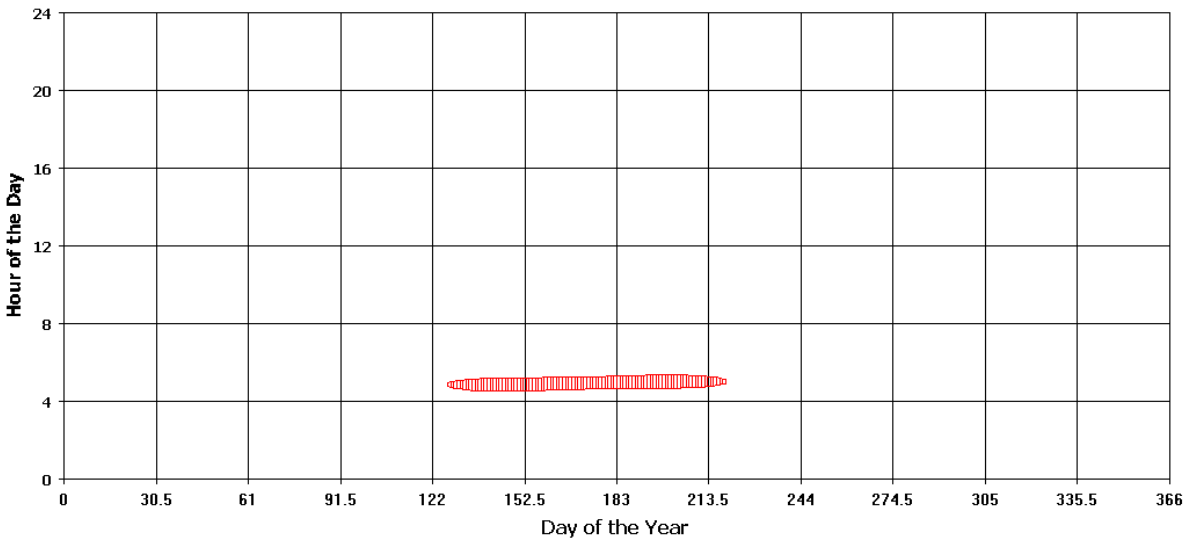
Chart A14.2 Shadow Times at Location 2, Wellesley Road for an east-facing window



Location 3, Bethune Way

Chart A14.3 shows the times that shadow flicker have been predicted to occur at Location 3, Bethune Way on a north-facing window. As shown on the graph, the effects could occur for short periods during early mornings from May until early August.

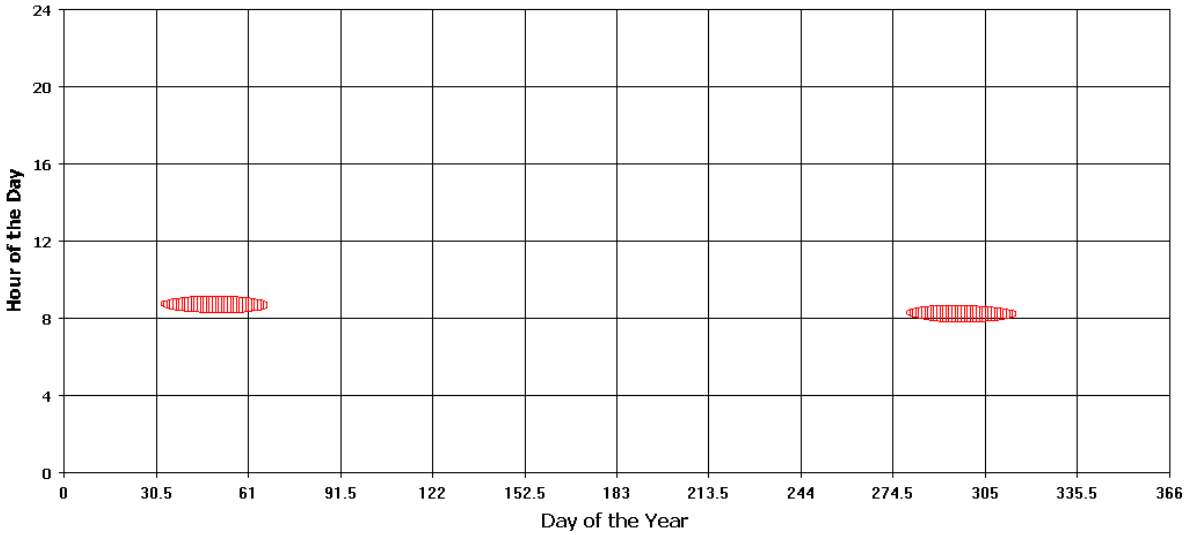
Chart A14.3 Shadow Times at Location 3, Bethune Way for a north-facing window



Randolph Wemyss Memorial Hospital

Chart A14.4 shows the times that shadow flicker have been predicted to occur at Randolph Wemyss Memorial Hospital on an east-facing window. As shown on the graph, the effects could occur for short periods during early mornings from February until early March and October until early November.

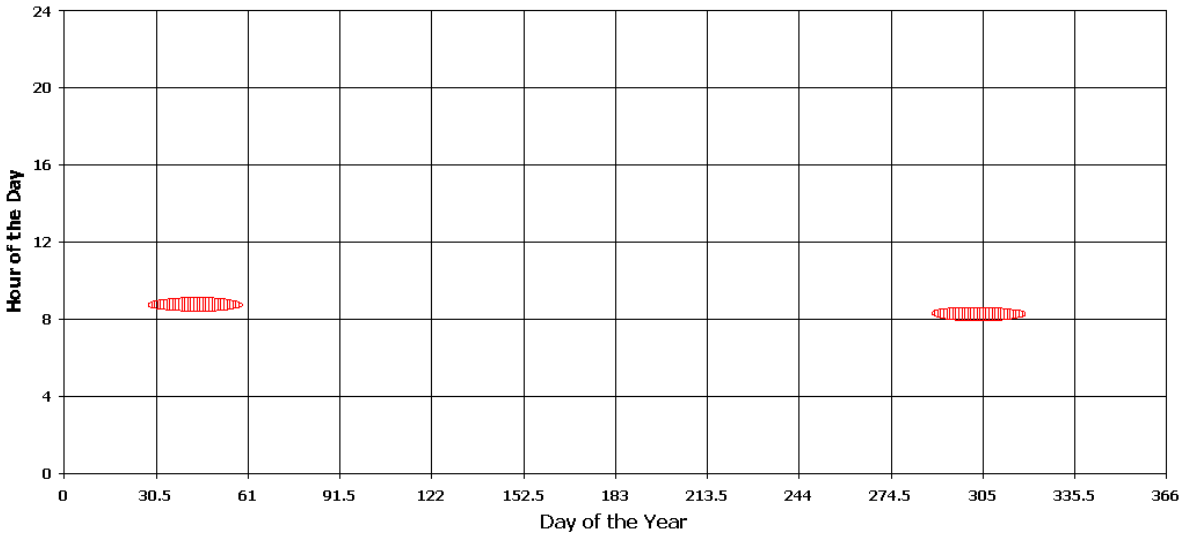
Chart A14.4 Shadow Times at Randolph Wemyss Memorial Hospital for an east-facing window



Denbeath Primary School

Chart A14.5 shows the times that shadow flicker have been predicted to occur at Denbeath Primary School on an east-facing window. As shown on the graph, the effects could occur for short periods during early mornings in February and mid-October until mid-November.

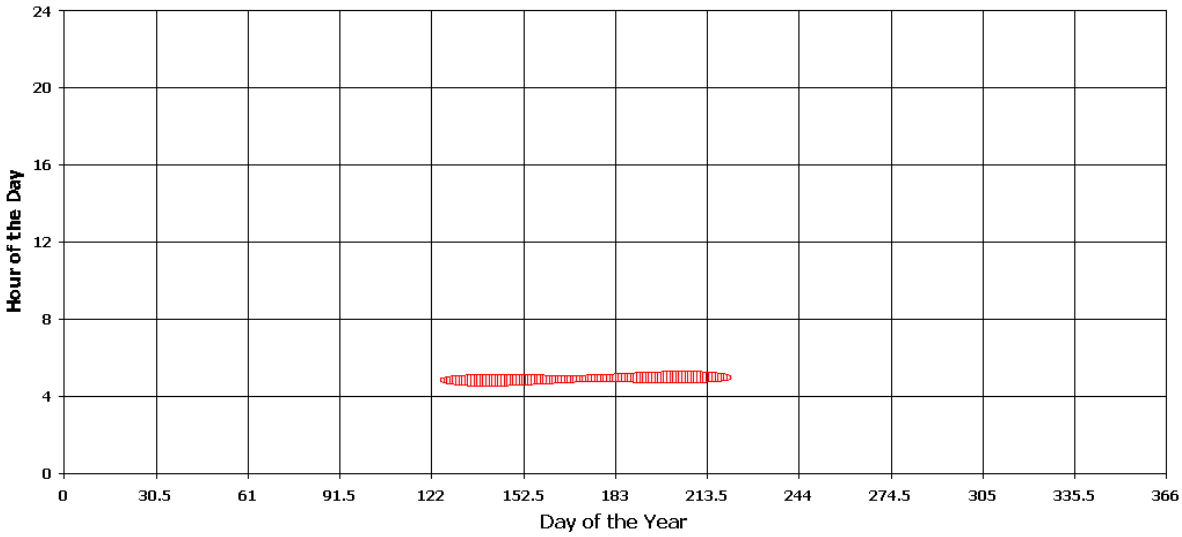
Chart A14.5 Shadow Times at Denbeath Primary School for an east-facing window



Location 4, Anderson Lane

Chart A14.6 shows the times that shadow flicker have been predicted to occur at Location 4, Anderson Lane on a north-facing window. As shown on the graph, the effects could occur for short periods during early mornings in May, June, July and early August.

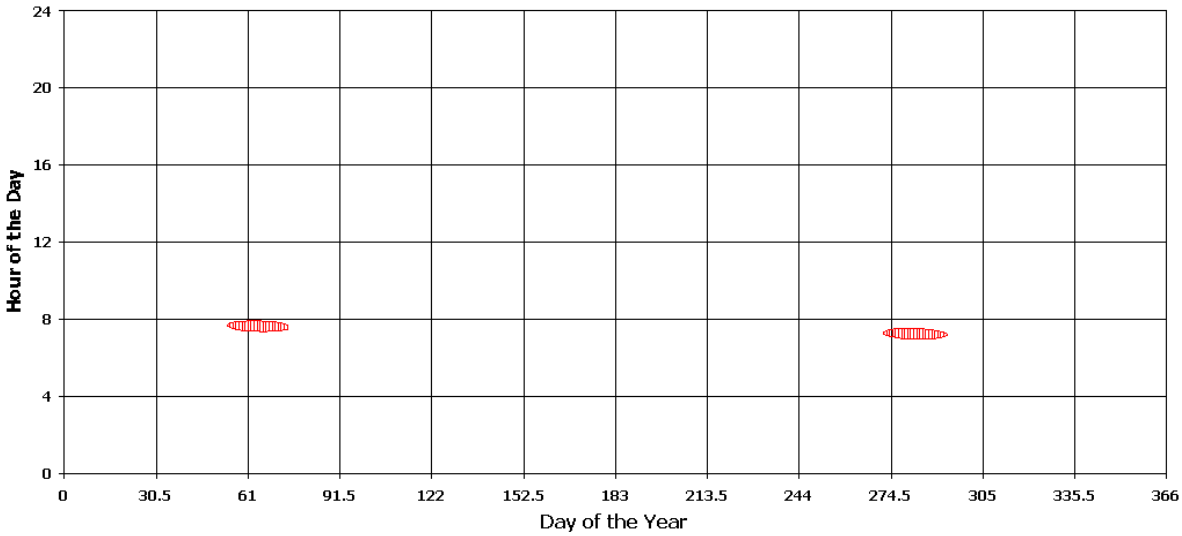
Chart A14.6 Shadow Times at Location 4, Anderson Lane for a north-facing window



Location 5, Den Walk

Chart A14.7 shows the times that shadow flicker have been predicted to occur at Location 5, Den Walk on an east-facing window. As shown on the graph, the effects could occur for short periods during early morning mid-February to mid-March and October.

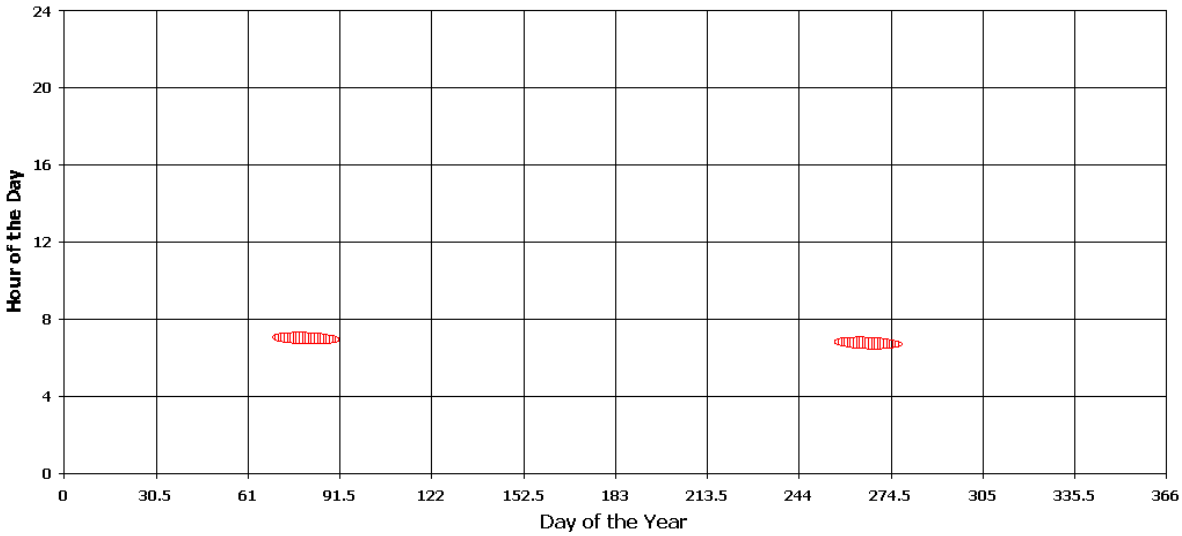
Chart A14.7 Shadow Times at Location 5, Den Walk for an east-facing window



Location 6, Omar Crescent

Chart A14.8 shows the times that shadow flicker have been predicted to occur at Location 6, Omar Crescent on an east-facing window. As shown on the graph, the effects could occur for short periods during early mornings in March and September.

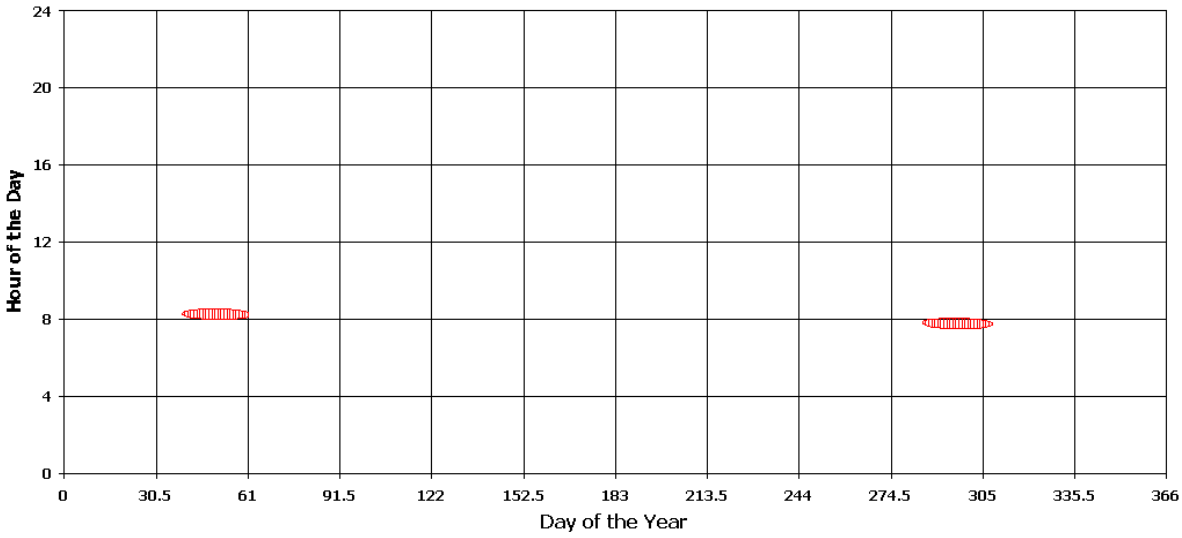
Chart A14.8 Shadow Times at Location 6, Omar Crescent for an east-facing window



Location 7, Den Walk

Chart A14.9 shows the times that shadow flicker have been predicted to occur at Location 7, Den Walk on an east-facing window. As shown on the graph, the effects could occur for short periods during early mornings in March and September.

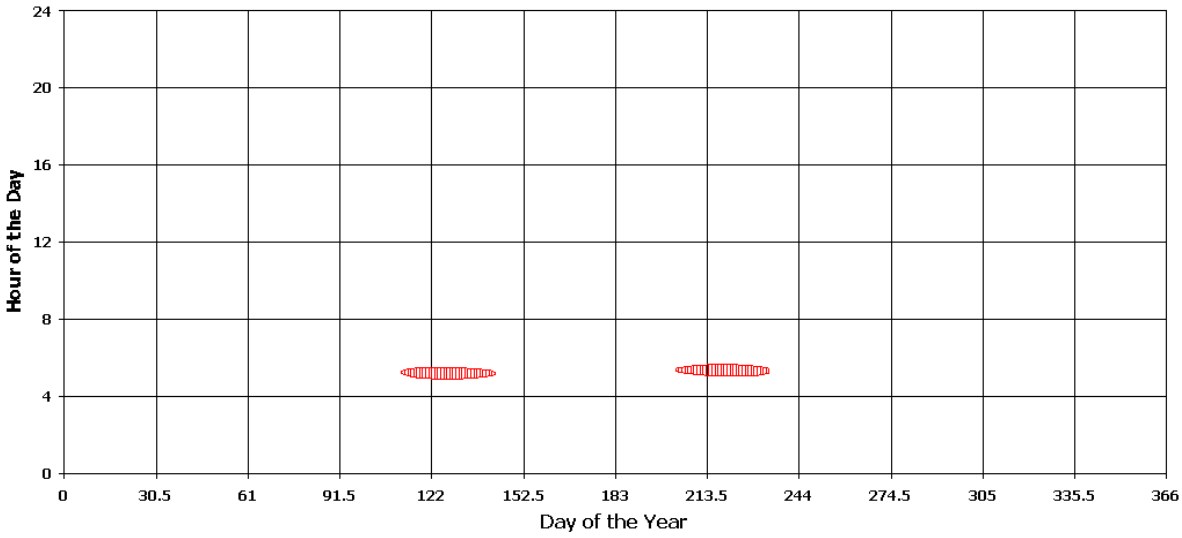
Chart A14.9 Shadow Times at Location 7, Den Walk for an east-facing window



Location 8, Braehead Gardens

Chart A14.10 shows the times that shadow flicker have been predicted to occur at Location 8, Braehead Gardens on a north-facing window. As shown on the graph, the effects could occur for short periods during early mornings from mid-April to mid-May and mid-July to mid-August.

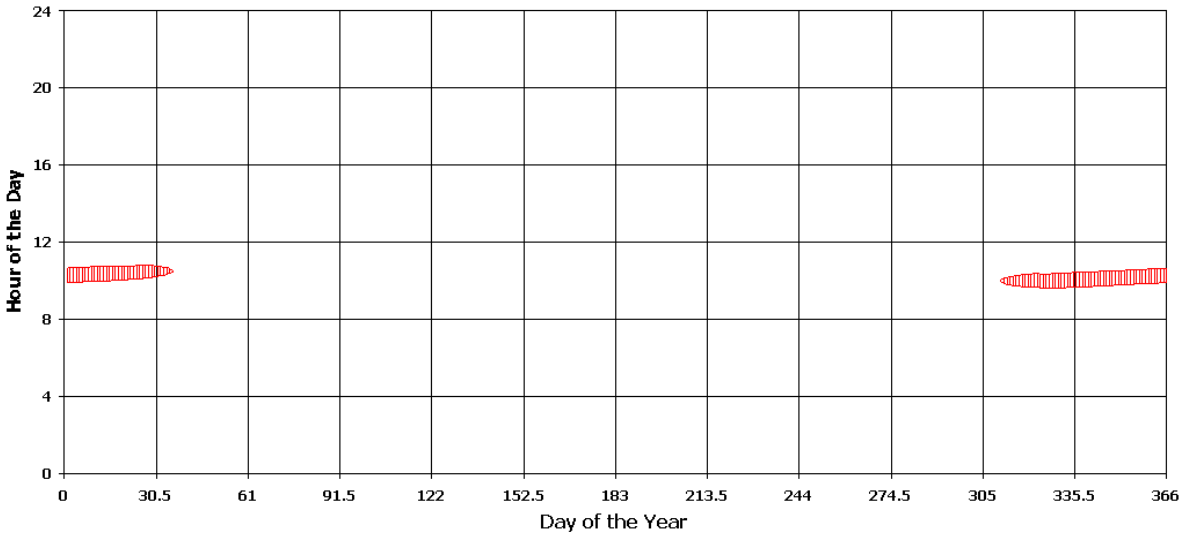
Chart A14.10 Shadow Times at Location 8, Braehead Gardens for a north-facing window



Location 9, Clyde Street

Chart A14.11 shows the times that shadow flicker have been predicted to occur at Location 9, Clyde Street on an east-facing window. As shown on the graph, the effects could occur for short periods during morning hours from mid-November until early February.

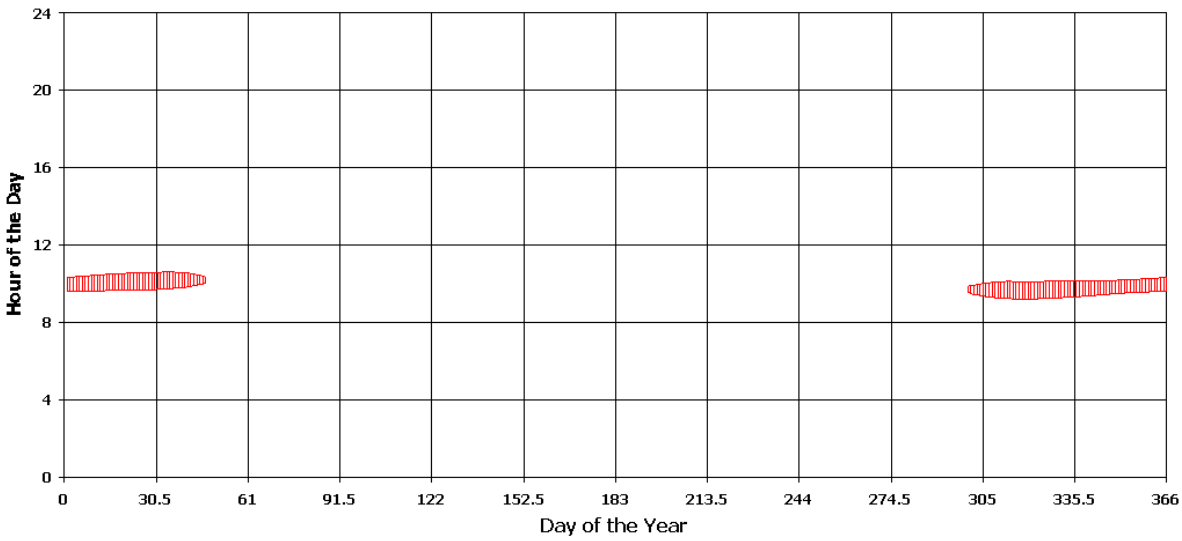
Chart A14.11 Shadow Times at Location 9, Clyde Street for an east-facing window



Location 10, Wellesley Road

Chart A14.12 shows the times that shadow flicker have been predicted to occur at Location 10, Wellesley Road on an east-facing window. As shown on the graph, the effects could occur for short periods during morning hours from mid-October until mid-February.

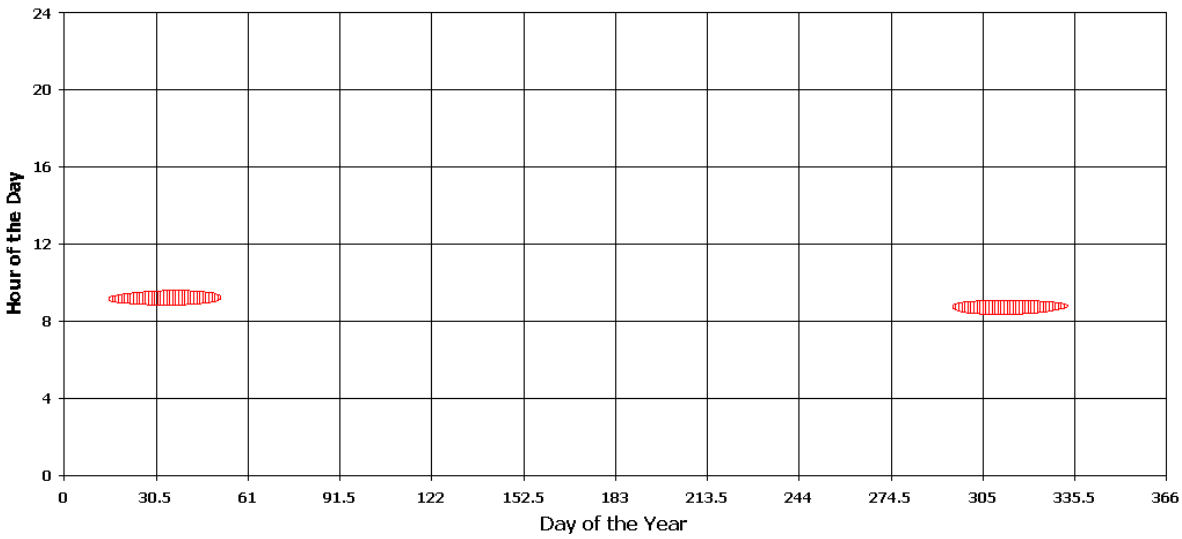
Chart A14.12 Shadow Times at Location 10, Wellesley Road for an east-facing window



Location 11, Ward Street

Chart A14.13 shows the times that shadow flicker have been predicted to occur at Location 11, Ward Street on an east-facing window. As shown on the graph, the effects could occur for short periods during morning hours from mid-January to mid-February and mid-October to late November.

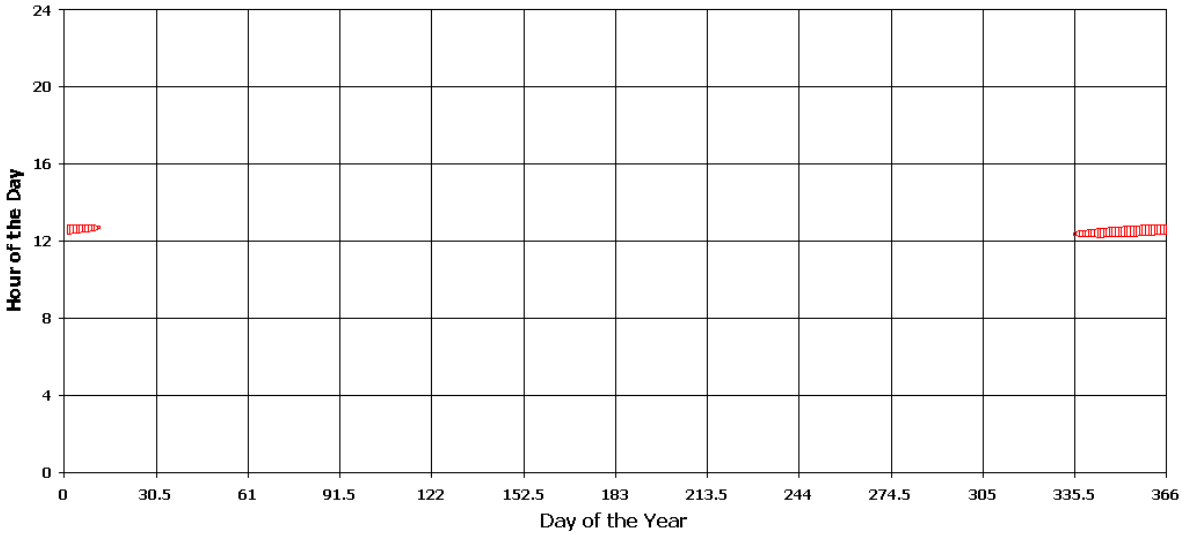
Chart A14.13 Shadow Times at Location 11, Ward Street for an east-facing window



Location 12, Swan Court

Chart A14.14 shows the times that shadow flicker have been predicted to occur at Location 12, Swan Court on a south-facing window. As shown on the graph, the effects could occur for short periods during early afternoon hours from December to mid-January as a worst case scenario, for any window located at 3.0 m AGL. The effect will decrease gradually for windows located at a higher elevation. No effects are predicted for elevations above 33 m.

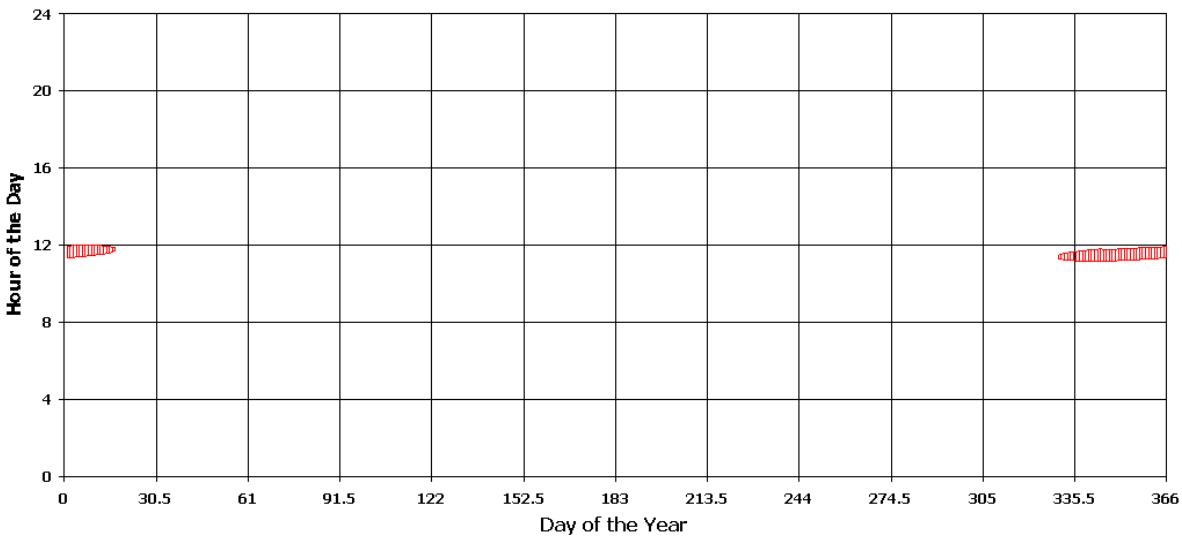
Chart A14.14 Shadow Times at Location 12, Swan Court for a south-facing window



Location 13, Swan View

Chart A14.15 shows the times that shadow flicker have been predicted to occur at Location 13, Swan View on a south-facing window. As shown on the graph, the effects could occur for up to 10.3 hours periods during early afternoon hours from late November to mid-January as a worst case scenario, for any window located at 3.0 m AGL. This gradually decreases for a window located at a higher elevation.

Chart A14.15 Shadow Times at Location 13, Swan View for a south-facing window



Location 14, Wellesley Road

Chart A14.16 shows the times that shadow flicker have been predicted to occur at Location 14, Wellesley Road on an east-facing window. As shown on the graph, the effects could occur for short periods during early morning hours from late February to March and mid-September to mid-October.

Chart A14.16 Shadow Times at Location 14, Wellesley Road for an east-facing window